THE VENUS TABLETS OF *AMMIZADUGA*

A SOLUTION OF BABYLONIAN CHRONOLOGY BY MEANS OF THE VENUS OBSERVATIONS OF THE FIRST DYNASTY

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PREFACE

AS will be seen from Chapter V, the authors have had this work in hand for several years. The greater part was in the hands of the printers in 1926, and, though other parts progressed more slowly, Dr. Fotheringham has thought it undesirable otherwise than in exceptional cases to refer to matter published after the beginning of 1927 or communicated to him privately after that date. None of this matter affects the conclusions at which he arrives.

Although Dr. Fotheringham acknowledges considerable assistance from Herr Schoch, neither is responsible for the views of the other. In order to secure full liberty of expression to Herr Schoch he has been permitted to cover in his chapter on Astronomical and Calendarial Tables some of the matter included in Dr. Fotheringham's chapters and on certain details he has expressed different opinions. Dr. Fotheringham has at Herr Schoch's request supplied the precepts for the use of Tables M and N and has given a purely verbal revision to the rest of the chapter.

Acknowledgements to Professor Schnabel and Dr. Thureau-Dangin for valuable material and suggestions are made in their proper places.

The Tables have been printed by the Isle of Wight County Press and the rest of the work by the Oxford University Press.

Professor Langdon wishes to thank the Trustees of the British Museum and the Keeper of the Department of Egyptian and Assyrian Antiquities for their permission to copy the astronomical texts of that collection which are published in this volume.

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LIST OF ABBREVIATIONS

AB.	*Altorientalische Bibliothek*, ed. EBELING, MEISSNER, and WEIDNER.
AJSL.	*American Journal of Semitic Languages.*
BE.	*Babylonian Expedition of the University of Pennsylvania.*
BH.	*Babylonian Historical Texts*, by SIDNEY SMITH.
BIN.	*Babylonian Inscriptions in the Collection of James B. Nies.*
BM.	British Museum.
BRM.	*Babylonian Records in the Library of J. Pierpont Morgan.*
CT.	*Cuneiform Texts from Tablets in the British Museum.*
EG.	ELIHU GRANT, *Babylonian Business Documents of the Classical Period.*
F.	TH. FRIEDRICH, *Altbabylonische Urkunden aus Sippar, Beiträge zur Assyriologie*, v 4.
Ga.	J. E. GAUTIER, *Archives d'une famille de Dilbat au temps de la première dynastie de Babylone.*
G.	E. M. GRICE, *Records from Ur and Larsa, Yale Oriental Series* V.
HG.	*Hammurabi's Gesetz*, by KOHLER, UNGNAD, and KOSCHAKER.
JAOS.	*Journal of the American Oriental Society.*
JRAS.	*Journal of the Royal Asiatic Society.*
KAH.	*Keilschrifttexte aus Assur historischen Inhalts*; vol. i by L. MESSERSCHMIDT; ii by O. SCHROEDER.
KAV.	*Keilschrifttexte aus Assur verschiedenen Inhalts*, by O. SCHROEDER.
KB.	*Keilinschriftliche Bibliothek.*
M.	B. MEISSNER, *Beiträge zum altbabylonischen Privatrecht.*
MN.	*Monthly Notices of the Royal Astronomical Society.*
MVAG.	*Mitteilungen der Vorderasiatischen Gesellschaft.*
OBI.	*Old Babylonian Inscriptions*, by H. V. HILPRECHT.
OECT.	*Oxford Editions of Cuneiform Texts*, ed. S. LANGDON.
OLZ.	*Orientalistische Literaturzeitung.*
P.	A. POEBEL, *Babylonian Legal and Business Documents*, BE. vi 2.
PBS.	*Publications of the Babylonian Section of the University Museum, Philadelphia.*
PSBA.	*Proceedings of the Society of Biblical Archaeology.*
Raw.	RAWLINSON, *Cuneiform Inscriptions of Western Asia.*
RA.	*Revue d'Assyriologie.*
Ranke.	H. RANKE, *Babylonian Legal and Business Documents*, BE. vi 1.
RFH.	*R. F. Harper Collection* in AJSL. xxxiii, 206 ff.
TD.	F. THUREAU-DANGIN, *Lettres et Contrats de l'époque de la première dynastie babylonienne.*
TSBA.	*Transactions of the Society of Biblical Archaeology.*
VAB.	*Vorderasiatische Bibliothek.*
VS.	*Vorderasiatische Schriftdenkmäler der staatlichen Museen zu Berlin.*
W.	LEROY WATERMAN, *Business Documents of the Hammurabi Period.* Also abbreviation for the Weld Collection in the Ashmolean Museum.
Warka.	J. N. STRASSMAIER, *Die altbabylonischen Verträge aus Warka, Verhandlungen des Fünften Orientalisten-Congresses.*
YBC.	*Yale Babylonian Collection.*
ZA.	*Zeitschrift zur Assyriologie.*
ZDMG.	*Zeitschrift der Deutschen Morgenländischen Gesellschaft.*

CHAPTER I

ANALYSIS OF THE CUNEIFORM TEXTS

THE large tablet K. 160 was first published in III Raw. 63, and was reproduced with transcription and translation by PROFESSOR SAYCE, TSBA. 1874, 316–39. Obverse 1–14 is a duplicate of K. 2321 + 3032 (a neo-Babylonian text published by JAMES A. CRAIG, *Astrological-Astronomical Texts* Pl. 46) Obv. 16–27. These lines contain 6 observations of the heliacal settings of Venus in the east and west for the 7th–11th years of Ammizaduga.[1] K. 160, begins with the heliacal eastern setting of Venus on the 21st of the 5th month in the 7th year of this king. The text of K. 160, 1–30, which contains 14 observations of the same backward and forward movements of Venus across her periods of darkness for the years 7–17 of Ammizaduga, was combined with K. 2321, Obv. 16–27, and the whole was published in this form by VIROLLEAUD, *Ishtār*, No. XII. In this composite text lines 1–15 constitute a new copy of K. 2321, Obv. 1–15; lines 16–27 are made up by combining K. 160, 1–14 with K. 2321, Obv. 16–27. The remaining observations for the years 19–21 of Ammizaduga are continued on K. 160, Rev. 34–46; the observation for the 18th year was suppressed or lost when the long insertion, Obv. 31–Rev. 33, was made in K. 160. This continuation of the original text in Obv. 34–46 was unfortunately detached from the main text and put under a separate number in VIROLLEAUD, *Ishtār* XIV.

By combining K. 2321 Obv. with K. 160, Obv. 1–30 + Rev. 34–46, a complete set of these movements of Venus for the 21 years of Ammizaduga is obtained, with the exception of the data for the year 18. It is obvious even to one possessed of only popular knowledge of astronomy that the text is often corrupt and the various scribes of Nineveh, Babylon, and Kish, whose copies in the 8th and 7th centuries we possess, were extremely careless about their figures. Numerous examples of dittography are indicated in my notes.

Undoubtedly K. 2321, a neo-Babylonian copy, and its duplicate, W. 1924, 802, excavated at Kish, and dated in the reign of Sargon of Assyria, represent the original tablet of the astronomers of Ammizaduga. This original text was made at Babylon, as the colophon of the *Kish tablet* proves, and was incorporated into the series *Enuma Anu Enlil* as the 62nd or 63rd tablet of that astronomical work. Rm. II 531 is a small Assyrian fragment of a duplicate of K. 160 and contains fragmentary lines of the groups for the years 13–17.

The reverse of K. 2321 contains the same observations as those of the 21 years of Ammizaduga on the obverse and on K. 160, but these are arranged according to the settings of Venus in either east or west in order of the months from *Nisan* to *Adar*. This discovery was first published by Dr. PAUL SCHNABEL, ZA. 36, 114–17, and the fact became clear to me,

[1] K. 160 is broken across the upper part and at least 20 lines are lost here. These contained seven observations partially restored from K. 2321. A photograph of K. 160 will be found on the frontispiece of VIROLLEAUD, *L'Astrologie Chaldéenne, Sin.* A small join which restores the beginnings of lines 34–9 of the obverse has been made since this photograph was taken. K. 2321 is also a long thin tablet like K. 160; it is written in neo-Babylonian script and is broken across the middle. Between the end of the obverse and the beginning of the reverse at least 50 lines are lost. I have collated both tablets in the British Museum, and have detected a large number of errors in previous copies. For permission to collate these important texts we are most grateful to DR. HALL, Keeper of the Department of Egyptian and Assyrian Antiquities.

when I discovered the *Kish tablet*, with its peculiar arrangement of groups (*kiṣru*) of these same observations. It was obvious that the scribe was grouping the observations by months here. I was requested by SCHNABEL and FOTHERINGHAM to collate all the tablets which contain the name *Ninsianna* for Venus. This was the name of Venus current in the late Sumerian period and in the time of the First Dynasty.[1] I also copied S. 174 and observed its similarity to K. 160 and 2321; the eastern and western settings do not occur in their natural order here, but are arranged on some other principle. In collating Rm. 134 and K. 7072 = VIROLLEAUD, *Suppl.* p. 48, it became evident, at once, that the scribe had arranged the settings of Venus, both eastern and western, beginning with *Nisan* and proceeding to *Ayar*.[2] By reconstructing the Reverse of K. 2321 with the aid of Rm. 134, K. 7072, S. 174 and W. 802 (which completed all the first lines of the original document), I was able to obtain duplicates and restorations of a great number of the observations on the obverse and on K. 160.

The scribe, who compiled the document K. 160, probably did not copy for the series *Enuma Anu Enlil*. For some reason he copied the original observations of the 21 years from the obverse of the Babylonian tablet and then inserted a long reconstruction, taken from some other Babylonian tablet, on the periods of visibility in the east and west. The compilers of the Babylonian and Kish tablets had arranged the observations of the 21 years of Ammizaduga in the order of the monthly settings, and we know from Rm. 134, K. 7072 and S. 174, that this text also existed at Nineveh. The omens depend upon the months of the *risings* and consequently this scribe, having more interest in astrology than in astronomy, has made an artificial set of Venus risings in consecutive monthly order throughout the year, assuming a regular period of visibility in east and west of 8 months and 5 days, a regular interval of invisibility between eastern setting and western rising of 3 months, and a regular period of invisibility between western setting and eastern rising of 7 days. He begins with an eastern rising in *Nisan*, but there is no *Nisan* rising, either eastern or western, in the Ammizaduga observations; moreover, in this scheme of monthly risings no allowance is made for intercalary months, and consequently the composition has no relation at all to the Ammizaduga observations. The scribe assumes a constant value of 30 days for the month. The scribe's scheme has scientific value only for reckoning the average periods of the ~~various~~ appearances of Venus, whose regular period is 584 days. The scribe assumes a period of 19 months 17 days for the period of Venus (8 months 5 days in east + 3 months' invisibility + 8 months 5 days in west + 7 days' invisibility = 19 months 17 days = 587 days). By assuming 360 days for the year he must add 5 or 6 days to the date of any appearance and then add 19 months 17 days to obtain the next corresponding appearance. Thus, in the first group the eastern rising is I 2 and the next eastern rising will be VIII 19 + 6 = VIII 25, as given in Group 12. But the risings exhibited in this scheme have no historical relation to each other and must have been selected from a large number of Venus observations in the records of previous centuries.

More interesting is a comparison of the omens on this document with those of the original document. The scribe indicates clearly enough that the omens are taken from the *risings* only. 'The heart of the land will be happy' occurs here with *Ulul* and *Tebit*, but with *Ulul* and *Adar* on the Ammizaduga documents. 'The harvest of the land will be successful' occurs with *Tebit*,

[1] See Langdon, *Tammuz and Ishtar*, 175.

[2] SCHIAPARELLI had already made this discovery in 1912, on the basis of K. 2321, and it is doubtful whether I should have seen the importance of Rm. 134 and K. 7072 if SCHNABEL and FOTHERINGHAM had not requested me to collate them.

Tammuz, *Ulul*, *Tešrit*, *Araḫsamna* and *Šabat* = *Ayar*, *Tešrit*, *Tebit*, and *Adar* of the Ammizaduga texts. 'King shall send greetings to king' in *Šabat* and *Adar* of the old source does not occur at all in his text! 'King shall send challenge of war to king' occurs in *Adar*, only, = *Adar*, only, in the Ammizaduga texts.

'Destruction shall be (in the land)' or 'calamity shall be, in the land' occurs in *Nisan*, *Ab*, *Araḫsamna*, = *Ab*, *Araḫsamna*, *Kislev*, of the old source, which uses only 'destruction shall be wrought'. But a *Nisan* rising did not occur in the Ammizaduga observations; consequently we have no indication of the character of that month there. Omens of rains and floods are entirely omitted in this text. *Kislev* is associated with 'dearth of grain and straw', as in the Ammizaduga texts. A rising in *Sivan* means calamity to the army of the Babylonians as in the omen for the years 8–9 on the old source. 'There will be hostilities in the land' occurs with *Ayar*, *Tammuz*, *Tešrit* = *Ayar*, *Tešrit*, in the Ammizaduga sources.

It is obvious that the omens of this inserted artificial text of K. 160 agree almost completely with those of the old source. *Ab*, *Sivan*, *Araḫsamna* and *Kislev* are clearly months of evil omen for Venus risings. Definitely propitious for Venus risings are *Ulul*, *Tebit*, *Šabat*, and *Adar*.

OMENS OF THE ORIGINAL SOURCE.

Setting.	*Rising.*	*Omen.*
Nisan—East	Ulul—West	*libbi mati iṭâb.* Year 12.
Nisan—West	Ayar—East	*nukurāti ina māti ibaššû ebur māti iššir.* Year 21.
Ayar—West	Ayar—East	*zunné u mîlé ibaššû ebur māti iššir.* Year 5.
Ayar—West	Ayar—East	*ebur mati iššir.* Year 13.
Sivan—East	Ulul—West	*libbi māti iṭâb.* Year 20.
Tammuz—East	Ulul—West	*libbi māti iṭâb.* Year 4.
Tammuz—West	Tammuz—East	*zunné ina šamé mîlé ina naḳbé ibaššû.* Year 16.
Tammuz—West	Ab—East	*zunné ina māti ibaššû arbûtu iššakan.* Year 8.
Ab—East	Araḫsamna—West	*zunné ina māti ibaššû arbûtu iššakan.* Year 15.
Ab—East	Araḫsamna—West	*zunné ina māti ibaššû arbûtu iššakan.* Year 7.
Ulul—West	Tešrit—East	*nukuratum ina māti ibašši ebur māti iššir.* Year 3.
Ulul—West	Ulul^{2}—East	*libbi māti iṭâb.* Year 11.
Tešrit—West	Araḫsamna—East	*zunné ina māti ibaššû arbûtu iššakan.* Year 14.
Araḫsamna—West	Kislev—East	*ḫušaḫḫi še'im u tibni ina māti ibašši arbûtu iššakan.* Year 6.
Araḫsamna—East	Tebit—West	*ebur māti iššir.* Year 2.
Araḫsamna—East	Tebit—West	*ebur māti iššir.* Year 10.
Kislev—East	Šabat—West	*ebur māti iššir.* Year 13.
Kislev—East	Šabat—West	*ebur māti iššir.* Year 5.
Tebit—East	Adar—West	*šarru ana šarri ṣalta išappar.* Year 21.
Šabat—West	Šabat—East	*tapdê šarrāni ^{d}Adad zunnê-šu ^{d}Ea naḳbê-šu ubbalam šarru ana šarri šulma išappar.* Year 1.
Adar—East	Sivan—West	*šumḳût umman māti.* Years 8–9.
Adar*—West	Adar—East	*šarru ana šarri šulmā išappar.* Year 9. Variant *ṣalta išappar.*
Adar—West	Adar—East	*ebur (mati) iššir šarru libbi māti iṭâb.* Year 17.
Adar—East	Sivan—West	*šumḳûtim umman-manda eli napḫari-(šunu šarru ibêl).* Years 16–17
Ulul^{2}—West	Ulul^{2}—East	*tapdû ina māti ruḳti ibašši: ina ekalli amtu. . .* Year 19.

It will be noted that 'the heart of the land will be happy' occurs only with risings in *Ulul*, *Adar*, and intercalary *Ulul*. 'The harvest of the land will prosper' occurs with risings in *Ayar*,

* Text Sivan.

Tešrit, *Tebit*, and *Šabat*. 'King shall send greetings to king' occurs with risings in *Šabat* and *Adar*, and 'King shall send challenge of war to king' is found also with an *Adar* rising.[1] 'Destruction shall be wrought' occurs with risings in *Ab*, *Araḫsamna*, *Kislev*. 'Rains and floods' occur with risings in *Ayar*, *Tammuz*, *Ab*, *Araḫsamna*, *Šabat*; this omen occurs in months both propitious and nefast. A rising in *Kislev* is regarded as particularly nefast:—'Dearth of grain and straw will be in the land *but the harvest will prosper*.' The nature of the omen seems to depend almost entirely on the month of *rising*. *Ayar*, *Ulul*, *Tebit*, *Šabat* and *Adar* are clearly propitiou smonths, especially for harvests. *Ab*, *Araḫsamna*, and *Kislev* are clearly nefast. Two risings in *Sivan* occur, one denoting the destruction of the Babylonian army, and the other the destruction of the *Umman-manda*, hence the month was either indeterminate, or (and this is more probable) we have here references to historical events as in the Sargon liver omens and many others.

OMENS OF THE RISINGS ON THE K. 160 INSERTION.

Rising.	*Omen.*
1. Nisan—East	*urubatum ina māti ibaššá.*
Adar—West	*šarru ana šarri nukurta išappar.*
2. Ayar—West	*nukurāti ina māti ibaššá.*
Tebit—East	*ebur māti iššir libbi māti iṭáb.*
3. Sivan—East	*miḳitti umman matti.*
Ayar—West	*nukurāti ina māti ibaššá.*
4. Tammuz—West	*nukurāti ina māti ibaššá.*
Adar—East	*šarru ana šarri nukurta išappar.*
5. Ab—East	*arbûtu ibašši.*
Tammuz—West	*nukurāti ina māti ibaššá ebur māti iššir.*
6. Ulul—West	*ebur māti iššir libbi māti iṭáb.*
Ayar—East	*nukurāti ina māti ibaššá.*
7. Tešrit—East	*nukurāti ina māti ibaššá ebur māti iššir.*
Ulul—West	*ebur māti iššir libbi māti iṭáb.*
8. Araḫsamna—West	*mata dannatu iṣabbat.*
Tammuz—East	*nukurāti ina māti ibaššá ebur māti iššir.*
9. Kislev—East	*ḫušaḫḫi še'im u tibni ina māti ibašši.*
Araḫsamna—West	*ebur māti iššir*
10. Tebit—West	*ebur māti iššir.*
Ulul—East	*ebur māti iššir libbi mati iṭáb.*
11. Šabat—East	*ebur māti iššir.*
Tebit—West	[*ebur māti iššir.*]
12. Adar—West	*šarru* [*ana šarri nukurta išappar*]. Cf. Groups 1 and 4.
Araḫsamna—East	*mata dannatu iṣabbat.*

[1] Also on Var. for ninth year.

TABLE OF THE RISINGS, SETTINGS, AND PERIODS OF VISIBILITY AND INVISIBILITY.

Sources.	*Year.*	*WS.*	*Interval.*	*ER.*	*K. 2321, Rev.*	*WS.*	*Interval.*	*ER.*	*Variants.*		
										WS.	*ER.*
K. 2321, 1–3	1	XI 15	3 days	XI 18	22–23	XI 25	3 days	XI 28			
6–7	3	VI 23	20 days	VII 13	7–8	VI 23	20 days	VII 13			
10–11	5	II 2	15 days	II 18	Rm. 134, 7–9	II 2	[15 days	II 18]	K. 7072	II 2	[II 18]
14–15	6	VIII 28	3 days	IX 1	K. 2321, 13–17	VIII 28	5 days	[IX 3]	W. 802	VIII 28?	IX 1
K. 160, Obv. 4–6 + K.2321, 18–19	8	IV 25	7 days	V 2							
K. 160, 9–10 + 2321, 22–3	9	XII 11	4 days	XII 15	26–27	[XII 11]	4 days	[XII 15]			
K. 160, 13–14 + 2321, 26–7	11	VI 26	11 days	VI² 7	9–10	VI 26	12 days	VI² 8			
K. 160, 17–18	13	II 5	7 days	[II 12]	—	—	—	—	Rm. II 531		II 12
K. 160, 20–21	14	VII 10	1 month 16 days	VIII 26*	10–12 W. 802, R. 12–13	VII 11	1 month 17 days	VIII 28 VIII 27	Rm. II 531	VII 10	VIII 26
K. 160, 24–5	16	IV 5	15 days	IV 20	—	—	—	—	Rm. II 531	IV 4	IV 20
K. 160, 28–9	17	XII 11	4 days	XII 15	26–27	[XII 11]	4 days	[XII 15]			
K. 160, R. 34–6	19	VI² 1	15 days	VI² 17							
K. 160, R. 40–2	21	I 27	7 days	II 3	Rm. 134; K. 7072	I 26	6 days	II 3			

Sources.	*Years.*	*ES.*	*Interval.*	*WR.*	*K. 2321, Rev.*	*ES.*	*Interval.*	*WR.*	*Variants.*		
										ES.	*WR.*
K. 2321, Obv. 4–5 W. 802	2	VIII 11	2 months 7 days	X 19	15	[VIII 11]	2 months 8 days	X 19			
8–9 W. 802	4	IV 2	2 months 1 day	VI 3							
12–13	5	IX 12	2 months 4 days	XI 16	19	[IX 24]	2 months 4 days	XI 28	W. 802	IX 25	XI 29
K.160,1–3,K.2321, Obv. 16–17	7	V 21	2 months 11 days	VIII 2	5–6	—	—	—	W. 802 16–17		
K.160,7–8. K.2321, 20–1	8–9	XII 25	[2 months 7 days]	[III 2]	24–5	[XII 25]	2 months 7 days	[III 2]			
K. 160, 11–12. K. 2321, 24–5	10	VIII 10	2 months 6 days	X 16	16	[VIII 8]	2 months 8 days	X 16			
K. 160, 15–16	12	I 9	5 months 16 days	VI 25	Rm. 134, 1–3. K. 7072, 2–3	I 8	5 months 17 days	VI 25			
K. 160, 18–19	13	[IX] 20	2 months	XI 21	K. 2321, R. 17–18	[IX] 21	2 months	[XI 21]	Rm. II 531	X 21	XI 11
22–3	15	V 20	2 months 15 days	VIII 5	—	—	—	—	Rm. II 531	V 21	IX 5
26–7	16–17	XII 25	3 months 9 days	III 2[4]	—	—	—	—	Rm. II 531	XII 15	[III 24]
Lost on K. 160.	18										
K. 160, R. 37–9	20	III 25	2 months 6 days	VI 24†							
43–5	21	X 28	[2 months]	XII 28	20–21	[X 28]	2 months	[XII 28]			

WS. = Western setting. *WR.* = Western rising. *ES.* = Eastern setting. *ER.* = Eastern rising.

* See notes on K. 2321, R. 12. † Read VI 1.

PLAN OF THE INSERTION IN K. 160, OBV. 31—REV. 33.

Rising.	*Period of Visibility.*	*Setting.*	*Interval.*	*Rising.*
1. I 2 East	8 months 4 days	IX 7 East	3 months	XII 8 West
2. II 3 West	8 months 3 days	X 7 West	7 days	X 15 East
3. III 4 East	8 months 4 days	XI 8 East	3 months	II 9 West
4. IV 5 West	8 months 4 days	XII 10 West	7 days	XII 17 East
5. V 6 East	8 months 4 days	I 11 East	3 months	IV 11 West
6. VI 7 West	8 months 4 days	II 12 West	7 days	II 19 East
7. VII 8 East	8 months 4 days	III 13 East	3 months	VI 13 West
8. VIII 9 West	8 months 4 days	IV 14 West	7 days	IV 21 East
9. IX 10 East	8 months 4 days	V 15 East	3 months	VIII 15 West
10. X 11 West	8 months 4 days	VI 16 West	7 days	VI 23 East
11. XI 12 East	8 months 4 days	VII 17 East	3 months	X 17 West
12. XII 13 West	8 months 3 days	VIII 17 West	7 days	VIII 25 East

CHAPTER II

TRANSCRIPTION AND TRANSLATION

K. 160, *Obverse*

1. [*šumma ina araḫ Abi ûm 21-kam* ^d.^*Nin-sī-an-na ina ṣit šamši*][1] *bal-it*
2. [*2 arḫê ûmī 11-kam ina šamê iḫ-ḫa-ram-ma*][1] *ina araḫ Araḫsamna ûm 2-kam* ^d.^*Nin-sī-an-na*
3. [*ina erīb šamši innamir*] *zunnê ina māti ibaššû ár-bu-tu iššakan*

If on the 21st of Ab Venus disappeared in the east, remaining absent in the sky for two months and 11 days, and in the month Araḫsamna on the 2nd day Venus was seen in the west, there will be rains in the land; desolation will be wrought. [7th year]

4. *šumma ina araḫ Du'uzi ûm 25-kam* ^d.^*Nin-sī-an-na ina erib šamši it-bal*
5. *ûmī 7-kam ina šamê iḫ-ḫá-ram-ma ina araḫ Ab ûm 2-kam* ^d.^*Nin-sī-an-na*
6. *ina ṣit šamši innamir zunnê ina māti ibaššû ár-bu-tu iššakan*

If on the 25th of Tammuz Venus disappeared in the west, for 7 days remaining absent in the sky, and on the 2nd of Ab Venus was seen in the east, there will be rains in the land; desolation will be wrought. [8th year]

7. *šumma ina araḫ Adar ûm 25-kam* ^d.^*Nin-sī-an-na ina ṣit šamši it-bal.* [8th + 9th years]

If in the month Adar on the 25th day, Venus disappeared in the east,[2] . . . . . .

8. *mu* ^giš^*dúr-gar kug-gi-ga*[3]*-kam*

Year of the golden throne. For restoration, v. K. 2321, R. 24–5.

9. *šumma ina araḫ Sivan*[4] *ûm 11-kam* ^d.^*Nin-sī-an-na ina erīb šamši it-bal 9 arḫê ûmī 4-kam ina šamê iḫ-ḫa-ram-ma*
10. *ina araḫ Adar ûm 15-kam ina ṣit šamši innamir šarru ana šarri šulma išapp-ár*

If on the 11th of Sivan[5] Venus disappeared in the west, remaining absent in the sky for 9 months and 4 days, and on the 15th of Adar she was seen in the east, king shall send greetings[6] to king. [9th year]

11. *šumma ina araḫ Araḫsamna ûm 10-kam* ^d.^*Nin-sī-an-na ina ṣit šamši it-bal 2-arḫê ûmī 6-kam*[7] *ina šamê iḫḫaram-ma*[8]
12. *ina araḫ Ṭebet ûm 16-kam ina erib šamši innamir ebūr māti iššir.*

[1] Restored from K. 2321, Obv. 16.

[2] The period of absence and the date of the western rising were omitted or suppressed to insert the date formula.

[3] The ideogram for 'gold' is usually read *guškin* = *ḫurāṣu*, but in all the variants for this passage the phonetic complement *ga* indicates a Sumerian word ending in *g*. See also PBS. X 20, 12 = AJSL. 39, 180, 12. This is the date formula of the *eighth* year of Ammizaduga; for the more complete forms see Poebel, BE. VI p. 100. In the preceding year, when this event actually occurred, this king placed a golden throne and his statue in Enamtila, which usually refers to the chapel of Enlil in Ekur at Nippur, see Langdon, *Babylonian Liturgies*, p. 134. But there was a chapel of Gula-Bau in Babylon, probably in Esagila, and this date formula undoubtedly refers to that chapel. See also Langdon, *Babylonian Wisdom*, 64, 7.

[4] So the text clearly on K. 2321, Obv. 22.

[5] *Sivan*, the 3rd month, must be changed to *Adar*. the 12th month, and the 9 months which follow are to be struck out. In other words, the scribe was operating with *figures*, not names of months, and 9 months were inserted in the wrong place. See note on K. 2321, Rev. 25, and Obv. 22.

[6] Var. K. 2321, Obv. 23 has *ṣalta išapp-ar*, shall send declaration of war.

[7] K. 2321, R. 16 as 8 here.

[8] Written *NI-ma*, but Var. K. 2321, Obv. 24, *iḫ-ḫa-ram-ma*.

If on the 10th of Araḫsamna Venus disappeared in the east, remaining absent 2 months and 6 days in the sky, and was seen on the 16th of Tebit in the west, the harvest of the land will be successful. [10th year]

13. *šumma ina araḫ Ululi ûm 26-kam* ᵈ·*Nin-sī-an-na ina erīb šamši it-bal ûmī 11-kam ina šamê iḫḫaram-ma*
14. *ina araḫ Ululi šani ûm 7-kam ina erīb šamši*[1] *innamir libbi māti iṭa-ab*

If on the 26th of Ulul Venus disappeared in the west, remaining absent in the sky 11 days, and was seen on the 7th of intercalary[2] Ulul in the east, the heart of the land will be happy. [11th year]

15. *šumma ina araḫ Nisani ûm 9-kam* ᵈ·*Nin-sī-an-na [ina ṣit šamši] it-bal 5-arḫê ûmī 16-kam ina samê [iḫḫaram-ma]*
16. *ina araḫ Ululi ûm 25-kam ina erīb šamši innamir libbi māti [iṭa-ab]*[3]

If on the 9th of Nisan Venus disappeared in the east, remaining absent in the sky 5 months and 16 days, and was seen on the 25th of Ulul in the west, the heart of the land will be happy. [12th year]

17. *šumma ina araḫ Aiari ûm 5-kam* ᵈ·*Nin-sī-an-na ina erīb šamši it-bal 7 (?) û-mi ina šamê iḫ-ḫaram-ma [ina araḫ Aiari ûm 12(?)-kam*[4]
18. *ina ṣit šamši innamir ebur māti iššir : [šumma ina araḫ Ṭebeti]*[5] *ûm 20*[6]*-kam ina ṣit šamši it-bal [1 arḫam ina šamê iḫḫaramma]*[7]
19. *(ina ṣit šamši it-bal ûmī 16-kam ina šamê iḫḫaram-ma)*[8] *ina araḫ Šabaṭi ûm 21-kam ina erīb šamši [innamir ......*[9]*]*

If on the 5th of Ayar Venus disappeared in the west, remaining absent in the sky 7 (?) days, and she appeared in the east on the 12th (?) of Ayar, the harvest of the land will be successful. If on the 20th of Tebit (?) she disappeared in the east, remaining absent in the sky one month, and on the 21st[10] of Šabat she appeared in the west. [13th year]

20. *šumma ina araḫ Tešrit ûm 10-kam* ᵈ·*Nin-sī-an-na ina ṣit šamši it-baι araḫ ûmī 16-kam [ina šamê iḫḫaramma]*
21. *ina araḫ Araḫsamma ûm 26-kam ina erīb šamši innamir zunnê ina māti ibaššû [ár-bu-tu iššakan]*

If on the 10th of Tešrit Venus disappeared in the west, remaining absent in the sky 1 month

NI=*uḫḫuru*, to loiter, with *ùr-lal*, 'to bind the legs', = *uḫḫuru*, II R. 47, Rev. 57. The Sumerian value is *zal*, to loiter, hence *gù-zal* = *guzallu*, *gišḫappu*, *nu'u*, *aḫurû*, loiterer, indolent person, imbecile, RA. 11, 124, R. 1 = BM. 38372, Rev. 10–14.

[1] So the text. Obviously an error for *ṣit šamši*, sunrise.

[2] Hence the 11th year of Ammizaduga was an intercalary year, and so was the 10th year. See KUGLER, *Sternkunde*, II 250.

[3] Rm. 134, 1–3 has *Nisan* 8 and an interval of 5 months, 17 days. Both have *Ulul* 25 (collated).

[4] Figures apparently assured by Rm. II 531, 1–2.

[5] Traces on K. 160 may be *KAN* or *AB*, but Rm. II 531, 3 favours *AB*. This line is repeated on K. 2321, Rev. 17–18, where the interval is 2 months and no space for the days, and the month names are lost.

[6] Rm. II 531, 3 has 21 here.

[7] At the end of line 18 there is a long break.

[8] The text enclosed in parentheses has been displaced from line 20.

[9] Restore *ebur mati iššir*, from K. 2321, R. 18.

[10] I read 21 on the tablet clearly. Rm. II 531, 4 has 11 plainly.

and 16 days, and appeared in the east on the 26th of Araḫsamna, there will be rains in the land;[1] desolation will be wrought. [Year 14]

22. *šumma ina araḫ Abi ûm 20-kam* ᵈ·*Nin-sī-an-na ina ṣit šamši it-bal 2 arḫê ûmī 15-kam*[2] *[ina šamê iḫḫaram-ma]*
23. *ina araḫ Araḫsamna ûm 5-kam*[2] *ina erīb šamši innamir zunnê ina māti ibaššû a[r-bu-tu iššakan]*

If on the 20th of Ab Venus disappeared in the east, [remaining absent in the sky] 2 months and 15 days, and appeared in the west on the 5th of Araḫsamna, there will be rains in the land; desolation will be wrought. [15th year]

24. *šumma ina araḫ [Du'uzi] ûm 5-kam*[3] ᵈ·*Nin-sī-an-na ina erīb šamši it-bal ûmī 15-kam [ina šamê iḫḫaram-ma]*
25. *ina araḫ [Du'uzi]*[4] *ûm 20-kam ina erīb šamši*[5] *innamir zunnê ina šamê mîlê ina naḳbê ibbaššû*

If on the 5th of [Tammuz] Venus disappeared in the west, [remaining absent in the sky] 15 days, and on the 20th of [Tammuz] appeared in the east, there will be rains in heaven and floods in the springs.[6] [16th year]

26. *šumma ina araḫ Adari ûm 25-kam* ᵈ·*Nin-sī-an-na ina ṣit šamši it-bal 3 arḫê ûmī 9-kam [ina šamê iḫḫaram-ma]*
27. *ina araḫ Simāni ûm 20(?)-kam ina erīb šamši innamir šumḳu-tim ummān-man-da*[7] *eli*[8] *napḫa-ri-[šu-nu šarru ibe-el]*

If on the 25th of Adar Venus disappeared in the east, [remaining absent in the sky] 3 months and 9 days, and appeared in the west on the 20th(?) of Sivan,[9] disaster of the Manda hordes; *over all of them the king shall rule.* [16th and 17th years]

[1] If *Araḫsamna* in line 21 be correct then *Tešrit* must be read in line 20, and the traces of this blurred sign seem to indicate *DUL*, as written in Rev. 9, i.e. *Tešrit*. The entire text in lines 20–21 is suspect; for the western setting and eastern rising should appear here. Note that the corrupt text at the beginning of line 19 has also 16 days, which is probably an insertion there, from line 20. The prototype of lines 18–21 has been incurably confused in transmission. *ina ṣit šamši it-bal ûmi 16-kam ina šamê iḫḫaram-ma* of line 19 has been taken from line 20, where *erīb šamši* stood originally. *erīb šamši* was changed to *ṣit šamši* by dittography with line 18, and the insertion in line 19 with *ṣit šamši* caused the original of line 20 to be corrupted to *ṣit šamši* also. Lines 20–21 must surely be corrected to western setting on the 10th of Tešrit, eastern rising on 26th of *Araḫsamna*. See the same errors in Rm. II 531, 5–6! Correct text on K. 2321, R. 11–12?

[2] Text clearly 15 and 5. See also photograph. Rm. II 531 has 21 in line 22, and *Kislev* for *Araḫsamna* in line 23.

[3] Rm. II 531, 10, has 4 here.

[4] *Du'uzu* is clear on Rm. II 531, 11.

[5] Sic! Read *ṣit šamši.*

[6] The figure 5 is fairly certain in line 24. Traces of *ŠU* for the month-name remain in both lines.

[7] The Ummān-Manda are the Cimmerians, CT. 34, 10, 16. According to FORRER, ZDMG. vol. 76, they were an Aryan people; WEIDNER, *Rivista degli Studi Or.*, IX 292, describes them as Indo-Germanic. See also STRECK, *Assurb.*, p. ccclxxv. They are mentioned in the *Hittite Law Code*, ZIMMERN, *Der Alte Orient*, 23 Heft 2, p. 14, § 55. But in the royal inscriptions of the neo-Babylonian Empire, the Ummān-Manda are certainly identical with the *Madai*, Medes; v. THUREAU-DANGIN, RA. 22, 28, 11, and GADD, *Fall of Nineveh*, 35, 59. The term is, therefore, applied to peoples who were nomads, and does not always indicate the same race. Cf. VIROLLEAUD, *Adad*, X 11, *tibût ummān dadme*. uprising of people of fixed abode, and *tibût Ummān-man-da*, *Sin*, III 7; XXXIII 30; *Ishtār*, XXI 42, 95, &c.

[8] *SU.*

[9] If *Adar* 25 in line 26 and the interval 3 months and 9 days be correct, then Venus would have risen on the 4th of *Tammuz*. But Rm. II 531, line 12, has *Adar* 15th for *Adar* 25th. If this be correct then *Sivan* 24 should stand in line 27.

28. *šumma ina araḫ Adari ûm 11-kam*[1] *d. Nin-sī-an-na ina e[rīb šamši] it-bal ûmī 4-kam ina šamê [iḫḫaram-ma]*
29. *GAB-BE* (?) ..... *ûm* [15-*kam innamir*] *ebūru* (*KI-A*)[2] *iššir libbi māti iṭa-ab*

If on the 11th of Adar Venus disappeared in the west, remaining absent 4 days in the sky and appeared [again in the east] on the [15th] day, the harvest will be successful; the heart of the land will be happy. [17th year]

30. *GAB* .... *din ša-ru zunnu šal-gu*[3] ....

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31. *šumma ina araḫ Nisanni ûm 2-kam d. Nin-sī-an-na ina ṣit šamši innamir ú-ru-ba-tum ina māti ibaššâ*
32. *adi ûm 6-kam šá araḫ Kislimi ina ṣit šamši izza-az ûm 7-kam ša araḫ Kislimi i-tab-bal-ma 3 arḫê ina šamê*
33. *iḫ-ḫa-ram-ma ûm 8-kam*[4] *ša araḫ Adari d. Nin-sī-an-na ina erīb šamši inappaḫ-ma šarru ana šarri nukurta išappa-ár*

If on the 2nd of Nisan Venus appeared in the east, distress will be in the land. Until the 6th of Kislev she will stand in the east; on the 7th of Kislev she will disappear, and, having remained absent 3 months in the sky, on the 8th of Adar Venus will shine forth in the west: king will declare hostility against king.

34. *šumma ina araḫ Aiari ûm 3-kam*[5] *d. Nin-sī-an-na ina erīb šamši innamir nukrāti ina māti ibaššâ*
35. *adi ûm 6-kam šá araḫ Ṭebiti ina erīb šamši izza-az ûm 7-kam šá araḫ Ṭebiti i-tab-bal-ma*
36. *ûmī 7-kam ina šamê iḫ-ḫa-ram-ma ûm 15-kam šá araḫ Ṭebiti d. Nin-sī-an-na*
37. *ina ṣit šamši inappaḫ-ma ebūr māti iššir libbi māti iṭa-ab*

If on the 3rd of Ayar Venus appeared in the west, there will be hostilities in the land; she will stand in the west until the 6th of Tebit; on the 7th of Tebit she will disappear, and, having remained absent 7 days in the sky, on the 15th of Tebit Venus will shine forth in the east; the harvest of the land will be successful; the heart of the land will be happy.

38. [*šumma ina araḫ*] *Simāni ûm* [4-]*kam d. Nin-sī-an-na ina ṣit šamši innamir miḳitti*[6] *ummān ma-at-ti*
39. [*adi*] *ûm 8-kam*[7] [*ša araḫ šabati*] *ina ṣit šamši izza-az ûm 8-kam*[7] *ša araḫ šabati it-tab-bal-ma*
40. [3] *arḫê ina šamê iḫ-ḫa-ram-ma ûm 9-kam ša araḫ Aiari d. Nin-sī-an-na*
41. [*ina*] *erīb šamši inappaḫ-ma nukrāti ina māti ibaššâ*

If on the [4th] of Sivan Venus appeared in the east, there will be a catastrophe of the army of the (home)-land. Until the 8th of Šabat she will stand in the east; on the 8th of Šabat she will disappear,[8] and, having remained absent [3] months in the sky, on the 9th of Ayar Venus will shine forth in the west; there will be hostilities in the land.

[1] Only the figure 10 is certain here. The stroke for the unit 1 is very doubtful. Only 10 or 11 is possible.

[2] WEIDNER, *Handbuch*, 174, suggested that *KI-A = eburu*; he compared *KI-A iššir*, THOMPSON, *Reports*, 253 A 2, with *eburu iššir* in 253, 2, &c. See K. 2321, R. 27.

[3] These signs are all uncertain.

[4] KUGLER corrects this figure to 7.

[5] This figure is on a new join or flake, now added to the tablet.

[6] *RI-RI-GA*. Cf. VIROLLEAUD, *Ishtār*, XX 85, with THUREAU-DANGIN, URUK. 30, 9.

[7] The figure 8 is certain in both places in line 39.

[8] 'Be taken away'.

42. [*šumma ina araḫ*] *Du'uzi ûm 5-kam d. Nin-sī-an-na ina erīb šamši innamir nukrāti ina māti ibaššâ ebūr māti iššir*
43. *adi ûm 9-kam ša araḫ Adari ina erīb šamši izza-az ûm 10-kam ša araḫ Adari ittabbal-ma*
44. *ûmī 7(?)-kam ina šamê iḫ-ḫa-ram-ma ûm 17-kam ša araḫ Adari d. Nin-sī-an-na*
45. *ina ṣit šamši inappaḫ-ma šarru ana šarri nukurta išappa-ár*

If on the 5th of Tammuz Venus appeared in the west, there will be hostilities in the land; the harvest of the land will be successful. Until the 9th of Adar she will stand in the west and on the 10th of Adar she will disappear, and, having remained absent in the sky 7 days, on the 17th of Adar Venus will shine forth in the east; king will declare hostility against king.

K. 160, *Reverse*.[1]

1. *šumma ina araḫ Abi ûm-6-kam d. Nin-sī-an-na ina ṣit šamši innamir zunnê ina šamê ibbaššû ár-bu-tu ibašši*
2. *adi ûm 10-kam šá araḫ Nisanni ina ṣit šamši izza-az ûm 11-kam ša araḫ Nisanni i-tab-bal-ma*
3. *3 arḫê ina šamê iḫḫaram-ma ûm 11-kam šá araḫ Du'uzi d. Nin-sī-an-na ina erīb šamši inappaḫ-ma*
4. *nukrāti ina māti ibaššâ ebūr māti iššir*

If on the 6th of Ab Venus appeared in the east, there will be rains in heaven; there will be disaster. Until the 10th of Nisan she will stand in the east; on the 11th of Nisan she will disappear, and, having remained absent 3 months in the sky, on the 11th of Tammuz Venus will shine forth in the west; hostilities will be in the land; the harvest of the land will be successful.

5. *šumma ina araḫ Ululi ûm 7-kam d. Nin-sī-an-na ina erīb šamši innamir*[2] *ebūr māti iššir libbi māti iṭa-ab*
6. *adi ûm 11-kam šá araḫ Aiari ina erīb šamši izza-az ûm 12-kam šá araḫ Aiari i-tab-bal-ma*
7. *7 û-mi ina šamê iḫ-ḫa-ram-ma ûm 19-kam šá araḫ Aiari d. Nin-sī-an-na*
8. *ina ṣit šamši inappaḫ-ma nukrati ina māti ibaššâ*

If on the 7th of Ulul Venus appeared in the west, the harvest of the land will be successful; the heart of the land will be happy. Until the 11th of Ayar she will stand in the west and on the 12th of Ayar she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 19th of Ayar; hostilities will be in the land.

9. *šumma ina araḫ Tešriti ûm 8-kam d. Nin-sī-an-na ina ṣit šamši innamir nukrāti ina mātāti ibaššâ ebūr māti iššir*
10. *adi ûm 12-kam šá araḫ Simāni ina ṣit šamši izza-az ûm 13-kam šá araḫ Simāni i-tab-bal-ma*
11. *3 arḫê ina šamê iḫ-ḫa-ram-ma ûm 13-kam šá araḫ Ululi d. Nin-sī-an-na*
12. *ina erīb šamši inappaḫ-ma ebūr māti iššir libbi māti iṭa-ab*

If on the 8th of Tešrit Venus appeared in the east, hostilities will be in the land; the harvest of the land will be successful. Until the 12th of Sivan she will stand in the east and on the 13th of Sivan she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 13th of Ulul: the harvest of the land will be successful: the heart of the land will be happy.

[1] III Raw. 63 Rev. 1 = VIROLLEAUD, *Ishtār*, XIII 16.

[2] Written *IGI*; *GAB* omitted. Also in lines 13, 17, 21, 25, 29.

13. *šumma ina araḫ Araḫsamna ûm 9-kam d.Nin-sī-an-na ina erīb šamši innamir māta*[1] *dannatu iṣabbat*
14. *adi [ûm 13-]kam šá araḫ Du'uzi ina erīb šamši izza-az ûm 14-kam ša araḫ Du'uzi i-tab-bal-ma*
15. *ûmī 7-kam ina šamê iḫ-ḫa-ram-ma ûm 21*[2]*-kam šá araḫ Du'uzi d.Nin-sī-an-na*
16. *ina ṣit šamši inappaḫ-ma nukrāti ina māti ibaššâ ebūr māti iššir*

If on the 9th of Araḫsamna Venus appeared in the west, disaster will seize the land. Until the 13th of Tammuz she will stand in the west; on the 14th of Tammuz she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth on the 21st of Tammuz (in the east); hostilities will be in the land; the harvest of the land will be successful.

17. *šumma ina araḫ Kislimi ûm 10-kam d.Nin-sī-an-na ina ṣit šamši innamir ḫušaḫḫi še'im u tibni ina māti ibaš-ši*
18. *adi ûm 14-kam šá araḫ Abi ina ṣit šamši izza-az ûm 15-kam ša araḫ Abi i-tab-bal-ma*
19. *arḫê 3 ina šamê iḫ-ḫa-ram-ma ûm 15-kam šá araḫ Araḫsamna d.Nin-sī-an-na*
20. *ina erīb šamši inappaḫ-ma ebūr māti iššir*

If on the 10th of Kislev Venus appeared in the east there will be hunger for grain and straw in the land. Until the 14th of Ab she will stand in the east; on the 15th of Ab she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 15th of Araḫsamna; the harvest of the land will be successful.

21. *šumma ina araḫ Ṭebiti ûm 11-kam d.Nin-sī-an-na ina erīb šamši innamir ebūr māti iššir*
22. *adi ûm 15-kam ša araḫ Ululi ina erīb šamši izza-az ûm 16-kam šá araḫ Ululi i-tab-bal-ma*
23. *ûmī 7-kam ina šamê iḫ-ḫa-ram-ma ûm 23-kam ša araḫ Ululi d.Nin-sī-an-na*
24. *ina ṣit šamši inappaḫ*[3]*-ma ebūr māti iššir libbi māti iṭâb*

If on the 11th of Tebit Venus appeared in the west, the harvest of the land will be successful. Until the 15th of Ulul she will stand in the west; on the 16th of Ulul she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 23rd of Ulul; the harvest of the land will be successful; the heart of the land will be happy.

25. *šumma ina araḫ Šabati ûm 12-kam d.Nin-sī-an-na ina ṣit šamši innamir ebūr māti iššir*
26. *adi ûm 16-kam šá araḫ Tešriti ina ṣit šamši izza-az ûm 17-kam šá araḫ Tešriti [i-tab-bal-ma]*
27. *3 arḫê ina šamê iḫ-ḫa-ram-ma ûm 17-kam ša araḫ Ṭebiti d.Nin-sī-an-na*
28. *ina erīb šamši inappaḫ-ma [ebur mati iššir]*

If on the 12th of Šabat Venus appeared in the east, the harvest of the land will be successful. Until the 16th of Tešrit she will stand in the east; on the 17th of Tešrit she will disappear, and, having remained absent 3 months in the sky, Venus will shine forth in the west on the 17th of Ṭebit; [the harvest of the land will be successful].

29. *šumma ina araḫ Adari ûm 13-kam d.Nin-sī-an-na ina erīb šamši innamir šarru [ana šarri nukurta išappa-ár]*
30. *adi ûm 16-kam*[4] *šá araḫ Araḫsamna ina erīb šamši izza-az ûm 17-kam šá araḫ Araḫsamna i-tab-bal-ma*
31. *ûmī 7-kam ina šamê iḫ-ḫa-ram-ma ûm 25-kam šá araḫ Araḫsamna d.Nin-sī-an-na*
32. *ina ṣit šamši inappaḫ-ma māta dannatu iṣabbat*

[1] Cf. King, *Magic*, 31, 6. [2] Virolleaud has 11 here, but III R. 63 correctly 21. [3] Sign *KUR*.
[4] This figure is clearly written and may be seen on the photograph.

If on the 13th of Adar Venus appeared in the west, king shall send challenge of war to king. Until the 16th of Araḫsamna she will stand in the west; on the 17th of Araḫsamna she will disappear, and, having remained absent 7 days in the sky, Venus will shine forth in the east on the 25th of Araḫsamna; calamity will seize the land.

33. 12 *ki-iṣ-ru-ta MU-ra-tum*[1] *šá d.Nin-sī-an-na gab-ri Bāb-ili-(ki)*

Twelve corresponding groups (of the motions) of Venus. A copy from Babylon.

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34. *šumma ina araḫ Ululi šanî-kam ûm 1-kam d.Nin-sī-an-na ina erīb šamši it-bal*
35. *ûm 15-kam ina šamê iḫḫaram-ma ina araḫ Ululi šanî-kam ûm 17-kam d.Nin-sī-an-na*
36. *ina ṣit šamši innamir*[2] *tapdû*[2] *ina māti ruḳ-ti ibašši : ina ekalli amtu . . . .*

If on the 1st of intercalary Ulul Venus disappeared in the west, remaining absent 15 days in the sky, and on the 17th of intercalary Ulul Venus appeared in the east, there will be a *defeat* in a distant land; in the palace a *female servant* will . . . [19th year]

37. *šumma ina araḫ Simāni ûm 25-kam d.Nin-sī-an-na ina ṣit šamši it-bal*
38. *2 arḫê ûmī 6-kam ina šamê iḫḫaram-ma ina araḫ Ululi ûm 24-kam*[3]
39. *d.Nin-sī-an-na ina erīb šamši innamir libbi māti iṭa-ab*

If on the 25th of Sivan Venus disappeared in the east, remaining absent 2 months and 6 days in the sky, and on the 24th of Ulul Venus appeared in the west, the heart of the land will be happy. [20th year]

40. *šumma ina araḫ Nisanni ûm 27-kam*[4] *d.Nin-sī-an-na ina erīb šamši it-bal*
41. *ûmī 7-kam ina šamê iḫ-ḫa-ram-ma ina araḫ Aiari ûm 3-kam d.Nin-sī-an-na*
42. *ina ṣit šamši innamir nukrāti ina māti ibaššâ ebūr māti iššir.*

If on the 27th of Nisan Venus disappeared in the west, remaining absent in the sky 7 days, and on the 3rd of Ayar Venus appeared in the east, there will be hostilities in the land; the harvest of the land will be successful. [21st year]

43. *[šumma ina araḫ Ṭebiti ûm 28-kam] d.Nin-sī-an-na ina ṣit šamši it-bal*
44. *[2 arḫê ina šamê iḫḫaramma ina] araḫ Adari ûm 28-kam d.Nin-sī-an-na*
45. *[ina erīb šamši innamir] šarru ana šarri ṣalta išappa-ar*

If on the 28th of Tebit Venus disappeared in the east, remaining absent 2 months in the sky, and on the 28th of Adar Venus appeared in the west, king will send a challenge of war to king. [Restored from K. 2321, R. 20–1.] [21st year]

46. [. . . . . *gab-ri* (?) . . . .] *ki* (?) *ki-i pî labiri-šu*[5]

[1] *Kiṣrûtu* is clearly a singular fem. as the adjective *MU-ratum* proves. Kugler, *Sternkunde*, 262, reads *gabratum*, but there is no adjective *gabru*. Apparently only *māḫiratum* or *paṭratum* are possible, and no adjective *paṭru* or *paṭiru*, *paṭiratum*, exists. Virolleaud also transcribes *gab-ra-tum*. Kugler rendered the phrase by '12 corresponding groups', which makes good sense. If *kiṣrûtu* means 'problem', and *paṭraṭum* be assumed as the correct reading, the sense may be '12 problems solved'. But I cannot see the sign *GAB* on the tablet. See also the photograph. Read *šaṭratum*?

[2] This source, Obv. 1–30 + Rev. 34–46, employs *IGI-GAB* for *namāru* in Obv. 1–30, but *IGI* only in Rev. 34–46, unless line 36 be an exception, as is supposed by my rendering. I take *ŠI* for *tapdû*, and cf. RA. 12, 7 n. 1. Virolleaud transcribed *gab-lim*, by which he probably means *ḳablu*. I cannot see *GAB* on the tablet; *MU* seems to be clearly written. What then is *MU-ši*? *GAB* would be the better reading.

[3] Sic: read 1 for 24.

[4] K. 7072 + Rm. 134, 4, has 26 here. Rm. 134 has 6-day interval.

[5] Text has *ki-i KA Ù-RA-šu*, like the original (it has been written and collated). Space for about 20 lines is broken away here. The colophon occupied a few lines, and the remainder was probably uninscribed.

CHAPTER III

TRANSCRIPTION AND TRANSLATION

K. 2321 + K. 3032, *Obverse.*

1. [*šumma ina araḫ šabati ûm 15-kam ᵈ·Nin-sī-an-*]*na ina erīb šamši it-bal ûmī 3-kam ina šamê iḫ-ḫa-ram-ma*
2. [*ina araḫ Šabati ûm 18-kam ᵈ·Nin*]*-sī-an-na ina ṣit šamši innamir tapdê šarrāni*
3. [*ᵈ·Adad zunnê-šu ᵈ·Ea naḳbê-šu*] *ub-ba-la šarru ana šarri šulma išappar*

[If on the 15th day of the month Šabat] Venus disappeared in the west, remaining absent in the sky 3 days, and [on the 18th day of the month Šabat] Venus appeared in the east, catastrophes of kings; [Adad] will bring [rains, Ea subterranean waters]; king will send greetings to king. See K. 2321, R. 22–3. [Year 1]

4. [*šumma ina araḫ Araḫsamni ûm 11-kam ᵈ·Nin-sī-an-*]*na ina ṣit šamši it-bal 2 arḫê ûmī 7-kam ina šamê iḫ-ḫa-ram-ma*
5. [*ina araḫ Ṭebeti ûm 19-kam ᵈ·Nin-sī-an-na*] *ina erīb šamši innamir ebūr māti iššir*

[If on the 11th day of the month Araḫsamna Venus] disappeared in the east, remaining absent in the sky 2 months and 7 days, and [on the 19th day of the month Tebit Venus] appeared in the west, the harvest of the land will be successful. See K. 2321, R. 17. [Year 2]

6. [*šumma ina araḫ Ululi ûm 23-kam ᵈ·Nin-sī-an-na*] *ina erīb šamši it-bal ûmī 20-kam ina šamê iḫ-ḫa-ram-ma*
7. [*ina araḫ Tešriti ûm 13-kam ᵈ·Nin-sī-an-na*] *ina ṣit šamši innamir nukrāti ina māti ibaššû ebūr māti iššir*

[If on the 23rd day of the month Ulul Venus] disappeared in the west, remaining absent 20 days in the sky, and [on the 13th day of the month Tešrit Venus] appeared in the east, there will be hostilities in the land; the harvest of the land will be successful]. [3rd year]

8. [*šumma ina araḫ Du'zi*[1] *ûm 2-kam ᵈ·Nin-sī-an-na ina*] *ṣit šamši it-bal 2 arḫê ûm 1-kam ina šamê iḫ-ḫa-ram-ma*
9. [*ina araḫ Ululi ûm 3-kam ᵈ·Nin-sī-an-na*] *ina erīb šamši innamir libbi māti iṭa-ab*

[If on the 2nd day of the month Tammuz Venus] disappeared in the east, remaining absent in the sky 2 months and 1 day, and [on the 3rd day of the month Ulul Venus] appeared in the west, the heart of the land will be happy. [4th year]

10. [*šumma ina araḫ Aiari ûm 2-kam ᵈ·Nin-sī-an-na ina*] *erīb šamši it-bal ûmī 15-kam*[2] *ina šamê iḫ-ḫa-ram-ma*
11. [*ina araḫ Aiari ûm 18-kam ᵈ·Nin-sī-an-na*] *ina ṣit šamši innamir zunnê u mîlē ibaššû ebûr māti iššir*

[If on the 2nd day of the month Ayar Venus] disappeared in the west, remaining absent in

[1] Text of W. 802 has *KU*, error from line 7.
[2] Var. W. 802 has 18 here and 18 in line 11, which is clearly a case of dittography.

the sky 15 days, and [on the 18th day of the month Ayar Venus] appeared in the east, there will be rains and floods; the harvest of the land will be successful. [5th year]

12. *šumma ina araḫ Kislimi ûm 10 +* [*2-kam ᵈ·Nin-sī-an-na ina*] *ṣit šamši it-bal 2 arḫê ûmī 4-kam ina šamê iḫ-ḫa-ram-ma*
13. *ina araḫ Šabati ûm 16-kam*[1] *ᵈ·Nin-sī-an-*[*na ina*] *erīb šamši innamir ebūr māti iššir*

If on the 12th of Kislev Venus disappeared in the east, remaining absent in the sky 2 months and 4 days, and on the 16th of Šabat Venus appeared in the west, the harvest of the land will be successful. See K. 2321, R. 19. [5th year]

14. *šumma ina araḫ Araḫsamna ūm 20 +* [8][2] *ᵈ·Nin-sī-an-na* [*ina erīb šamši*] *it-bal ûmī 3-kam ina šamê iḫ-ḫa-ram-ma*
15. *ina araḫ Kislimi*[3] *ûm 1-kam ᵈ·Nin-sī-an-na ina* [*ṣit šamši innamir*] *ḫušaḫḫi še'im u tibni ina māti ibašši*[4] *ár-bu-tu iššakan.*

If on the 28th of Araḫsamna Venus disappeared [in the west], remaining absent in the sky 3 days, and on the 1st of Kislev Venus appeared [in the east], hunger for grain and straw will be in the land; desolation will be wrought. [6th year]

16–17 = K. 160, Obv. I 1–3.

Venus disappeared in the east, Ab 21st; period of absence 2 months and 11 days; rose in the west, Araḫsamna 2nd. [7th year]

18–19 = K. 160, Obv. I 4–6.

Venus disappeared in the west, Tammuz 25th; period of absence 7 days; rose in the east, Ab 2nd. [8th year]

20–1 = K. 160, Obv. I 7–8.

Venus disappeared in the east, Adar 25th, in the 8th year of Ammizaduga. [8th and 9th years]

22–3 = K. 160, Obv. I 9–10.

Venus disappeared in the west, Adar 11th;[5] period of absence 4 days; rose in the east, Adar 15th. [9th year]

24–5 = K. 160, Obv. 11–12.

Venus disappeared in the east, Araḫsamna 10th; period of absence 2 months and 6 days; rose in the west, Tebit 16th.[6] [10th year]

26–7 = K. 160, Obv. 13–14.

Venus disappeared in the west, Ulul 26th; period of absence 11 days; rose in the east, intercalary Ulul 7th. [11th year]

[1] Var. W. 802 has 29 here, and in line 12 *Kislimu* 25.
[2] *ḫi-pí eš-šu*, scribal note, 'a recent defacement of the text'. The units of this figure were lost on the original from which Ašurbanipal's scribe made his copy. Var. W. 802 has 18, clearly an error for 28.
[3] The text has *Kislimu* clearly. See K. 2321, R. 12–13.
[4] Here Var. inserts *KI-MiN*, which probably refers to line 13, *ebur māti iššir*.
[5] The text has *Sivan* for *Adar*, and the interval is 9 months and 4 days!
[6] Text of K. 2321 has 16 clearly.

Reverse[1]

1. *šumma ina araḫ Nisanni d.Nin-sī-an-na ûm 8-kam ina ṣit šamši it-bal* 5 *arḫê ûmī 17-kam ina šami-e iḫ-ḫi-ram-ma*
2. *ina araḫ Ululi ûm 25-kam d.Nin-sī-an-na ina erīb šamši innamir lib-bi māti iṭâb*[2] [Year 12]
3. *šumma ina araḫ Nisanni d.Nin-sī-an-na ûm 26-kam ina erīb šamši it-bal ûmī 6-kam ina šami-e iḫ-ḫi-ram-ma*
4. *ina araḫ Aịari ûm 3-kam ina ṣit šamši innami-ir nu-ku-ra-tu ina māti ibaššâ ebur māti iššir*[3] [Year 21]
5. *šumma ina araḫ Aịari d.Nin-sī-an-na ûm 2-kam ina erīb šâmi-e it-bal ûmī 15-kam ina šami-e iḫ-ḫi-ram-ma*
6. *ina araḫ Aịari ûm 18-kam d.Nin-sī-an-na ina ṣit šamši innami-ir zunnê u mîlê ibaššû ebur māti iššir*[4] [Year 5]
7. Set in west, Ayar 5th, interval 7 days; rose in east,
8. Ayar 12th. [Year 13] Restored from K. 160, 17–18.
9. Set in east, Sivan 25th, interval 2 months 6 days; rose
10. in west, Ulul 1st. Restored from K. 160, R. 37–9. [Year 20]
11. Set in east, Tammuz 2nd, interval 2 months and 1 day; rose in
12. west, Ulul 3rd. Restored from K. 2321, Obv. 8–9. [Year 4]
13. Set in west, Tammuz 5th, interval 15 days; rose in east,
14. Tammuz 20th. K. 160, Obv. 24–5. [Year 16]
15. Set in west, Tammuz 25th, interval 7 days; rose in east, Ab 2nd.
16. Restore from K. 160, 4–6, and K. 2321, Obv. 18–19. [Year 8][5]
17, 18 = 3, 4, on fragment.

[*šumma ina araḫ Abi ûm 20-kam d.Nin-sī-an-na ina ṣit šamši it-bal* 2 *arḫê ûmī 15-kam ina šami-e*] *iḫ-ḫi-ram-ma*

[*ina araḫ Araḫsamna ûm 5-kam ina erīb šamši innami-ir zunnê ina māti ibaššû*] *ár-bu-tu iššakan*

Restored from K. 160, Obv. 22–3; and Sm. 174, 4–5. [Year 15][6]

19, 20 = 5, 6, on fragment.

[*šumma ina araḫ Abi ûm 21-kam d.Nin-sī-an-na ina ṣit šamši it-bal* 2 *arḫê ûmī 11-kam ina*] *šami-e iḫ-ḫi-ram-ma*

[*ina a raḫ Araḫsamna ûm 2-kam*] *d.Nin-sī-an-na ina erīb šamši innami*[*-ir zunnê ina māti*] *ibaššû ár-bu-tu iššakan*

Restored from K. 160, 1–3, and K. 2321, Obv. 16–17; Sm. 174, 6–7. [Year 7][6]

[1] Text in VIROLLEAUD, *Ishtār*, XV.

[2] 12th year. Restored from Rm. 134 and K. 7072 = K. 160, 15–16. K. 7072 has 25th of *Ulul* clearly.

[3] 21st year. Restored from Rm. 134 and K. 7072 = K. 160, R. 40–2. Rm. 134 has interval of 6 days, and 26th of *Nisan*; K. 160 has 7 days and 27th of *Nisan*. K. 7072 has *Ayar* 3.

[4] 5th year. K. 7072 and Rm. 134 = K. 2321, Obv. 10–11.

[5] This should correspond to K. 2321, rev., first line on the fragment, which has *ebur māti iššir*, but the corresponding omen on the obverse has *arbutu iššakan*! Since the omen for lines 13–4 has *ina šamê mîlê ina naḳbê ibaššû*, and this may agree with Sm. 174, 3, *zunnê ina šamê* (?), FOTHERINGHAM would invert 13 + 14 and 15 + 16.

[6] FOTHERINGHAM would invert these two paragraphs as here restored; he argues that the observations are usually in order of years (*Nisan* 12, 21, *Ayar* 5, 13, *Tammuz* 4, 8, 16, *Ulul* 3, 11, *Adar* 8, 9).

7. *šumma ina araḫ Ululi d.Nin-sī-an-na ûm 23-kam ina erīb šamši it-bal ûmī 20-kam ina šamê iḫ-ḫi-ram-ma*
8. *ina araḫ Tešrit*[1] *ûm 13-kam ina ṣit šamši innami-ir nu-kur-a-tum ina māti ibašši ebūr māti iššir*

If on the 23rd of Ulul Venus disappeared in the west, remaining absent 20 days in the sky, and appeared in the east on the 13th of Tešrit, there will be hostility in the land; the harvest of the land will be successful. [Year 3]

9. *šumma ina araḫ Ululi d.Nin-sī-an-na ûm 26-kam ina erīb šamši it-bal ûmī 12-kam*[2] *ina šamê iḫ-ḫi-ram-ma*
10. *ina araḫ Ululi šanî ûm 8-kam*[3] *ina ṣit šamši innamir libbi māti iṭa-ab*

If on the 26th of Ulul Venus disappeared in the west, remaining absent 12 days in the sky, and appeared in the east on the 8th of intercalary Ulul, the heart of the land will be happy. K. 160, Obv. 13–14. [11th year]

11. *šumma ina araḫ Tešrit d.Nin-sī-an-na ûm 11-kam ina erīb šamši it-bal* 1 *araḫ ûmī 17-kam ina šamê iḫ-ḫi-ram-ma*
12. *ina araḫ Araḫsamna ûm 28-kam d.Nin-sī-an-na ina ṣit šamši innam-ir zunnê ina māti ibaššû ár-bu-tu iššaka-an*[4]

If on the 11th of Tešrit Venus disappeared in the west, remaining absent 1 month and 17 days in the sky, and on the 28th of Araḫsamna Venus appeared in the east, there will be rains in the land; destruction will be wrought. K. 160, Obv. 20–1. [Year 14]

13. *šumma ina Araḫsamna d.Nin-sī-an-na ûm 28-kam ina erīb šamši it-bal ûmī 5-kam ina šamê iḫḫiram-ma*
14. *ina araḫ Kislimi* [*ûm 3-kam ina*] *ṣit šamši innami-ir ḫusaḫḫi še'im u tibni ina māti ibašši*

If on the 28th of Araḫsamna Venus disappeared in the west, remaining absent 5 days in the sky, and [on the 3rd] of Kislev she appeared in the east, there will be hunger for grain and straw in the land. K. 2321, Obv. 14–15. [6th year]

15. [*šumma ina araḫ Araḫsamna d.Nin-sī-an-na ûm 11-kam ina*] *ṣit šamši it-bal* 2 *arḫê ûmī 8-kam ina šamê iḫḫiram-ma ina araḫ Ṭebiti ûm 19-kam ina erīb šamši innami-ir ebūr māti iššir*

If on the 11th of Araḫsamna Venus disappeared in the east, remaining absent in the sky 2 months and 8 days, and on the 19th of Tebit she appeared in the west, the harvest of the land will be successful. K. 2321, Obv. 4–5. [Year 2]

16. [*šumma ina araḫ Araḫsamna d.Nin-sī-an-na ûm 8-kam ina ṣit šamši*] *it-bal* 2 *arḫê ûmī 8-kam ina šami-e iḫ-ḫi-ram-ma ina araḫ Ṭebiti ûm 16-kam ina erīb šamši innami-ir ebūr māti iššir*

K. 2321, Obv. 24–5; K. 160, Obv. 11–12. [Year 10]

[1] Text *KU*. So already CRAIG.

[2] K. 160, Obv. 13 has 11.

[3] K. 160, Obv. 14 has 7.

[4] This impossible astronomical statement agrees with the major text K. 160, Obv. 20–1, where the figures are *Tešrit* 10, interval 1 month and 16 days, and *Araḫsamna* 26. The Kish duplicate, Rev. 12, has *Araḫsamna* 27, which FOTHERINGHAM identifies as the only correct date, astronomically, in this observation. *Tešrit* in line 11 is clearly an error for *Araḫsamna*, but the figure 11, or 10, on all three texts is erroneous. The interval according to FOTHERINGHAM should be about 3 days, consequently *Araḫsamna* 24 should stand in line 11.

17. [*šumma ina araḫ Kislimi* *d.Nin-sī-an-na ûm* 2]1-*kam ina ṣit šamši it-bal* 2 *arḫê ina šami-e iḫ-ḫi-ram-ma*
18. [*ina araḫ Šabati ûm* 21-*kam ina erīb šamši*] *innami-ir ebūr māti iššir*

K. 160, Obv. 18–19. [Year 13]

19. [*šumma ina araḫ Kislimi* *d.Nin-sī-an-na ûm* 24-*kam ina*] *ṣit šamši*[1] *it-bal* (2) *arḫê*[2] *ûmī* 4-*kam ina šami-e iḫḫiram-ma ina araḫ Šabati ûm* 28-*kam ina erīb šamši*[3] *innamir ebūr māti iššir*[4]

K. 2321, Obv. 12–13, and Kish tablet. [Year 5]

20. [*šumma ina araḫ Ṭebiti* *d.Nin-sī-an-na ina ûm* 28-]*kam ina ṣit šamši it-bal* 2 *arḫê ina šami-e iḫ-ḫi-ram-ma*
21. [*ina araḫ Adari ûm* 28-*kam ina erīb šamši innami-*]*ir šarru ana šarri ṣalta išappa-ar.*

An eastern setting in Tebit is expected here, and the only observation possible is the broken text of K. 160, R. 43–5, for the 21st year, where the western rising is on the 28th of Adar. The omens also agree, and there seems to be no alternative. [Year 21]

22. [*šumma ina araḫ Šabati* *d.Nin-sī-an-na ûm* 25-]*kam ina erīb šamši it-bal ûmī* 3-*kam ina šami-e iḫḫiram-ma ina araḫ Šabati ûm* 28-*kam*
23. *ina ṣit šamši innami-ir tapdê šarrāni*] *d.Adad zunnê-šu* *d.É-a nakbê-šu ub-ba-lam šarru ana šarri šulma*(*ma*) *išappa-ár*

This is obviously identical with K. 2321, Obv. 1–3, and Kish tablet, Obv. 1–3, but the figures there are 15–18, being raised by 10 on K. 2321, Rev. 22; the omission or insertion of the unit 10 is a common error. [Year 1]

24. [*šumma ina araḫ Adari* *d.Nin-sī-an-na ûm* 25-]*kam ina ṣit šamši it-bal* 2 *arḫê ûm* 7-*kam ina šami-e iḫ-ḫi-ram-ma*
25. [*ina araḫ Simani*[5] *ûm* 2-*kam*] *ina erīb šamši innami-ir šumkut ummān ma-at-ti.* [Year 8]

This is probably the fragmentary observation in K. 160, Obv. 7, and K. 2321, Obv. 20, and has been entered before the setting on Adar 11th in line 26.[6]

26. [*šumma ina araḫ Adari ûm* 11-*kam* *d.Nin-sī-*]*an-na ina erīb šamši it-bal ûmī* 4-*kam ina šami-e iḫ-ḫi-ram-ma*
27. [*ina araḫ Adari ûm* 15-*kam ina*] *ṣit šamši innami-ir : (ina šamê innamir) šarru ana šarri šulma*(*ma*) *išappa-ár ebūru*[7] *iššir libbi māti iṭa-ab.* [Year 17]

This entry apparently combines K. 160, Obv. 9–10 = K. 2321, Obv. 22–3 (9th year), and

[1] The text has *erīb šamši.*

[2] The text has no figure before *arḫê.*

[3] The text has *ṣit šamši.*

[4] The scribe has interchanged the eastern setting with the western rising in his copy. Obviously the month *Kislev* stood in line 19, and if a western setting be assumed as in the text then the interval cannot be so long as a month, to the eastern rising in *Šabat*; the scribe's text imposes the restoration of *Šabat* in line 19, which would make the successive order of month-names wrong. The interval has no number before 'month'; the scribe's copy had a figure here, but he observed that, if the text be correct, the interval must be less than a month, and he consequently omitted the figure.

[5] So, since the 8th year had no intercalary *Adar*. Note that the next observation on K. 160, Obv. 9, has *Simanu* erroneously for *Adar*, a corruption taken from *Simanu* which had been suppressed.

[6] This is due to a secondary principle introduced into the method here. When settings occur in the same month the scribe follows the order of the years. This was discovered by Fotheringham.

[7] *KI-A.*

K. 160, Obv. 28–9 (17th year). Note that the omen here combines the omens of these two years, and that *KI–A*, ideogram for *ebūru*, or *ebūr māti*, has been erroneously inserted into K. 160, Obv. 29.[1]

28. [24? *ki-iṣ-ru-ti*] *ša* *d.Nin-sī-an-na a-ḫu-tum*

This restoration 'Twenty-four groups (of the motions) of Venus, *aḫûtum*', is suggested by K. 160, Rev. 33. The Rev. of K. 2321 does not include two observations: (1) the eastern setting on the 15th of *Adar*, year 16, and (2) the western setting of intercalary *Ulul* 1st, year 19.[2] There should be 13 eastern settings and 13 western settings in the 21 years of Ammizaduga, or a total of 26 settings on the reverse of K. 2321. *aḫûtu* is probably the classical plural of the adjective *aḫu*, 'strange', 'rare', 'unusual', that is 'groups arranged in a different order from those on the obverse'. *aḫûtum* may possibly be a variant of *aḫîtum*, as *šakûtum* of *šakîtum*. Cf. also *nîkûtum* for *nîkatum*, 'adulteress', *Assyrian Code of Laws*, §§ 23, 33. On this supposition *Ninsianna a-ḫu-tum* means the 'hostile Venus', for which see the title of Ishtār *mul-bar*, the hostile star, Chiera, *Sumerian Religious Texts*, No. 1, Col. III 16; IV 22, and my edition of this text in JRAS. 1926, pp. 15–72. Cf. *kakkab a-ḫu-u*, title of Nergal, Mars, K. 7646; Weidner, *Handbuch*, p. 9, line 11. But Venus is not, by any means, always a hostile star.

[The technical term corresponding to *kiṣru* in modern astronomy is 'conjunction'.—J.K.F.]

29. *šumma* *mul**sag-me-gar ina še-ir-ti ik-*[*tu-*]*un šarrāni nakrûti ultallamu tuppu* 63-*kam enuma Anu* *d.Enlil*

If Jupiter, in the morning (of his heliacal rising), was *brilliant*, hostile kings will make peace. 63rd tablet of 'When Anu, Enlil'.

This catch-line occurs at the end of K. 3601 = Virolleaud, *Ishtār* IV, a tablet of entirely different Venus observations, and is partially preserved on the duplicate, K. 11840, *Babyloniaca*, VI 253. The Kish tablet has the same catch-line, but numbers the tablet 62 in the series. An extract of the 64th (63rd ?) tablet begins with this line, DT. 77 = Virolleaud, *Suppl.*[1] XLIV, and is cited by Thompson, *Reports*, 185, 1; 186, 1; 196, 11; 271, edge. *Ishtār* IV 35 apparently explains the obscure verb *iktun* by *šarrura išši*, 'he bore brilliance'. Jastrow, *Religion* 639, supposed *iktun* to stand for *iktum*, and rendered 'is covered', but even were the verb *katāmu*, 'to cover', assumed, it cannot be passive or neuter. Thompson, *Rep. Index*, placed the form under *kānu*, for which there is, so far as the form goes, justification in *liktunu*, *Epic of Creation*, IV 35; VI 12 b; this would mean 'he was firm, certain'. Undoubtedly we have here a new verb, *kānu* or *kat*(*t*)*ānu*.

K. 2321, a neo-Babylonian copy, was written by the hand of Nergaluballiṭ, and the Kish duplicate has a long colophon, '37 lines (observations), a copy from Babylon, written according to its original and collated, by the hand of Nergal-epuš, son of ...., Kish, in the year .... of Sargon, king of [the land of Assyria]'. The Kish tablet was therefore copied in the period 721–705, and is the oldest copy which we now possess.

The reverse of the Kish tablet (12–13) ends with the western setting in *Tešrit*, and the

[1] A conflate text is also suggested by the colon after the sign *ŠI* and the insertion *AŠ-AN-Ši*, probably a remnant of a second *ina ṣit šamši innamir*.

[2] Also the group for the year 18, suppressed on K. 160, after line 29, by the long insertion, does not appear on K. 2321, Rev. This eastern setting should have occurred in *Araḫsamna*.

eastern rising on the 27th of *Araḫsamna* (26th and 28th on the other texts), year 14 = K. 2321, Rev. 11–12. It is followed by 2 *kiṣru ša* d·*Ninsianna*, but there is only *one* observation or group above it; *kiṣrutum* in K. 160, Rev. 33, is employed for a single group. Line 11 begins *ta-bar-*[*ri* ?], 'thou shalt see (?)', and line 10 has 4 *ki-*[*iṣ-ru-ti*], and in fact the ends of 4 groups remain on the tablet above it, hence a group must be missing between lines 11–12, and this is undoubtedly the group, K. 160, Rev. 34–6, western setting on intercalary *Ulul* 1st, also omitted on K. 2321. The four groups on the Kish tablet, Rev. 2–9, do not entirely agree with the text of K. 2321, Rev. 3–10. Lines 6–7 do correspond to the proper group, K. 2321, Rev. 7–8, but the remaining three do not, and consequently the Kish tablet arranged the 26 observations on some other principle. K. 2321, Rev., clearly adheres to the scheme of arranging the groups in the monthly order of Venus settings, whether eastern or western. It is not possible to discover what principle the scribes of Kish followed on the reverse of this tablet.

CHAPTER IV

TRANSCRIPTION AND TRANSLATION

Rm. II 531

1. [*šumma ina araḫ Aiari ûm* 5-]*kam* [d·*Nin-sī-an-na ina erīb šamši it-bal* 7 *û-mi ina šami-e iḫḫaram-ma*]
2. [*ina araḫ Aiari*] *ûm* 12-*kam ina* [*ṣit šamši innamir ebūr māti iššir*] [Year 13]
3. *šumma ina Ṭebiti*(!)*ûm* 21-*kam*[1] d·[*Nin-sī-an-na ina ṣit šamši it-bal* . . . . *ina šami-e iḫḫaram-ma*]
4. *ina araḫ Šabati ûm* 11-*kam* d·[*Nin-sī-an-na ina erīb šamši innamir*] [Year 13]
5. *šumma ina araḫ Tešriti ûm* 10-*kam* d·*Nin-sī-an-na* [*ina erīb šamši it-bal* 1 *araḫ ûmi* 16-*kam ina šami-e iḫ-ḫa-ram-ma*]
6. *ina araḫ Araḫsamna ûm* 26-*kam ina ṣit šamši*[2] *innamir zunnê* [*ina māti ibaššu*] [Year 14]
7. *šumma ina araḫ Abi ûm* 21-*kam* d·*Nin-sī-an-na ina ṣit šamši* [*it-bal* 2 *arḫê ûmî* 16(?)-*kam ina šami-e*]
8. *iḫ-ḫa-ram-ma ina araḫ Araḫsamna*[3] *ûm* 5-*kam ina erīb šamši* [*innamir zunnê ina māti ibaššû*]
9. *ár-bu-tu* [*iššakan*] [Year 15]
10. *šumma ina araḫ Du'uzi*[4] *ûm* 4-*kam* d·*Nin-sī-an-na ina erīb šamši* [*it-bal ûmî* 16-*kam ina šami-e iḫḫaram-ma*]
11. *ina araḫ Du'uzi ûm* 20-*kam ina ṣit šamši innamir zunnê u* [*mîlê ibaššû*] [Year 16]
12. [*šumma ina araḫ*] *Adari ûm* 15-*kam* d·*Nin-sī-an-na ina ṣit šamši it-bal* [. . . *arḫê* . . . *ûmî* -*kam ina šami-e iḫḫaram-ma*]
13. [*ina araḫ* . . . *ûm* . . .-]*kam ina erīb šamši innamir* . . . .[5] [Years 16 + 17]
13. [*šumma ina araḫ Adari ûm* 11-*kam*] d·*Nin-sī-an-na* [*ina erīb šamši it-bal*, &c.].[6]

S. 174

This small fragment probably belongs to the same tablet as Rm. 134 or K. 7072, that is, to an Assyrian copy of the reverse of K. 2321, and partially restores lines 14–20 of these two tablets as reconstructed in my edition of Rm. 134 + K. 7072; see the restoration of K. 2321, Rev. 1–5. Line 8 of S. 174 corresponds to K. 2321, Rev. 7, and line 9 to K. 2321, Rev. 8.

[1] K. 160, Obv. 18, has 20 here and 21 in line 19, which is probably correct.
[2] Text *erīb šamši* as on K. 160, Obv. 21, where line 20 has also a false text, *ṣit šamši* for *erīb šamši*.
[3] Text has *Kislev*, which is corrected after K. 160, Obv. 23. The scribe should have *Araḫsamna* here, which he falsely entered in line 10!
[4] Text *Araḫsamna*!
[5] The traces are certainly not *RU-TIM* as on K. 160, Obv. 27.
[6] See K. 160, Obv. 28.

PLATE I

K 160 Obverse

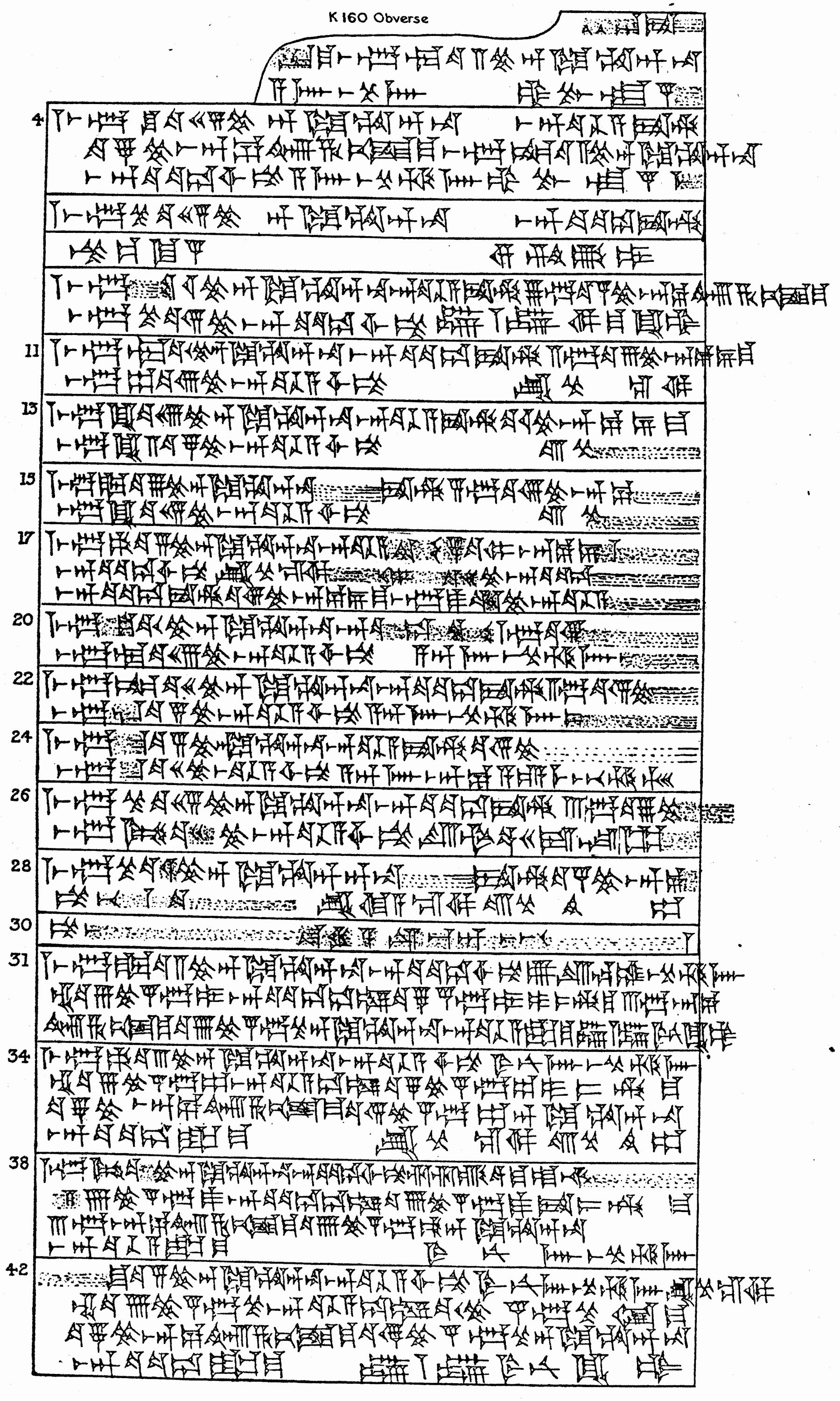
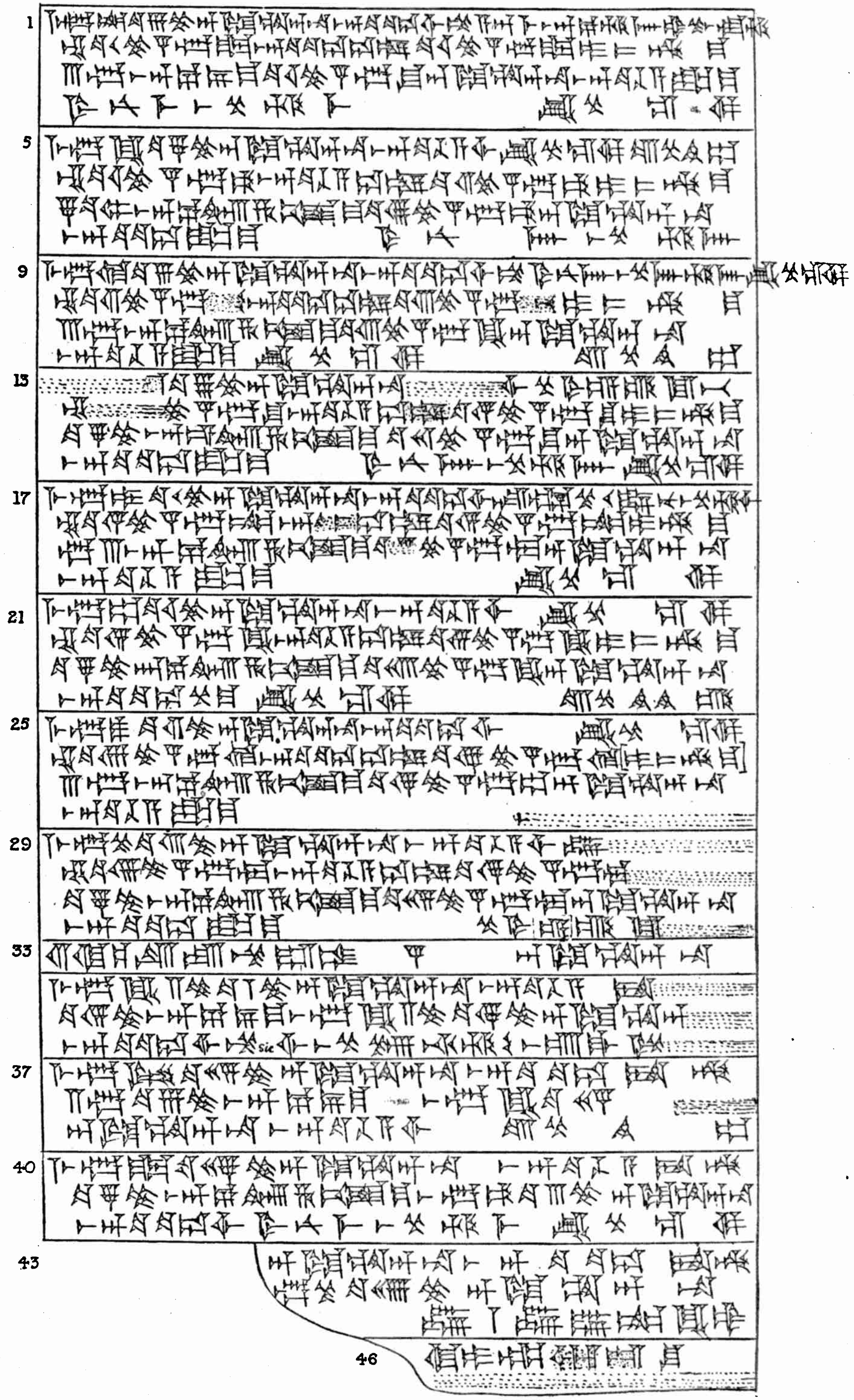
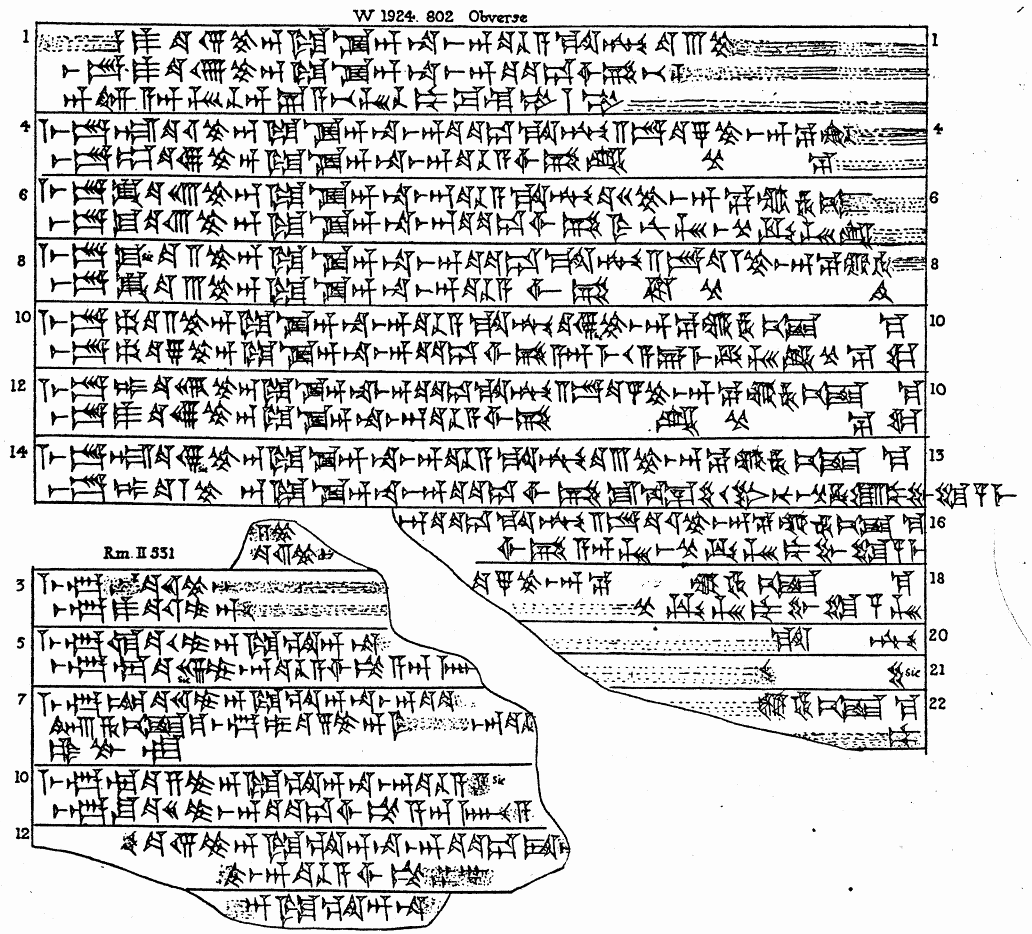


PLATE II

K 160 Reverse




W 1924. 802 Obverse
Rm. II 531
sic

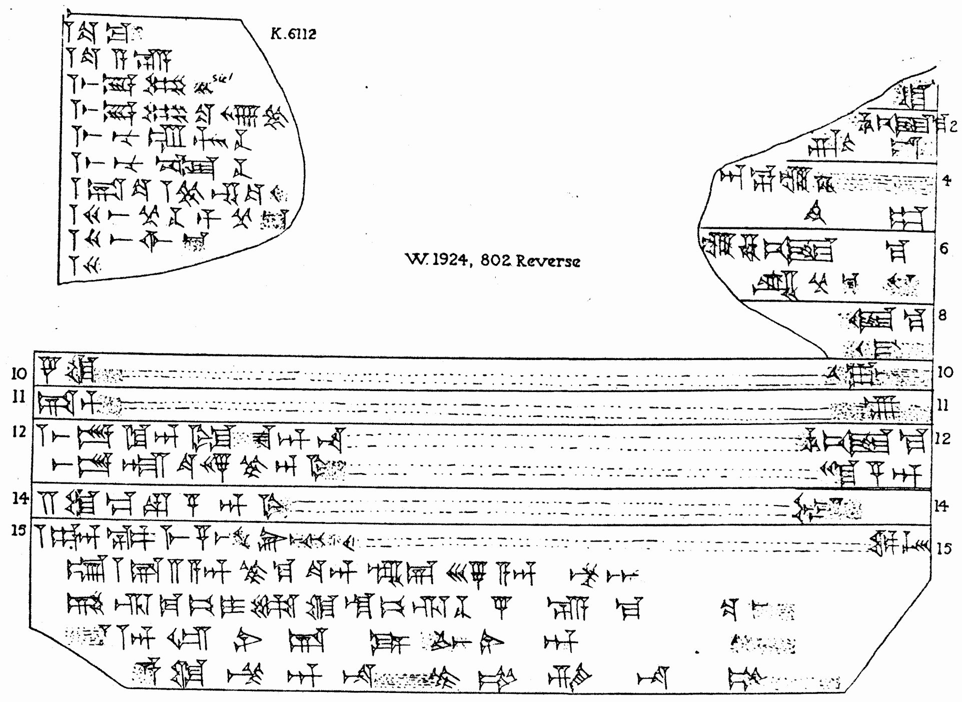

K.6112
sic!
W. 1924, 802 Reverse

Plate V

K 2321 + 3032 Obverse

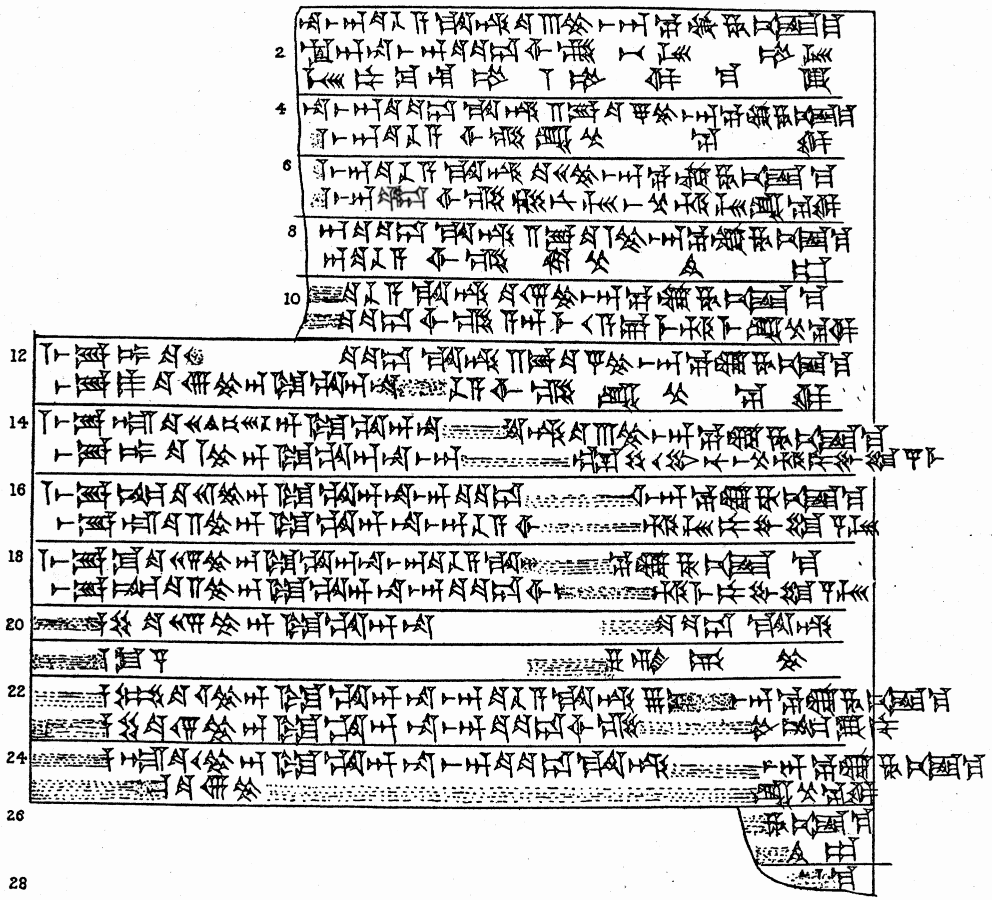
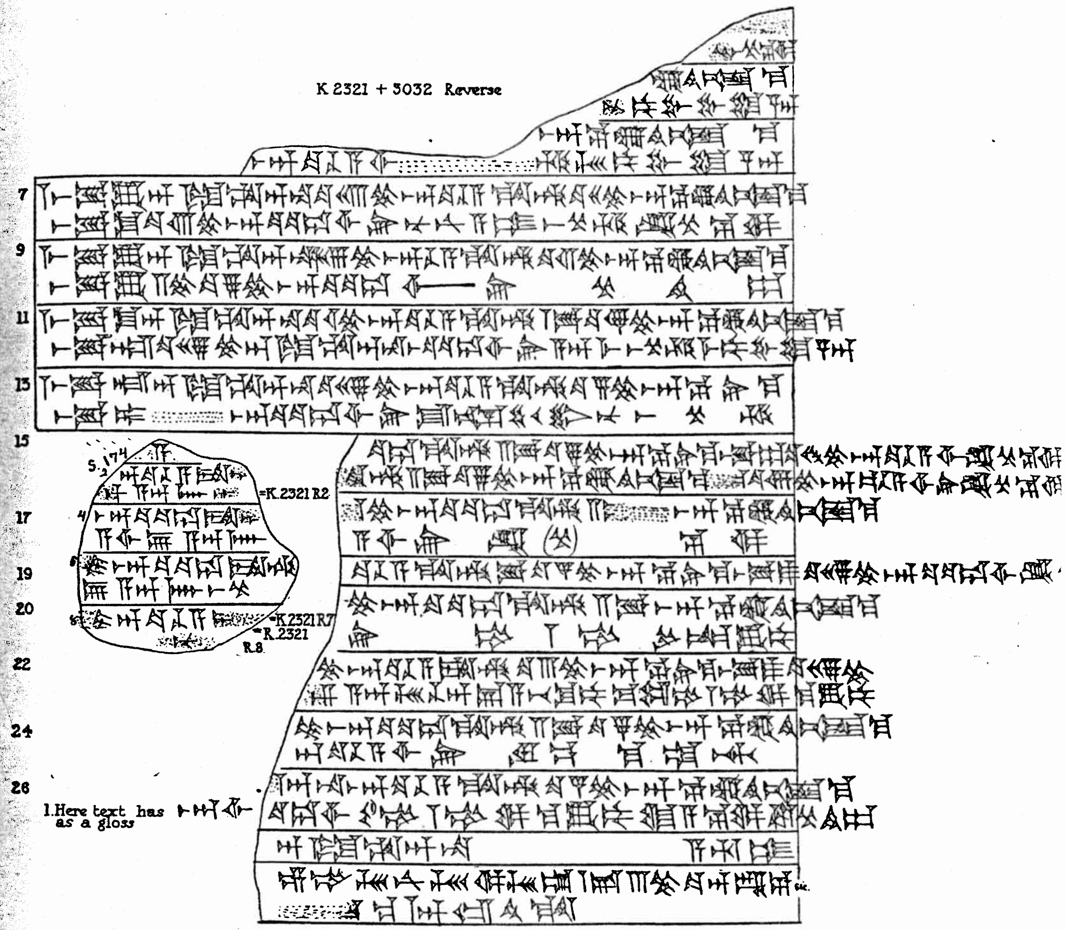


Plate VI

K 2321 + 3032 Reverse



1. Here text has as a gloss

CHAPTER V

PAST STUDIES OF THE SUBJECT

AMONG the tablets discovered by SIR HENRY LAYARD in his excavation of the library of Ashurbanipal at Kuyunjik, the ancient Nineveh, in 1850 and following years, and deposited in the British Museum, is a document in the Assyrian language (K. 160), the cuneiform text of which was published by SIR HENRY RAWLINSON and GEORGE SMITH, *Cuneiform Inscriptions of Western Asia*, vol. iii (1870), pl. 63, under the title of 'Table of the Movements of the Planet Venus and their influences'. This text, which as we know contained serious errors, was reprinted with interlinear transcription and translation by SAYCE, *The Astronomy and Astrology of the Babylonians, with Translations of the Tablets relating to these Subjects*, TSBA. iii (1874), pp. 316–39. The translation is fairly successful as a rendering of the astronomical contents, but it expresses the different phenomena categorically, instead of hypothetically, and the duration of invisibility of Venus is in each case given as the date of reappearance measured from the date of disappearance. This latter error is of purely grammatical importance. It is not surprising that the eighth line, which contains the year-formula of the eighth year of the reign of Ammizaduga, expressed as usual in the Sumerian language, should have been wrongly read and, in consequence, not recognized as a date. The system of dating by year-formulae was first made known by GEORGE SMITH in his paper *Early History of Babylonia*, TSBA. i (1872), pp. 45 ff. SMITH'S paper gave translations of many such formulae, but no cuneiform texts. There was, therefore, nothing to suggest that the words in the eighth line were such a formula. In SAYCE'S paper the text and translation are not accompanied by any commentary or other attempt at the explanation of the tablet, which is briefly described [1] as a long table of the phases of Venus. How completely it could be misconceived is shown by a reference made by LENORMANT, *La Divination* (1875), p. 21, note, who refers to SAYCE'S paper and describes the document as a complete table of the movements of the planet and of auguries from its positions during one year.

A translation of the text with an astronomical discussion was contributed by BOSANQUET and SAYCE under the title of *The Babylonian Astronomy*, No. 3. *The Venus Tablet* to MN. 40 (1880), pp. 565–78. The translation differs very little from that which SAYCE had published six years earlier, and contains substantially the same false interpretation of the line which is now known to contain the year-formula. In this paper BOSANQUET and SAYCE went far in the way of interpreting the tablet. They realized that it consisted of three parts, the first of which contained a series of observations of Venus including last appearance in the east, first appearance in the west, last appearance in the west, first appearance in the east, continued through at least six synodic periods, the day of the month of each phenomenon and the duration of invisibility being recorded. The rest of this part they considered too imperfect for analysis. The second part they found to be different in style and grammar from the rest; and, though it contained phenomena of Venus similar to those contained in the first part, they noticed that these were made to recur at uniform intervals; by a not unnatural misunderstanding they concluded that it gave Venus a synodic period six months too long, and decided that it was a fabrication by some person wholly

[1] p. 196.

unacquainted with the phenomena. The third part was found to be analogous to the first and to consist of a continuous series of observations. BOSANQUET and SAYCE were in doubt whether the calendar to which the observations were referred was a lunar calendar or one where each month contained 30 days. They realized that the date of a conjunction of Venus and the Sun with its attendant disappearance and reappearance of the planet recurred at periods of just under eight years, and computed that Venus would return to the same phase at the same date in the sidereal year at the close of a period of 235·182 sidereal years. They went on to say:

'It would be quite possible in this way to calculate the dates at which the observations of this tablet could have been made; but a conjectural element enters into the reconstruction of the calendar of the observations. And as there is nothing to associate these observations with historical dates, there is no possibility of a real contribution to ancient history in this case.'

The astrological influences of the phases were not discussed in this paper.

Though unable to date the observations astronomically, they observed that the antique style and the fact of their belonging to the collection supposed to have been made by Sargon of Agade tended to refer them to a period older than 1700 B.C.

BOSANQUET and SAYCE'S analysis of the observations may be made clearer to those who are not astronomers by a little explanation of the successive phenomena of the planet Venus. Venus, moving in an orbit smaller than the Earth's, must always appear to be much in the same direction as the Sun. She may sometimes be to the left of the Sun, sometimes to the right of him, but she is never more than 48° distant from him, and at her greatest distance crosses the meridian between three and four hours before or after him. The result is that she can only be seen in the morning before sunrise or in the evening after sunset, and if she is very near the Sun she cannot be seen at all, except that very clear-sighted people may sometimes see her near the Sun in broad daylight. We have no mention of any such observation at Babylon. Venus is therefore in succession:

(1) the evening star, Greek Hesperos and Latin Vesper;
(2) invisible;
(3) the morning star, Greek Phosphoros, Latin Lucifer;
(4) invisible;

and then the evening star again.

The synodic period or mean duration of the four phases is 584 days, while the length of the individual phases is variable. Five of these periods will last 2,920 or, more exactly, 2,919½ days; eight solar years are 2,922 days; 99 lunar months are 2,923½ days. The result is that a particular phase of Venus recurs at the same season of the year and month at intervals of eight years; only the return is not absolutely exact, for it falls about 2½ days earlier in the solar year and 4 days earlier in the lunar month. From this it follows that if a conjunction of Venus with the Sun falls two days after new moon, it may be expected to fall two days before new moon eight years later, but will not fall near new moon again till 64 years after the first date, when eight intervals of four days will have amounted to a complete month. At this recurrence the conjunction will fall 17 days earlier in the solar year, so that if the exact position of the calendar months in the solar year is not fixed, a phase of Venus may recur in the same month and on or near the same day of the month at intervals of 8, 56, 64, and even 112 or 120 years. When Venus at conjunction is between the Earth and the Sun, she is said to be at inferior conjunction; when the Sun at conjunction with Venus is between her and the Earth, Venus is said to be at superior conjunction.

The notice of the tablet by Bezold, *Catalogue of the Cuneiform Tablets in the Kouyunjik Collection of the British Museum*, vol. i (1889), p. 42, recorded the fact that it is in neat Assyrian characters, but added nothing further to our knowledge. It is there described as 'Astrological forecasts'. The second volume of this catalogue, also by Bezold (1891), contains notices of two other tablets which, as we now know, contain some of the same appearances and disappearances of Venus as K. 160. These are K. 2321 + K. 3032 and K. 7072. The first of these is described as 'Babylonian Astrological forecasts, which form, according to the colophon, the 63rd tablet of the Series "When Anu and Enlil".[1] The obverse begins "...-*na* disappeared in the west, remaining absent in the sky 3 days, and"'.[2] K. 7072 is thus described, 'Fragment out of the middle, $2\frac{1}{2}$ in. by $1\frac{1}{2}$ in. 7+...lines. Fragment of a text containing astrological forecasts for the various months, taken from observations of the Star Nin-sī-an-na'.[3]

In the fourth volume of the catalogue (1896) Bezold deals with three more tablets which are now known to preserve parts of our text. One of these, S. 174, is described as 'Fragment out of the middle $1\frac{7}{16}$ in. by $\frac{7}{8}$ in.; 9+...lines. Part of a text containing astrological forecasts taken from observations of the Sun', a somewhat misleading description of a text which gave little indication of its character. Another, Rm. 134, is described as 'Left half, upper portion, $2\frac{5}{16}$ in. by $2\frac{1}{4}$ in.; 10+ ... lines. Part of a text containing astrological forecasts similar to those of K. 7072'. Then follow the words in cuneiform with which each paragraph begins. The remaining text, Rm. II 531 is described as 'Fragment of the left half, $2\frac{1}{4}$ in. by $1\frac{5}{8}$ in.; 15+...lines; partly vitrified. Part of a text containing astrological forecasts for the various months, taken from observations of the d·Nin-sī-an-na,[3] and other stars'. As will be seen from Langdon's study, the document is not arranged by months, and is not taken from observations of any star except Ninsianna, i.e. Venus.

In 1898 Jastrow dealt briefly with K. 160 in his *Religion of Babylonia and Assyria*, pp. 371, 372, and translated select passages from the first and second part of the document. His translation differs in detail from Sayce's and in particular he correctly translates the intervals of disappearance as such; he recognized the hypothetical form of some of the appearances in the second part of the tablet, but still treats the statements in the first part as categorical; but his suggestions for the translation of the eighth line were equally unhappy with his predecessor's. He also made the suggestion that the document belonged to the series 'Illumination of Bel', i.e. to the series 'When Anu and Enlil', a conjecture that was destined to be confirmed by Schiaparelli's identification of this document with that represented by K. 2321 + K. 3032. On the whole Jastrow, unlike Bosanquet and Sayce, showed more interest in the astrological than in the astronomical significance of the documents.

In 1899 J. A. Craig published in *Assyriologische Bibliothek*, xiv, cuneiform texts of the documents belonging to the series known as the 'Illumination (?) of Bel', so far as he was able to recover them. No. 46 in this volume contains the text of K. 2321 + K. 3032 and of K. 3129, which professes to be the 63rd of that series. It is no discredit to Craig that his text should have been found to contain errors which are corrected by Langdon in this volume.

So far attention had nowhere been drawn to the partial identity of any of these different texts dealing with Venus phenomena. This was reserved for the Italian astronomer Schiaparelli, whose 'Venusbeobachtungen und Berechnungen der Babylonier', *Das Weltall*, 6. Jahrg.,

[1] Bezold gives the cuneiform text of this phrase. I owe this translation to Langdon.
[2] Langdon's translation.
[3] Printed in cuneiform.

Heft 23, 7. Jahrg., Heft 2 (1906), constitutes a most important study of the character and interpretation of these texts. He recognized that K. 2321 + K. 3032 contains fragments of two documents, one of which, on the obverse, is the same as the main document of K. 160, though, since both tablets are imperfect, the greater part of each lies outside the range of the other. This document, which he called C, he recognized as containing a continuous series of observations of appearances and disappearances of Venus, preserved for 21 consecutive years. He conceived that in its complete state it would have contained three Venus periods or 24 years. The document on the reverse of K. 2321 + K. 3032 which he called B was, he found, a series of actual observations of disappearances and appearances of Venus arranged according to the months in which they occurred, without any mention of the years to which they belonged. Relying unduly on the accuracy of the numbers in the published texts, he held that these observations were entirely distinct from those in Document C. The insertion which forms the second part of K. 160, which Schiaparelli called Document A, was found by him to be a table by means of which, given the time of any reappearance of Venus, the time of the next disappearance and reappearance could be computed, assuming mean intervals between the different phenomena. With a mean lunation of 29·5 days, he found that the intervals used implied a synodic period of 577·5 days, about 6·4 days less than the true period of 583·9 days. He noticed the close similarity of all these texts in form and character and in terminology, and laid stress on their all using exclusively what he regarded as the rare name *Nin-sī-an-na*, or, as he wrote it, *Nin-dar-an-na*, for Venus, from which he inferred that the three documents had their origin in the same astrological school, and therefore, since Document A professes to be copied from a Babylonian original, he inferred that all three documents must be of Babylonian origin. Bezold had already recognized that, while K. 160 is in Assyrian script, K. 2321 + K. 3032 is in Babylonian script. Schiaparelli, while exhibiting in full the recorded dates of disappearance and reappearance with the recorded intervals of invisibility, as he found them in the printed cuneiform texts, and in the case of Document C assigning them to their proper year in the series of 21 years, did not attempt a translation of any of the documents, but illustrated their character with a few examples. Like Sayce, he treated the expressions as categorical, but like Jastrow, to whom he does not refer, he translated the references to intervals of invisibility correctly. While realizing that the real value of the record for the Babylonians lay in the astrological omens, he neither collected these nor dealt with them in detail.

Among the most interesting parts of Schiaparelli's paper are his astronomical examination of Documents B and C and his attempt to determine the date of the observations contained in the latter document. He assumed that the dates exhibited on the tablets were not all observations in the modern sense, but that in a minority of instances observation had been impossible, and the recorded dates had been deduced by computation from other observations. Neglecting what appeared to be doubtful dates, he found that the intervals of invisibility at inferior conjunction yielded an *arcus visionis* of 5·42°, and with this value he proceeded to determine the series of years which would best agree with the recorded dates of the Venus phenomena. Since the tablets were found at Nineveh, he assumed that the observations must be older than the destruction of that city, which was then placed in 606 B.C., while an upper limit seemed to be provided by the reference in Document A to a disaster of the *ummān-man-da* or Manda hordes, with which he identified the *ummān-matti* (properly 'army of the land'), which suffers disaster in Documents B and C. Believing that the *ummān-man-da* made their first appearance in history in the eighth century before Christ, and being impressed by their complete absence from the extensive records of Ashurnasirpal II, Shalmaneser III, and Shamshi-Adad V, whose reigns extend from 882 to 810 B.C., he concluded that his inquiry could be limited to the seventh and eighth centuries before Christ. He found that the solution depended on the assumed position of the Babylonian months in the solar year. With a mean date for the 1st of Nisan 16 days after the spring equinox, he found 657 B.C. as the first of the series of 21 years; with mean 1st of Nisan 18 days after the equinox he found 665 B.C.; with mean 1st of Nisan 11 days before the equinox he found 812 B.C., in which case the 17th year, with which the defeat of the *ummān-man-da* was connected, fell in the year 796 B.C. and would, so he thought, be the earliest well-attested reference to that people. Finally he found that with the mean 1st of Nisan five or seven days later than the equinox, the data would be satisfied by a series of years beginning in 868 or 876 B.C. respectively. He left it to orientalists to determine whether so early a reference to *ummān-man-da* was possible. He felt, however, that the dates 657, 665, and 812 B.C. were more probable, but that new discoveries and investigations would be necessary to decide the question. As an example of method this work is excellent. Unfortunately for these conclusions, the Manda are now known to have been mentioned as far back as the Hittite laws of the seventeenth century B.C. A clue to the date had yet to be discovered.

In 1908 appeared the two parts *Sin* and *Ishtār* of Virolleaud's *L'Astrologie Chaldéenne, Texte Cunéiforme*, the former of which contained those documents believed to belong to the book entitled *enuma* (Anu) *ilu* *Bel* (now read *enuma Anu ilu En-lil*) which dealt with the Moon and the latter those which dealt with the fixed stars. The frontispiece to *Sin* is a photograph of K. 160. No. XII in *Ishtār* is a composite text, in which lines 1–15 are lines 1–15 of the obverse of K. 2321 + K. 3032, lines 16–27 are a conflate text based on lines 16–27 of K. 2321 + K. 3032 and lines 1–14 of the obverse of K. 160, and lines 28–43 are lines 15–30 of K. 160, ending where the series of observations is interrupted at the conclusion of the first part of that document. No. XIII is the second part of K. 160. No. XIV is the third and concluding part of K. 160. No. XV is the reverse of K. 2321 + K. 3032. A transcription of these texts was published by Virolleaud in 1909 in *L'Astrologie Chaldéenne, Transcription, Ishtār*. The same editor published in 1910 a *Supplément* to his *L'Astrologie Chaldéenne*, in which he included as No. XLI the cuneiform text and transcription of Rm. 134, and as No. XLII the cuneiform text and transcription of K. 7072. He also included the cuneiform text of S. 174 in his 'Fragments astrologiques', published in the same year in *Babyloniaca*, iii. 285.

1910 is also the date of Father Kugler's *Im Bannkreis Babels*. In a note on pp. 147–8, he showed that, reckoning the month at a conventional length of 30 days and the year at a conventional length of 360 days, the insertion in K. 160—Schiaparelli's Document A—implies a synodic period of 587 days.

Next in order of time comes Jastrow's German treatise, *Die Religion Babyloniens und Assyriens*, II. Band, II. Hälfte, pp. 617–25, which bears on its title-page the date 1912, though the earlier part of the half-volume was in the hands of scholars in time to be used by them in works which appeared in 1911 and 1912. In this treatise Jastrow makes use of Virolleaud's work, but appears to have been ignorant of Schiaparelli's. He gives a translation of the texts of the two documents which Schiaparelli had called B and C, beginning with the 12th line of the obverse of K. 2321 + K. 3032. He regards the two documents as a single text broken by a gap of unknown length. Though he recognizes that the dates on the tablets are

derived from observation, he attempts no astronomical control, and his emendations of dates are in consequence unfortunate. The references to the appearances are recognized as hypothetical throughout. The mysterious phrase in the eighth line of the obverse of K. 160, the twenty-first of the obverse of K. 2321 + K. 3032, once more has a false meaning found for it, but Jastrow's interest was mainly in the omens and in their relation to the phenomena. He imagined that he had discovered that a medium interval of invisibility was accompanied by a favourable omen, while an interval which was short or long for its particular phase was accompanied by an unfavourable omen, a somewhat curious result since in the same work he translates in full Sm. 781, col. ii (Virolleaud, *Supplément*, No. XXXVII), which gives omens in good general agreement with those of K. 2321 + K. 3032, but makes them depend entirely on the month in which Venus disappears, giving different omens according as the disappearance is in the morning or in the evening, and taking no notice of the duration of invisibility. Jastrow also translates the insertion (Schiaparelli's A) but in view of the schematism of its intervals of visibility and invisibility, and, as he thinks, of its omens in relation to the season of the year for the different phases, he suspects that it is merely a school exercise.

In 1911 Weidner contributed to *Memnon*, v 29–39, a paper entitled 'Die astronomische Grundlage des Venusjahres', in which he included a transcription and translation of this insertion, deduced from it the knowledge of a synodic period of Venus amounting to 584 days, and by a somewhat bold argument tried to show that the document in its original form dates from the end of the fifth millennium before Christ.

In 1912 Kugler produced Teil II, Heft I, of the second book of his *Sternkunde und Sterndienst in Babel*. Pp. 257–311 of this publication are concerned with the two Venus tablets which had engaged the attention of Schiaparelli and with discussions arising out of them. He writes with full knowledge of the work of his predecessors, but gives neither full text nor full translation of the documents, nor even a full *résumé* of Schiaparelli's criticism on which he builds. In order, therefore, to follow Kugler in detail it is necessary to refer to the older studies of the documents. He has, also, chosen to rename the documents and in so doing has used Schiaparelli's names in a new sense. Thus Schiaparelli's A is Kugler's B. The text of Schiaparelli's B, found on K. 160, is Kugler's A, and the two texts, B and C in Schiaparelli's notation, found in K. 2321 + K. 3032, are called by Kugler, A′. I prefer, with Schiaparelli, to use the letters of the alphabet as names for documents, in preference to Kugler's system, in which the nomenclature is partly by documents and partly by tablets, but in order to avoid the confusion of using a symbol in a different sense from that in which it has been used by Kugler I will in the present study use the terms L, M, and N, which have not hitherto been used in this connexion.

L is the document in which the phenomena are arranged in chronological order, and is equivalent to Schiaparelli's B. It is found on K. 160, Obv. 1–29, Rev. 34–45; K. 2321, Obv.; Rm. II, 531; W. 1924, 802, Obv.

M is the document in which the phenomena are arranged in calendarial order, and is equivalent to Schiaparelli's C. It is found on K. 2321, Rev.; K. 7072; Rm. 134; S. 174.

N is the document containing an artificial series of phenomena, inserted in K. 160, and is equivalent to Schiaparelli's A. It is found on K. 160, Obv. 31–Rev. 33.

Kugler devotes some space to a more detailed demonstration of the conclusion, which he had drawn from Document N, that its compiler regarded 19 months 17 days or 587 days as the conventional length of the synodic period of Venus, and replies to SCHIAPARELLI's deduction of a period of $577\frac{1}{2}$ days and WEIDNER's deduction of one of 584 days. KUGLER is undoubtedly right, so long as we recognize that the conventional month is not an exact period independent of the calendar month, but is merely the calendar month reckoned inexactly. The writer would not expect the synodic phenomena to recur at a mean interval of 587 days precisely, but at an interval of 19 months 17 days which might be treated for purposes of computation as 587 days, but would not be so treated for purposes of observation. The observer would look for a repetition of the phenomena after 19 calendar months 17 days, ignoring intercalary months. It seems impossible to convert this into an exact number of days, and we must not suppose that the writer imagined that he knew the exact number of days in the synodic period.

After a few explanatory remarks KUGLER proceeds to give a transcription and translation of K. 160, obv. lines 1–14, as a specimen of the character of the text. Like the earlier translators he treats the references to phenomena as categorical. Then follows a tabular presentation of the phenomena contained in Document L, so far as it is represented by K. 160. This is followed by a discussion of some length in which very little use is made of K. 2321 + K. 3032, and the impression is created that the discussion was written before KUGLER was aware that the two tablets represented the same document, and was only imperfectly revised afterwards. The discussion begins with a presentation of late Babylonian material illustrating the length of the synodic period of Venus and the intervals between the different appearances and disappearances. He then proceeds to deduce the intercalary years from the intervals separating the phenomena recorded in K. 160. Here he fails to show his usual arithmetical skill. Using * for a year with second Adar and ** for a year with second Ulul, he gives the following as intercalary years. [For convenience I number the years from the beginning of Document L, adding 6 to the number given by KUGLER.] (9)* or (10)**, (11)**, (14)**, (17)*, (19)**, of which (11)** and (19)** are directly attested. If he had reckoned the intervals accurately he would have found (9)* or (10)**, (11)**, (13)**, (19)**, (20)** or (20)*.[1] Or, accepting his conjectural emendation of the western rising in the 13th year, he should have had (9)* or (10)**, (11)**, (13)* or (14)**, (19)**, (20)** or (20)*. These will be discussed later along with the other intercalary years.[2]

Then follows a critical and in large measure successful investigation of errors made by copyists, followed by a very unconvincing attempt to detect and explain errors which appear to go back to the parent document. There remains a residuum of dates which KUGLER regards as trustworthy and which are reserved for an astronomical test when a clue shall have been found to the age of the tablet. The dates so selected have at least the merit of not being prima facie incoherent. One group among them is affected by textual uncertainty. The others are probably among the best in the series.

KUGLER next endeavours to prove that the constant values used for intervals in Document N are derived from the figures contained in Document L, or in that part of it which is represented by K. 160. The whole argument appears to be a piece of arithmetical jugglery. It is based upon arbitrary assumptions as to the length of mean lunation used by the author of N, now 30 days, now $29\frac{1}{2}$ days, as suits KUGLER's convenience. It is based on arbitrary assumptions

[1] The dates of observations at inferior conjunction in Adar of the 17th year and at superior conjunction (Sivan-Ulul) in the 20th year show that there was only one intercalation between these conjunctions.

[2] KUGLER is in fact merely repeating an error made by SCHIAPARELLI, who found that Years 9, 11, 14, 17, and 19 were intercalary.

as to his use of intercalary months, and it is based on arbitrary assumptions as to the extent to which the corruptions, existing in K. 160, were in the text used by the author of N. It also assumes what seems very doubtful, that the first five years of the text of L were already missing in the older text from which N is derived, while the sixth year, which is also missing from K. 160, is supposed to have been present.

Then KUGLER announces his great discovery, that the misunderstood words in line 8 of the obverse of K. 160, line 21 of the obverse of K. 2321 + K. 3032, are the year-formula of the eighth year of Ammizaduga, and this announcement is followed by a table giving the complete series of dates recorded in Document L as obtained from a combination of K. 160 with the obverse of K. 2321 + K. 3032, such a table as SCHIAPARELLI had previously compiled. Here it is shown that the year-formula in question belongs to the eighth year of the twenty-one years of the document, which, as KUGLER rightly concludes, contains the twenty-one years of the reign of Ammizaduga.

Then comes an exposé of the dates on the reverse of K. 2321 + K. 3032 (Document M). KUGLER ignores SCHIAPARELLI's recognition of these as a single series of observations arranged according to the months in which they fell, and breaks them up into three series. First he finds a series of four pairs of observations near inferior conjunction arranged in calendarial order, then five pairs near superior conjunction the order of which he does not explain, and finally three pairs of observations consisting of one at inferior, one at superior, and another at inferior conjunction. He supposes that the two first of these three are in chronological order, but infers from the duration of invisibility in the last that it cannot follow chronologically its predecessor on the tablet. On the whole he realizes that these observations are not chronologically continuous with those in Document L, and pays no further attention to them. He also ignores the astrological omens.

Then he resumes his comparison of the dates of Document L with those of the reign of Ammizaduga and points out that the leap-years in the reign of Ammizaduga known to us through contracts are 4*, 10**, and 11**, where, as before, * indicates a year with second Adar and ** a year with second Ulul. This, as he points out, is the only example known to us of a second Ulul being intercalated in two successive years,[1] and this is supported by the intercalations in Document L, where, as has been seen, a second Ulul is directly attested in the eleventh year, while the tablets imply either a second Adar in the ninth year or a second Ulul in the tenth year and are therefore consistent with a second Ulul in the tenth year.

Having established that the observations belong to the reign of Ammizaduga, KUGLER next seeks an astronomical verification. He points out that each observation of an appearance or disappearance of Venus, being dated by the lunar month, involves a more or less definite relation between the Sun, Venus, and the Moon. The reference to Ammizaduga limits the inquiry to a few centuries, and he assumes that he need only examine dates falling between 2080 and 1740 B.C. He does not regard the position of the Babylonian months in relation to the Julian calendar as absolutely fixed, but thinks it safe on a superficial examination of contracts relating to harvest to suppose that Nisan began not earlier than the middle of the Julian March nor later than the middle of the Julian June. In order to avoid elaborate computations he examines in the first instance one pair only of the dates which he had previously found to be

[1] We now know that second Ulul was intercalated in the 39th and 40th years of Hammurabi, and in the 8th and 9th and again in the 16th and 17th years of Samsuiluna.

trustworthy, the western setting of Venus in the 6th year on Araḫsamna 28, followed by her eastern rising on Kislev 1, an interval of three days only, from which he concludes that the inferior conjunction must in that year have been within two or three days of the new moon of Kislev. He then seeks between 2080 and 1740 B.C. for inferior conjunctions between the middle of November and middle of February of the Julian calendar falling within two or three days of new moon. He finds nine such phenomena, but he has for some reason overlooked the conjunction of −1759 February 1. He then proceeds to narrow the selection further by the assumption, which, even if the computed dates of conjunction and new moon were beyond doubt, would not be astronomically justifiable, that the interval between new moon and conjunction must not exceed a day. In this way he has only three solutions left. These would make the first year of Ammizaduga begin in 2041, 1977, and 1857 B.C. respectively. After noticing that of these three dates 1977 B.C. agrees best with the conclusions hitherto attained by Assyriologists and historians, KUGLER proceeds to test it by an astronomical computation of the angular depression of the Sun below the horizon at the time of rising or setting of Venus on a series of dates of first or last visibility of that planet, as given in Document L. The test is made almost entirely by means of observations near inferior conjunction, only two pairs of observations near superior conjunction being subjected to the test. Altogether KUGLER finds two instances where both the dates of evening setting and morning rising are confirmed by computation, four instances where one of the two is confirmed, two instances where both dates would hold good for observations separated by eight or sixteen years from the years implied in the document, and three instances where one observation in each pair would hold good if transferred eight or sixteen years backwards or forwards. He also finds two instances where the date given for evening setting would hold good for morning rising. In the last of these instances, belonging to the 13th year of Ammizaduga, he has exhibited no computation, and it would appear that his statement that Venus should be visible on Ayar 5 of that year is even on his own data erroneous, and should be changed to Ayar 7, which is inconsistent with his proposed correction of the reading in the text. From the frequency with which he has succeeded in explaining apparently false dates by transferences of genuine dates by eight or sixteen years KUGLER infers that the compiler of our Document L had before him a list of observations in chronological order in which several of the dates were missing or illegible and that these have been restored from a document similar to Document M in which the observations were arranged in calendarial order without any indication of the year to which they belonged. To this it may be replied that, so long as the recorded dates are in the neighbourhood of the computed dates, any conceivable discrepancy could be explained by KUGLER's method. If a recorded last visibility falls a few days before, or a recorded first visibility a few days after, the computed date, we merely assume that Venus was missed for a few days. If the difference between observed and computed dates is in the opposite direction or is too long to be explained by this method, we merely transfer the observation eight or sixteen years backwards or forwards, for since the phenomena always recur four days earlier in the lunar month at the end of each eight-years period any discrepancy not exceeding eight days can be explained in this way. The combination of these devices gives a far better result on the assumption that the pair of observations in the 6th year really belongs to that year than on the assumption that it has been transferred eight years. The date 1977 B.C. for the first year of Ammizaduga is therefore supposed to be established as against 1985 B.C.

It remains to compare it with a possible 2041 or 1857 B.C. This time the test is no longer strictly astronomical. As has been remarked in our discussion of BOSANQUET and SAYCE, after the lapse of an eight-years period, a conjunction of Venus falls about $2\frac{1}{2}$ days earlier in the solar year than it had done at the beginning of that period. In 64 years the date of the phenomenon in the solar year is shifted by 19 days, and in 120 years it is shifted by 35 days. KUGLER doubted whether an astronomical verification would yield a decisively different result so far as the comparison of computed appearances and disappearances of Venus with the lunar calendar is concerned, but he considered it possible to discover by means of literary evidence at what season the months named on our documents fell, and thus to choose between theories which placed those months at perceptibly different seasons of the natural year. With this end in view he began by computing the date of equinox for each year from the 7th to the 21st of Ammizaduga on the assumption that his first year began in 1977 B.C., and the date of the new moon of Nisan for each of these years on the assumption that the months in which the phenomena were recorded had been correctly identified in his astronomical study. This of course included the assumption that his inferences as to the position of intercalary months were correct. As has been seen, he places the beginnings of the 18th, 19th, and 20th years one month too late. When, therefore, he deduces that on the theory in question the mean interval between the equinox and the 1st of Nisan was 35·15 days, we must correct this figure by deducting $29{\cdot}53 \times \frac{3}{15}$ days, i. e. 5·91 days, so that the mean interval becomes 29·24 days. In view, however, of the fact that the first and last years of this series both began later than the mean date, KUGLER thought it wise to include the 6th year, which he assumed to be a leap-year with second Ulul. He overlooked the fact that this assumption would place eleven lunar months approximately between inferior conjunction in the 6th year and superior conjunction in the 8th year, an interval too long by one month. It will be seen, therefore, that he places the beginning of the 6th year one month too early, so that his mean interval between equinox and the new moon of Nisan as determined from the 16 years requires to be reduced by $29{\cdot}53 \times \frac{2}{16}$ days, i. e. by 3·69 days, or from 34·59 to 30·90 days. Adding 1·50 days for the mean interval between new moon and the beginning of Nisan, he obtains a mean interval of 36 days between equinox and Nisan 1, and fixes the mean position of the latter at April 26 of the Gregorian calendar. Adopting the above revision of the position of his intercalations, we find that April 22 would have been more correct. He notes that the earliest new moon of Nisan in these 16 years fell 23 days before the mean date, and the latest 16 days after the mean date. Making the corrections mentioned above, the extremes should be 29 days earlier and 26 days later than the mean date. KUGLER contrasts this mean date for Nisan 1 with that which he found for the period 358 to 339 B.C., when it was April 4 Gregorian. It will be seen from the table which he published on p. 285 of the study under discussion that if he had chosen to shift his whole chronology by seven Venus periods, or 56 years, all the lunar dates would have fallen 18 days earlier in the solar year, and we should have had April 4 for the mean date of Nisan 1 in the years 6–21 of Ammizaduga as well as in the years 358–339 B.C.

KUGLER then proceeds to demonstrate to his satisfaction that such a transference of the calendar months by 18 days backwards or forwards is inconsistent with the information supplied by those dated contracts which can be connected with agricultural operations. He cites from modern writers the opinion that the Babylonian harvest season begins about May 10 and closes about the end of that month. These dates probably relate to wheat-harvest, and it will be seen later that they are far too late for barley-harvest, which was the principal harvest in the time of the first dynasty of Babylon, and that the correct date is from about April 10 to May 15, so that KUGLER's error in the date of harvest exactly coincides with the difference between a year beginning in the mean on April 4 and one beginning in the mean on April 26. If, therefore, the evidence which KUGLER has collected supports his chronology on the assumption that his date for harvest is correct, it would support a chronology falling 56 years later, when the correction just mentioned is applied.

KUGLER then produces a series of contracts from KOHLER and UNGNAD's *Hammurabi's Gesetz.* He deals first with contracts to make payments in silver or barley 'at the time of harvest' and finds that these generally imply that the harvest was later than the eleventh month, while six contracts imply that it fell in the twelfth month at the earliest, and two contracts of the reigns of Sinmuballit and Hammurabi would place it at the earliest in the first month. Then he cites from the same source a series of contracts hiring labourers for the coming harvest. The latest dated of these is on the 30th day of second Adar in the 4th year of Ammizaduga, which KUGLER equates with April 30 Gregorian. This he considers fatal to any attempt to throw the chronology 56 or 64 years farther back, which would bring it to May 18 or May 16. Of course, if we threw back the date of harvest 22 days, this contract would tell with equal force against KUGLER's own solution.

KUGLER then proceeds to deal with contracts for letting fields. He gives examples from KOHLER and UNGNAD of such contracts for every month from Araḫsamna to Ayar, citing altogether 19 from Ayar, 9 from Nisan, 2 from Adar, 1 from Šabat, 1 from Tebit, 1 from Kislev, and 9 from Araḫsamna. A reference to KOHLER and UNGNAD will, however, show that two of the last-named really belong to Tešrit, and KUGLER himself treats one of them as belonging to Tešrit in his discussion. He supposes that contracts dated in Nisan and Ayar were made after harvest, while those dated in other months were made before harvest, and infers that Nisan was the proper harvest month. This argument appears to be very precarious. The agricultural operations of the year would not be concluded until the corn was threshed and divided between landlord and tenant. It may be presumed that a contract for the new year was generally made before these operations were concluded, but it seems unsafe to suppose that such contracts were regularly made after harvest. KUGLER, however, uses it as a means to prove that the chronology cannot be reduced by 56 years, in which case he remarks that Ayar, not Nisan, would be the harvest month, and the Ayar contracts could not be made to fall after harvest. He also supposes that the Araḫsamna and Tešrit contracts were made immediately before seed-time, which, according to him, would be in November and December. This he thinks is consistent with the solution which he favours, but inconsistent with one 64 years earlier, which would place these contracts at the end of December. This again appears to be a precarious argument. It should be noted that contracts for letting fields are to be found in KOHLER and UNGNAD in every month of the Babylonian year. KUGLER's selection is far more exhaustive in Nisan, Ayar, and Araḫsamna than in the other months, and must not be taken as evidence of the actual distribution of lettings throughout the year. KUGLER's final conclusion is that the contracts by which Babylonian months can be correlated with definite seasons of the year exclude all solutions separated by 56 years or more from that which makes the first year of Ammizaduga begin in 1977 B.C., while solutions differing by less than 56 years from this solution are astronomically inadmissible.

The whole discussion must be regarded as a masterly piece of work, and while it is open to criticism in detail, the method is excellent. It is to be regretted that KUGLER did not attempt a more complete astronomical computation of the recorded phenomena both on his own and on alternative theories, and also that he adopted a questionable date for harvest, and thus weakened the effect of the contracts as a means of deciding between rival astronomical theories.

The discussion is followed by a chapter on the relative positions of the First, Second, and Third Babylonian Dynasties, which lies outside the scope of my share in the present work.

KUGLER's conclusions met with general acceptance, but doubt was expressed in 1913 by EDUARD MEYER, *Geschichte des Altertums*, 3ᵉ Aufl. i. 2, pp. 369–72, who, while provisionally accepting KUGLER's chronology, expressed himself unable to check his astronomy or to judge of the correctness of his conjectural emendations of the text. He found the chronology in good agreement with that current in later times in Babylon, but in disagreement with that current in Assyria, and pointed out that it requires us to assume that more than five hundred years (1925 to 1380 B.C.) elapsed without any private documents and with hardly any inscriptions. 'He therefore regarded it as not excluded that these dates might hereafter be found untenable.[1]

In the following year WEIDNER expressed the opinion that KUGLER's restoration of the chronology of the First Dynasty of Babylon was extremely problematical. See his *Alter und Bedeutung der babylonischen Astronomie*, p. 69, where, founding on a neo-Babylonian tablet published by KING in *Cuneiform Texts*, xxxiii, and on an unpublished duplicate of the same, according to which the vernal equinox appears to be placed on Nisan 15, he drew the inference that at least since the time of Hammurabi Nisan 15 coincided in the mean with the vernal equinox, a conclusion inconsistent with KUGLER's, which appeared to place it 50 days in the mean after the equinox.

In 1915 KING expounded and discussed the new chronology in his *History of Babylon*, pp. 106–18. He mentions KUGLER's three astronomical solutions, and decides with KUGLER for 1977 B.C. as the date of the first year of Ammizaduga on the ground that this agrees with the duration of 368 years which the kings' list assigns to the Second Dynasty, and he finds it supported by both Babylonian and Assyrian statements of a later age.

In 1917 there appeared in MVAG. xx, 1915, 4, a long article by WEIDNER entitled *Studien zur assyrisch-babylonischen Chronologie und Geschichte auf Grund neuer Funde.* On p. 24 of this article WEIDNER announced that an astronomical examination of the Venus tablets would shortly appear, from which it would be seen that the most probable date for the First Dynasty of Babylon lay 168 years later than KUGLER's. This new chronology was brought into connexion with the chronology of Assyria, and WEIDNER maintained that it agreed with all the statements of a later age except those of Nabuna'id.

We learn from a later paper by WEIDNER [2] that the new examination of the Venus tablets was the joint work of himself and NEUGEBAUER and that it involved some corrections of the text. In 1925 SCHNABEL[3] published the fact that the manuscript of this study was lost in the German revolution of 1918.

In 1920 HOMMEL, in an appendix to *Assyr. Bibl.* xxv, Nies, 'Ur Dynasty Tablets', pp. 197–9, expressed the view that the year-formula of Ammizaduga's 8th year was inserted into the Venus tablets by a scribe in the reign of Ashurbanipal, who adopted a system of chronology current

[1] The same criticisms had been expressed by MEYER in *Sitzungsberichte d. k. preuss. Akad. d. Wissenschaften*, 1912, pp. 1063, 1064, except that he did not on that occasion suggest that KUGLER's dates might hereafter be found untenable.

[2] MVAG. xxvi (1921), 2, p. 41.

[3] ZA. xxxvi, p. 113.

from the eighth century B.C. onwards, which placed all early dates about 170 years too high. HOMMEL was thus able to accept KUGLER'S identification of the recorded phenomena while accepting a historical chronology falling seven years later than WEIDNER'S. This curious suggestion implies that the scribe who inserted the year-formula knew the true interval of time that had elapsed since the Venus observations, but was in error to the extent of 170 years in his historical chronology, a most improbable supposition. It also ignores the agreement between the intercalations implied on the tablets and those supplied by the contracts of the reign of Ammizaduga. As will be seen, this agreement can be checked throughout the whole reign of Ammizaduga. In 1920 UNGNAD, in ZDMG. 74, p. 425, expressed doubt about the reliability of KUGLER'S chronology on the ground that it placed the delivery of dates too late in the year. In support of this view UNGNAD cited VS. xiii 18, which has since appeared as No. 1724 in the sixth volume of his *Hammurabi's Gesetz* (1923). He states that in this document the delivery of dates was fixed for Kislev 1, or, as he thinks, at the same time of year as in late Babylonian times when Nisan 1 fell approximately between the middle of March and the middle of April of the Gregorian calendar. The document selected by UNGNAD was certainly unfortunately chosen. It asks for payment not on Kislev 1, but merely in Kislev, thus permitting the tenant to postpone payment to the last day of Kislev. The document belongs to the 23rd year of Hammurabi, in which year the last day of Kislev would fall on or about December 25 Gregorian according to KUGLER'S chronology. This is certainly late for a delivery of dates, but, as LANGDON has pointed out to me, the contract requires the delivery not only of dates, but of planks of wood, and even of 10 talents of palm branches blown down by the wind, which would hardly be available until the winter storms had begun. It may also be noted that even in the Persian period Kislev was an unusually late season for requiring delivery of dates. In 1921 UNGNAD repeated in OLZ. 24, 17, his doubt of the trustworthiness of KUGLER'S conclusion, adducing the difficulty of reconciling it with the Assyrian king list as well as its failure to place the date-harvest at the proper season, and expressed a desire to see the rival examination of the Venus tablets which WEIDNER had adumbrated.

So far the strictly astronomical part of KUGLER'S reconstruction of the chronology had remained unanswered, and his calendarial study had been questioned on very unconvincing evidence, WEIDNER'S argument assuming (1) that the astronomical statements of a neo-Babylonian document represented the state of the calendar under the First Babylonian Dynasty, and (2) that the fixed Nisan of that document was identical with the mean Nisan of the lunar calendar, while UNGNAD'S argument rested on a single date-contract, whose relevancy to the calendarial question was at least doubtful. It may, therefore, seem strange that in 1922 KUGLER, in his *Von Moses bis Paulus*, pp. 497-501, announced his conversion to the late date for this dynasty, mainly because of the arguments which WEIDNER and UNGNAD had adduced. The first objection which he brings against his former conclusion is the well-known one that it is inconsistent with the Assyrian chronological tradition [1], but he regards this as inconclusive in view of the support which it receives from the Babylonian chronological tradition. The second objection is based on the dates of autumn lettings. Seed-time according to his information was in November and December, from which he infers that the latter half of October would be the most likely time for autumn lettings. He finds that the contracts of Araḫsamna 20 in the 10th year of Ammizaduga and of Tešrit 28 in the 14th

[1] It will be seen from LANGDON'S reconstruction of the Assyrian and Babylonian chronology that there is no such inconsistency.

year of Ammizaduga fall on December 14 and December 8 Gregorian respectively, according to the solution which he had propounded, and he regards these as suspiciously late dates. But, as has been seen, such contracts are distributed throughout the whole year and prove little or nothing. His third objection to his original solution is based on the date-harvest. He argues that the date-harvest must have been in Tešrit, because the division of the crop between landlord and tenants is repeatedly mentioned as due in Araḫsamna. He cites one contract for delivery in Araḫsamna and one for delivery on Araḫsamna 1. He also cites II Raw. 15, 40 c.d., for delivery on Araḫsamna 30. He had apparently overlooked LANGDON'S paper, RA. xiv (1917), pp. 16–19, in which this date is shown to belong to a grammatical exercise and to have no bearing on the delivery of dates. KUGLER computes that on his original solution the mean Araḫsamna 1 would be November 19 of the Gregorian calendar, which he regards as too late for delivery of dates, since according to him the date-harvest falls in September and October. By reducing his chronology 120 years he thought he would transfer this date to October 15, and by reducing it 176 years he would transfer it to September 28. The argument does not appear to be conclusive, though it suggests that some reduction in the chronology would improve the agreement with date-harvest.

On these grounds KUGLER rejected his original solution and imagined that with it the late Babylonian chronological tradition must also be abandoned. If so, he felt that the Assyrian tradition must be adopted, which he thought inconsistent with a reduction by 120 years only, and he therefore decided on a reduction by 176 years. This had in his eyes, as in WEIDNER'S, the further merit of bringing the vernal equinox into an approximate coincidence with the mean Nisan 1. He did not review the arguments by which he had previously applied the contracts for payments at the time of harvest nor the contracts for hiring labourers. Thus while the rejection of his original theory was based on the contracts bearing on the seasons of the year, his new solution was only preferred to an intermediate solution on the evidence of a supposed Assyrian chronological tradition and on a very doubtful interpretation of a late astronomical text. It was not supported by a single computation of an appearance or disappearance of Venus, but it was naïvely assumed that these phenomena would be separated by the same intervals of time from the conjunction of 1796 B.C. December 1 by which those computed for the original solution were separated from the conjunction of 1971 B.C. January 23.

In 1923 LANGDON published the second volume of the *Oxford Editions of Cuneiform Texts*, including the chronological prism, W. 444. In order to obtain a basis for the reduction of the dates on this prism he requested me to examine the astronomical data on which KUGLER had based his two systems of chronology. The time available before the publication of his work was not sufficient to permit a recomputation of all the observations contained on the tablets, much less to permit a discussion of the motion of Venus in the light of all the ancient observations. But it was clear to me that the table in KUGLER'S *Sternkunde und Sterndienst*, ii 285, on which both his earlier and his later determination of the date of the 6th year of Ammizaduga depended, suffered from two defects: (1) the dates given for conjunction and new moon depended on tables which did not take account of the latest values for the motion of the Sun and Moon, nor of such corrections to the motions of Venus as seemed to be implied in the acceleration of the Sun which I had evaluated from ancient observations; (2) the table took no notice of the duration of invisibility of Venus, but only of the date of conjunction. The duration of invisibility was, as has been seen, computed by KUGLER for his earlier solution, but for no other solution. Since the duration of invisibility at a given place is dependent on the geocentric latitude of the planet, which in its turn is mainly dependent on the heliocentric latitude of the planet, which is dependent on the distance of the planet from its node, and since at inferior conjunction the longitude of the planet is always exactly 180° different from the longitude of the Sun, the duration of invisibility will depend on the distance of the Sun from the planet's node, but since the node changes its longitude very slowly the duration of invisibility may be said within a range of a few hundred years to depend entirely on the longitude of the Sun, or in other words on the season of the year. It was therefore to be expected that since KUGLER's different solutions placed the conjunction in question at different seasons of the year, they would be accompanied by different geocentric longitudes of Venus and different durations of invisibility. In this way I found that the solutions lying 112 or more years later than KUGLER's earlier solution were inconsistent with an invisibility of three days only. I found that a solution 56 years later than KUGLER's earlier solution would stand the test of the observations in question, and I found that if the apparent acceleration of the Sun's motion were explained by a change in the length of the day and if a corresponding apparent acceleration were assumed in the motion of Venus, Venus would not be visible on the day which KUGLER had originally regarded as the 28th of Araḫsamna, the day of her last visibility in the 6th year of Ammizaduga. I therefore inferred that, if this explanation of the solar acceleration was correct, the 6th year of Ammizaduga must have been 1916–1915 B.C. and the 1st year of Ammizaduga, 1921–1920 B.C. This conclusion was published by LANGDON in the preface to the second volume of *Oxford Editions of Cuneiform Texts* (1923).

At that time I was employing HERR CARL SCHOCH of Berlin on the reduction of certain ancient eclipses, and when he had finished this task I thought the most useful work that I could give him would be the reduction of ancient planetary observations, in order to see whether they afforded evidence of an apparent acceleration. SCHOCH computed for me the angular distance of the Sun below the horizon at all late Babylonian observations of first or last visibility of Venus, but as soon as I had introduced him to the Venus tablets his mind began to run on a possible restoration of ancient Babylonian chronology and even on a continuous restoration of the Babylonian calendar by means of the recorded intercalary months. He also formed the idea of using references on contracts to the 30th day of a month as a test for the computed interval between two successive first appearances of the lunar crescent, thus providing a new astronomical criterion for deciding between rival restorations of the Babylonian calendar. In the hope of obtaining more information than was given in KUGLER's *Sternkunde und Sterndienst* about contracts containing intercalary months he entered into a private correspondence with KUGLER, and thus provided that scholar with material which he partly misunderstood and which he used in his *Sternkunde und Sterndienst in Babel*, Buch II, Teil II, Heft 2 (1924), pp. 622–7. This Heft is a valuable contribution to the chronology of the last nine centuries before Christ, but also contains, on pp. 563–71, a discussion of early Babylonian chronology, which reproduced with small verbal changes the discussion which had already appeared in *Von Moses bis Paulus*. The earlier parts of the Heft would appear to have been printed off before KUGLER had arrived at his new conclusions, and it is only in the concluding pages that notice is taken of my work. The computations, but not the conclusions, contained in those pages are due to SCHOCH, who had compiled, in 1922, tables for the rapid computation of the phases of the Sun, Moon, and planets, and who had also compiled tables for computing the first visibility of the moon, based on late Babylonian data. He also constructed, in 1924, tables for the rapid conversion of Babylonian dates into dates of the Julian calendar, in which the inequalities in the Moon's

motion and the irregularity of Babylonian intercalation are disregarded, but which will in about 80% of cases place the beginning of a Babylonian month on the right day, though there is room for an error of one day, and though it may sometimes be necessary to re-identify the months according to the theory that is adopted of their position in the natural year and of Babylonian intercalation.[1] KUGLER's study will be noticed in its proper place so far as is necessary for the purposes of the present work. In June 1924 I engaged SCHOCH to come to Oxford to assist me in a study of the whole problem. Before leaving Germany he had on his own account contributed a brief note on the bearing of astronomy on the subject to *Astronomische Nachrichten*, Band 222 (1924), pp. 27, 28, in which he stated that according to his tables a last visibility of Venus on the evening of Araḫsamna 28 followed by a reappearance on Kislev 1 was possible only in 1971 and 1915 B.C. within the 3,000 years following 3000 B.C. He himself regarded 1915 B.C. as the correct date.

The present study is largely the result of SCHOCH's co-operation with me. Almost all the astronomical computations were made by SCHOCH with the aid of his own tables; the restoration of the calendar is my own work, and supersedes a restoration which SCHOCH had attempted with less complete material. The references to 30-day months were collected by SCHOCH and have been verified and revised by me with LANGDON's assistance. The subject was a matter of daily discussion between SCHOCH and myself while he resided with me from June to December 1924. In October 1924 we learned from DR., now PROFESSOR, SCHNABEL that he had discovered that K. 7072 and Rm. 134 were fragments of Document M, and he afterwards drew our attention to the value of the fragments contained in Rm. II, 531, and S. 174.[2] With the aid of the two first-named of these tablets together with the omens, which SCHIAPARELLI and KUGLER had ignored, he drew the conclusion that M contains the same observations as L, but that, whereas they are arranged in chronological order in L, they are arranged in calendarial order in M. He also emphasized the importance of the omens for the reconstruction of the text. In December 1924 M. THUREAU-DANGIN communicated to SCHOCH at the joint request of SCHOCH and LANGDON for use in our work a number of unpublished contracts for division of date-crops belonging to the later years of Hammurabi. We also had the benefit of a revised collation and translation of K. 160 and K. 2321 + K. 3032 by LANGDON, and of his translation of K. 7072, Rm. 134, and Rm. II, 531. After returning to Germany SCHOCH published on his own responsibility a condensed study of the whole chronological question and concluded in favour of a chronology falling 64 years later than that which I had proposed. This work appeared under the title of *Ammizaduga*, von C. SCHOCH, Selbstverlag, Berlin-Steglitz, Kuhligkshof 5, 1925. A review of the literature of the subject with a brief announcement of his own views and contributions was published by SCHNABEL in ZA. xxxvi (1925), pp. 109–22, in which he concluded in favour of the chronology which I had proposed. SCHOCH came to the same conclusion in a paper entitled 'Die erste Dynastie von Babylon', *Klio* xx (1925), pp. 107–9.

Since SCHOCH's papers consist mainly of work which he had done for me as my assistant and since SCHNABEL's paper apart from the history of the subject consists mainly of work privately communicated to me which became inseparably united with my own studies, their work will be incorporated in the present study without separate discussion here.

[1] These tables appear in a revised form as an appendix to the present volume.

[2] WEIDNER had informed him that he had recognized that S. 174 must be a fragment of one of these texts and SCHNABEL had identified it as a fragment of Document M.

MEYER published in 1925 a 'Nachtrag' to the first volume of his *Geschichte des Altertums* under the title *Die ältere Chronologie Babyloniens, Assyriens und Ägyptens*. He acknowledges the force of the arguments in favour of the solution which I had proposed, but in view of the errors which appear to exist in the Venus tablets and of the doubt attaching to any restoration of the chronology where the series of intercalations is not known for certain, and in view of his preference on historical grounds for a shorter system of chronology, he leaves the question undecided between KUGLER's solution published in 1922 and mine published in 1923.

In *The Illustrated London News*, Oct. 10, 1925, p. 666, LANGDON announced that in 1924 a fragment of a clay tablet had been excavated at Kish, completing the text contained on K. 2321. Photographs of the obverse of both tablets were included in his article.

CHAPTER VI

THE VISIBILITY OF THE LUNAR CRESCENT

THAT the late Babylonians began their months at the actual or supposed date of the first appearance of the lunar crescent in the evening sky is well known. Elaborate computations of the date of this appearance have come down to us, and we are able to check Babylonian lunar dates for predicted phenomena with sufficient frequency to know the high accuracy with which the late Babylonians were able to predict this phenomenon. The late Babylonian ephemerides must in the nature of the case have been regulated by predicted appearances. But it is not so easy to determine whether observations were dated from the actual or from the predicted appearance of the Moon.

In 274 B.C. November 1 Julian we have[1] on an observation-tablet an example of a new month being made to begin after two successive months of 29 days on an evening on which it is recorded that the sky was cloudy and the Moon was not seen. Now in any calendar governed by observations of the Moon, there must have been some rule to govern the length of the month when observation was impossible, but it may be regarded as certain that two months in succession would not be given 29 days only unless the Moon was actually seen at the end of the latter month or unless computation had shown that the Moon ought to be visible. There would appear to be three possible explanations of a month beginning on that evening: (1) that the Moon was seen by other observers; (2) that the calendar was governed regularly by the predicted appearance of the crescent; (3) that the predicted date of appearance of the crescent was adopted when it was too cloudy to observe the Moon on the particular evening.[2] LANGDON has drawn my attention to JOHNS, *Assyrian Deeds and Documents*, iv (1923) 333, under *ḳakkadu* (4), and to KOHLER and UNGNAD, *Assyrische Rechtsurkunden* (1913), 258, 3; 263, 5; 649, 5, for references to the appearance of the crescent, apparently referring to the first day of the month. These documents belong to the seventh and sixth centuries before Christ, when accurate methods of prediction were certainly beyond the reach of Babylonian science, but they do not by themselves prove that the beginning of the month was determined by observation instead of by such methods of computation as were available at that time. A stronger proof that the beginning of the month was fixed by observation is to be found in the success with which SCHOCH has represented the attested dates of the beginning of the month by an astronomical formula. If this formula had applied only after the discovery of the anomalistic motion of the Moon[3], it would have been possible to maintain that SCHOCH's formula was equivalent to the formula used by neo-Babylonian astronomers in making predictions, and afforded no proof that the beginning of the month was fixed by observation.

But, as SCHOCH's tables appear to satisfy the attested first days of the month at all epochs,

[1] ZA. VII (1892), 229.

[2] According to SCHOCH's tables the Moon should not have been visible that evening, but he informs me that between 400 B.C. and 100 B.C. in August, September, and October the beginning of the month on observation-tablets sometimes falls earlier than the date given in his tables, if the Moon's argument of latitude, as in this case, falls between 40° and 140°.

[3] Callippus (about 330 B.C.) is supposed to have been the earliest Greek astronomer who could give a mathematical representation of the anomalistic motion of the Moon. But it was known at Babylon in the sixth century B.C.

the inference is that the attested beginnings of the month must have been determined originally by actual observation of the crescent.

We have not the same wealth of observations for early times, but a month beginning with the actual appearance of the crescent is the simplest and most primitive of all forms of month, and it is therefore reasonable to expect that both in astronomy and in civil life the month was in early times reckoned from the first visibility of the crescent.

The term *ud-ná-a*, 'day of passing (of the Moon) into darkness', usually rendered by *ûm bubbulim*, 'day of the ravishing or taking away (of the Moon)' is used from a very early date for the day when the Moon was last visible in the early morning. We generally find this day identified with the 28th day of the month, but examples exist of the 24th,[1] 25th, 27th, 29th, and 30th days of the month being called by this name. The term is sometimes given an extended meaning so as to apply to any night during the period of the Moon's darkness and also to the day of the Moon's reappearance. For the old moon to be seen last on the morning of the 28th day is in excellent agreement with a month beginning at the appearance of the crescent. Early dates such as the 24th or 25th might be supposed to indicate that the month did not regularly begin with the appearance of the crescent, but might begin a few days later. On the other hand, an occasional last visibility so early may be simply due to weather conditions. It may be doubted whether in practice the calendar was governed by actual observation or by a rough computation of the date of appearance, but, as will be seen later, such evidence as we possess points to a calendar regulated by observation.

In order, therefore, to reduce Babylonian lunar dates to the Julian or to the Gregorian calendar it is necessary to have some knowledge of the conditions of visibility of the lunar crescent. There are three causes which affect the visibility of the crescent: (1) the phase of the Moon, i. e. the degree to which it is illuminated by the Sun; (2) the extent to which its light is absorbed in passing through the Earth's atmosphere; (3) the brilliance of the part of the sky in which it is situated, that is, of the background against which it is seen. The first of these depends, theoretically, partly on the distance of the Moon from the observer, which is in inverse ratio to its parallax, and partly on the angle subtended at the Moon by a line joining the Sun and the Earth. The effect of variations in the lunar parallax is for our present purpose negligible, as also is the angle subtended at the Sun by a line joining Earth and Moon. The angle at the Moon may therefore be regarded as equal to 180° less the angular distance between Sun and Moon as seen from the Earth, and the phase of the Moon may in consequence be regarded as dependent on this angular distance. Such evidence as we have would tend to show that the brilliance of the lunar crescent is roughly proportional to the cube of the angular distance. This angular distance may be regarded as a function of the altitude of the Moon above the horizon and of the difference in azimuth of Sun and Moon at time of sunset or at the time when the Sun is at some given distance below the horizon. The extent to which the Moon's light is absorbed by the atmosphere depends partly on the absorbing power of the atmosphere at the particular place and on the particular day and partly on the amount of atmosphere which its rays have to traverse. The latter depends wholly on the altitude of the Moon above the horizon, but, owing to the difference between the absorptive power of the atmosphere at different places and seasons, any study of the effect of altitude on the brilliance of a heavenly body should,

[1] THOMPSON, *Reports*, 85, Obv. 2–4, K. 752. In this case the phenomenon is described by the phrase, 'When the Moon disappears out of its reckoning'.

if possible, take into account the atmospheric conditions, which were, probably, as favourable at Babylon as at any place where observation has been made. The brilliance of any part of the sky during daylight or twilight, given constant weather conditions, is dependent on its position in altitude and azimuth as compared with the Sun. It would, therefore, appear that, apart from variations in weather beyond the reach of astronomical computation, all the causes affecting the visibility of the Moon may be reduced to difference in azimuth and altitude of Sun and Moon. In a paper on the smallest visible phase of the Moon, published in MN. 70 (1910), pp. 527–31, I analysed a series of 48 successful observations of first sight of new moon made with the naked eye by JULIUS SCHMIDT at Athens in 1859–79, one such observation made by him at Corinth in 1862, one such made by AUGUST MOMMSEN at Athens in 1879, 18 unsuccessful attempts at observation of new moon made by JULIUS SCHMIDT at Athens in 1860–76, one such made by him at Troy in 1864, one such made by MOMMSEN at Athens in 1879, two successful observations of last visibility of old moon made by JULIUS SCHMIDT at Athens in 1870 and 1872, one such by FRIEDRICH SCHMIDT at Athens in 1871, two such by MOMMSEN at Athens in 1879 and 1880, and one unsuccessful observation of the old moon by MOMMSEN at Athens in 1879, 76 observations in all. I found in the case of each observation the altitude of the Moon at sunset for evening and at sunrise for morning observations, ignoring the effect of parallax and refraction on both bodies, and I also found the difference between the azimuths of the two bodies at the same moment. I found that the following table would satisfy all the observations with the exception of FRIEDRICH SCHMIDT's successful observation in the morning and one of JULIUS SCHMIDT's successful observations in the evening.[1]

Difference in azimuth at sunset or sunrise.	Minimum altitude of Moon at sunset or sunrise to be visible same evening or morning.
0°	12·0°
5	11·9
10	11·4
15	11·0
20	10·0
23	7·7

The two exceptions fall respectively 3·1° below the tabular minimum altitude with 2·8° difference in azimuth, and about 3·6° below the tabular minimum altitude with 20·5° difference in azimuth. In *The Journal of Theological Studies*, xii (1910), p. 121, I dealt with a rule given by Maimonides for making the same computation for Jerusalem, and reduced his rule to a form similar to my own, as follows:

Difference in azimuth at sunset.	Minimum altitude of Moon at sunset to be visible same evening.
0°	11·8°
5	11·3
10	9·7
15	9·7
20	9·7
23	7·3

[1] The precepts given in NEUGEBAUER's *Tafeln zur astronomischen Chronologie* iii (1922), xxviii–xxxi, for computation with my figures are based on the setting of the Sun's upper limb as affected by refraction. The figures given by me were for the setting of the centre of the Sun's disk, disregarding refraction. To compensate for this the figures headed h_2 in his 'Tafel 14' should be diminished by about 0·8°.

This rule gives a somewhat discontinuous result, but on the whole implies a smaller minimum altitude for a given difference in azimuth than I had deduced from the Athens series.

In *The Observatory*, xliv (1921), pp. 308–11, I dealt with a number of early observations of the evening crescent, partly collected from the *Journal of the British Astronomical Association*, partly supplied from his own observations by SCHOCH, and partly obtained by an appeal for observations issued by SCHOCH and myself with the aid of PROFESSOR H. H. TURNER of Oxford. In none of these observations did the difference in azimuth exceed 16·1°, and only in one instance did it exceed 7·1°. These observations are, therefore, of little value for the minimum altitude which should be associated with large differences in azimuth. In the series were two observations made at different places in England on 1916 May 2 where with a difference of azimuth of 0·6° and 0·7° respectively the Moon was seen 3·7° below my tabular minimum altitude. Otherwise there was no instance of her being found with the naked eye more than 1·2° below my tabular minimum altitude.

A slightly better result might have been obtained by taking the differences in altitude and azimuth of the two luminaries for the time when the Sun was 4° below the horizon instead of for the time when the Sun was on the horizon. But in view of variable atmospheric conditions, the gain in accuracy would have been more apparent than real.

SCHOCH has investigated about 400 beginnings of months in the neo-Babylonian period, which can be fixed by astronomical observations or predictions referred to the days of the month. 250 of these are months in which observations are recorded, while 150 are taken from ephemerides. He has been able to construct tables for computing the minimum age at which the crescent should be visible, taking into consideration the longitude of the Sun or season of the year, the Moon's elliptical orbit and her latitude. He has in this way been able to satisfy 380 out of the 400 dates of first visibility assumed in the Babylonian observations and ephemerides. Of the 20 discrepancies he attributes 10 to a delay in the appearance of the crescent due to bad weather, while 10 remain enigmatical. On the other hand he finds 55 cases where the crescent computed by the formula which I had deduced from the Athens observations would appear one day later than the date used for the beginning of the month in Babylonian observations. For the sake of comparison he has made a computation in which his formula is reduced to a form analogous to mine, as follows:

Difference in azimuth at sunset.	Minimum altitude of Moon at sunset to be visible same evening.
0°	10·7°
5	10·3
10	9·4
15	7·6
19	6·3

This formula implies a greater transparency of the air at all altitudes than I had deduced from the Athens observations. It also implies that the transparency diminishes less rapidly at Babylon than at Athens as the horizon is approached, so that the difference between the two formulae is most marked for the low altitudes which accompany great differences in azimuth. I have no hesitation in adopting SCHOCH's figures for use in computations for Babylon.

CHAPTER VII

THE VISIBILITY OF VENUS

THE visibility of Venus like that of the Moon is affected by the atmospheric absorption of her light, which depends on the altitude of the planet above the horizon, and by the degree of illumination of the sky, which depends on the angular distance of the Sun below the horizon. It is not, however, appreciably affected, so far as first and last visibility are concerned, by the phase of the planet, for we find that there is little difference in the stellar magnitude of the planet at different first or last appearances. Difference in azimuth, in so far as it affects the illumination of the part of the sky where the planet is situated, might be regarded, but it is unimportant compared with difference in altitude. Since the time of Ptolemy, it has been customary to regard the visibility of a star as dependent on the angular distance of the Sun below the horizon at the time of the rising or setting of the star. We shall call this angular distance γ. The minimum value of γ which will render a star visible is known as the *arcus visionis*. Ptolemy found that the *arcus visionis* (in Greek καθόλου διάστασις) of Venus was 5° (*Math. Syn.*, ed. HEIBERG, ii [1903], p. 597). It appeared to me desirable to determine the *arcus visionis* for Babylon by an analysis of neo-Babylonian observations. At my request SCHOCH computed the value of γ for eighteen such observations, which we found published in Assyriological works. We adopted NEWCOMB's mean places and mean motions of Venus and the Sun for the epoch A. D. 1800 Jan. 0·0, but applied to NEWCOMB's acceleration for 1800 the correction of $+1{\cdot}521''$ per century for the Sun and $+2{\cdot}472''$ for Venus. The correction to the Sun's acceleration is that which I deduced in my paper, *A Solution of Ancient Eclipses of the Sun*, MN. 81 (1920), p. 126. The correction to the acceleration of Venus is obtained on the assumption that the correction to the Sun's acceleration bears the same ratio to the correction to the acceleration of Venus that the mean motion of the Sun bears to the mean motion of Venus. This would be the case if the apparent acceleration of the Sun were due either to a retardation of the Earth's rotation or to an increase in the Sun's mass. All other terms are taken from NEWCOMB, except the obliquity of the ecliptic, which is taken from my paper in MN. 78 (1918), p. 411. The observations of the year 419–418 B. C. were communicated by SCHNABEL and reduced by me on the same assumptions.

The result of our reduction of the neo-Babylonian observations is given below:

Last visibility in evening, 'Western setting'.

Reference.		*Babylonian date.*		*Julian date, days reckoned from noon.*	γ.
KUGLER, *Sternkunde*, i 70		Cambyses 7	Sivan 10	523 B.C. June 12	7·68°
VAT. 4924		Ochus 5	Ayar 22	419 B.C. May 16	5·94
EPPING and STRASSMAIER,	ZA. vii 229	S. A. 38	Araḫsamna 1	274 B.C. November 4	6·35
" "	ZA. vi 91	S. A. 110	Tešrit 19	202 B.C. October 9	4·80
" "	ZA. vi 221	A. A. 153 / S. A. 217	Araḫsamna 23	95 B.C. November 28	5·1
" "	ZA. v 357	A. A. 164 / S. A. 228	Šabat 10	83 B.C. February 10	3·89

To these I may add a western setting observed by LANGDON at Kish, A. D. 1926 January 31 Gregorian, where the value of γ was 12·55°.

Reference.	Babylonian date.		Julian date, days reckoned from noon.	γ.
		First visibility in morning, 'Eastern rising'.[1]		
KUGLER, *Sternkunde*, i 71	Cambyses 7	Sivan 27	523 B.C. June 29	8·44°
VAT. 4924	Ochus 5	Sivan 3	419 B.C. May 26	5·71
EPPING and STRASSMAIER, ZA. vii 230	S. A. 38	Araḫsamna 11	274 B.C. November 14	2·6
„ „ ZA. vi 91	S. A. 110	Araḫsamna 4[2]	202 B.C. October 24[3]	4·92
KUGLER, *Sternkunde*, i 84	S. A. 132	Šabat 29	179 B.C. March 12	7·49
EPPING and STRASSMAIER, ZA. vi 221	{A. A. 153 / S. A. 217}	Araḫsamna 27	95 B.C. December 2	2·3
„ „ ZA. v 357	{A. A. 164 / S. A. 228}	Šabat 12	83 B.C. February 12	8·08
		Last visibility in morning, 'Eastern setting'.		
KUGLER, *Sternkunde*, i 70	Cambyses 7	Adar 7	522 B.C. March 3	4·93
„ „ Erg. 233[4]	. . . .	Ulul 26	425 B.C. September 21	5·4
„ „ i 84	S. A. 132	Nisan 15	180 B.C. April 8	5·55
		First visibility in evening, 'Western rising'.		
KUGLER, *Sternkunde*, i 70	Cambyses 8	Nisan 13[5]	522 B.C. May 6	6·20
„ „ Erg. 234[4]	. . . .	Araḫsamna 26	425 B.C. November 19	6·3
VAT. 4924	Ochus 5	Adar II 21	418 B.C. April 5	5·91
KUGLER, *Sternkunde*, i 84	S. A. 132	Ab 1	180 B.C. July 20	11·21
EPPING and STRASSMAIER, ZA. v 355	{A. A. 164 / S. A. 228}	Ayar 11	84 B.C. May 21	6·38

[1] Sometimes a later date is given for eastern rising with a note that Venus was already seen on an earlier specified date. In such cases I have adopted the earlier date.

[2] 14 in text. But the date clearly falls before Araḫsamna 7, and 4 would appear to be the correct reading.

[3] EPPING makes Araḫsamna begin one day earlier than we do, but this involves too early an appearance of the crescent.

[4] The year to which this tablet belongs is not preserved. WEIDNER who published it in *Alter und Bedeutung der babylonischen Astronomie und Astrallehre* (1914) recognized it as an observation-tablet, but failed to date it. KUGLER, loc. cit., dated it correctly, but mistook it for an ephemeris. SCHOCH gives six reasons for regarding it as an observation-tablet:

(1) The appearance of the crescent agrees regularly with his computation. This, as he remarks, is not conclusive, because the ephemerides as well as the observations generally agree with his computations.

(2) The appearances and disappearances of Sirius, Jupiter, Saturn, and Venus are in full agreement with computation. The difference nowhere exceeds two days. But here again the Babylonian ephemerides are generally in good agreement with his computations.

(3) The western setting and morning rising of Mars vary from his computation by three and four days respectively. The dates given on Babylonian ephemerides habitually deviate from computation by ten or twelve days. Therefore the dates given here must be the result of observation.

(4) The Mercury phases are as follows:

WR. 2 days before computation.
WS. 2 days before computation.
ER. 4 days after computation (perhaps delayed by weather conditions). ES. 1 day before computation.
WS. Day of computation. MR. 1 day after computation.
The concluding interval between WS. and MR. is correctly given as 14 days. 13 days is the minimum duration at inferior conjunction, and 41 days the maximum. The Babylonians had not the requisite knowledge to predict the phases of Mercury with such accuracy.

(5) The time given for the lunar eclipse is only seven minutes earlier than that found by computation for the beginning of the eclipse. Babylonian ephemerides do not give the exact time of an eclipse, and no Babylonian astronomer of the fifth century B.C. could predict it with such accuracy.

(6) The lunar eclipse is described by the words *Sin atala iškun*, which refer regularly to an observed eclipse. It is true that the solar eclipse, which is misdated, and which was not visible at Babylon, is described as *Šamaš atala*, but that is clearly an error. The observation-tablet of 568–567 B.C. includes a predicted eclipse of the Moon which was not visible at Babylon, using the words *atalu Sin ša LU*. See NEUGEBAUER and WEIDNER in *Berichte der k. sächsischen Gesellschaft*, 67 (1915), phil. hist. Klasse, pp. 31, 35, 50. The scribe of our text was right in inserting the solar eclipse, but ought to have stated that it was not observed.

The last four of these reasons are conclusive.

[5] So the text. KUGLER proposes to read 'Ayar'.

With these I compare some naked-eye observations made in England in the years 1923–6. I give the most successful observation at each observed appearance and disappearance:

Place.	Observer.	Gregorian date, days reckoned from noon.	γ.
	Western setting.		
Oxford	J. K. F. and Miss Dalton	1924 June 20	6·11°
Bicester	S. W. Hayes and Miss Hayes	1926 February 8	3·21
	Eastern rising.		
Dedham	H. G. Tomkins	1924 July 13	6·42
Charing	Rev. D. R. Fotheringham	1926 February 13	11·56

With these we may compare a western setting observed by HERR STILLHART at St. Gall, Switzerland, 1926 February 6, where the value of γ was 6·2°, and an eastern rising observed by HERR WIDMER at Bertiswil, Switzerland, 1926 February 4, where the value of γ was 5·4°.

Western rising.

Place.	Observer.	Gregorian date, days reckoned from noon.	γ.
Oxford	J. H. Jeffree	1923 November 7	5·20°
Bicester	S. W. Hayes	1925 May 30	6·06

To appreciate the Babylonian observations properly it is necessary to arrange them according to the season of the year. I have therefore classified them according to the months of the Gregorian calendar in which they fall, reckoning the day according to civil usage from midnight. For this purpose we must deduct five days from eastern and six from western observations before 501 B.C., four days from eastern and five from western observations between 501 and 301 B.C., three days from eastern and four from western observations between 301 and 201 B.C., two days from eastern and three from western observations between 201 and 101 B.C., and one day from eastern and two from western observations after 101 B.C. The values of γ then group themselves as follows:

WS. = western setting; ER. = eastern rising; ES. = eastern setting; WR. = western rising.

January	12·55° (WS.)		
February	3·9 (WS.),	8·1° (ER.),	4·9° (ES.)
March	7·5 (ER.),	5·9 (WR.)	
April	5·55 (ES.),	6·2 (WR.)	
May	5·9 (WS.),	6·4 (WR.),	5·7 (ER.)
June	7·7 (WS.),	8·4 (ER.)	
July	11·2 (WR.),		
August	None		
September	5·4 (ES.)		
October	4·8 (WS.),	4·9 (ER.),	6·35 (WS.)
November	2·6 (ER.),	6·3 (WR.),	5·1 (WS.)
December	2·3 (ER.)		

It will be observed that the value of γ is markedly lower in the autumn and winter months September–February than in the spring and summer months March–July, the lowest values being found in November and December, while the value steadily rises till July. But the high value of γ at LANGDON's observation in January shows that unfavourable weather may occur in the winter as well as in the summer. It will be noticed that, while six out of twelve γ's in

September–February are less than 5°, the ten γ's in March–July all exceed 5°, and six of them exceed 6°. It will also be observed that while in June and July the English observations are more successful than the Babylonian observations in the same months, the reverse is the case on an average in February, May, and November. It may also be noted that the twenty-one ancient observations contain nine pairs of 'settings' followed by 'risings', and three isolated observations. In six of the nine pairs the setting shows a lower value of γ than the rising. This is what we should expect, for the observer of a setting ought to know from the previous day's observation where to look, while the observer of a rising has no such guidance.

The effect of the empirical correction to the accelerations is to diminish the value of γ at western settings and to increase it at eastern risings. As the two lowest values (2·3° and 2·6°) are both found at eastern rising, while the lowest for western setting is 3·9°, it is clear that the rejection of this correction would increase any difficulty that there may be in accepting the data supplied by the neo-Babylonian observations.

Since this chapter was written I have found from the Greenwich meridian observations of the Sun, 1750–78 and 1839–1925 an empirical acceleration of +1·4″ per century for the Sun, in good agreement with that deduced from the ancient observations. See MN. 87 (1926), pp. 142–167; 87 (1927), pp. 182–5. De Sitter has since obtained from the transits of Mercury (1677–1924) an empirical acceleration of Mercury which on the assumption that the accelerations are in proportion to the mean motions would correspond to an acceleration of +1·55″ per century for the Sun. See *Bulletin of the Astronomical Institutes of the Netherlands*, 4 (1927), pp. 21–38. The acceleration assumed in this chapter for Venus would appear, therefore, to be well supported by such modern observations as are available.

CHAPTER VIII

REDUCTION OF THE OBSERVATIONS ON THE VENUS TABLETS

FOR accurate work on the lunar dates of disappearance and reappearance of Venus it is necessary to compute the beginning of the lunar month by Schoch's crescent tables and to compare the value of γ for one or more days about the date when the first or last visibility of Venus might be expected. But for a preliminary test cruder methods will suffice. Schoch printed in a paper entitled *The 'Arcus Visionis' in the Babylonian Observations*,[1] and again in *Ammizaduga*,[2] handy tables for converting Babylonian into Julian dates and vice versa. In the former publication he assumed for purposes of computation the accuracy of Weidner's restoration of the chronology of the First Dynasty, while in the latter he assumed the accuracy of the chronology which he had himself proposed, falling 64 years later than that which I had favoured.[3] It must also be remembered that until the year 528 B.C.[4] intercalation at Babylon was irregular, so that any table for converting Babylonian dates must necessarily be subject to occasional errors of one lunar month. A student who does not accept the system of chronology to which Schoch's table is adapted must be prepared for the possibility of an error of a second lunar month, and it seems best, therefore, to identify the months independently of Schoch's tables and to confine those tables to the problem of identifying the days of an identified lunar month with days in the Julian calendar. In the case of the Venus observations the computed dates of disappearance and reappearance define the position of the months, and the handy tables are of use for identifying the days.

Any lunar date may be converted at a glance with the handy tables, and in eighty per cent. of the cases the day so found will agree with that given by the crescent tables. When, therefore, dates are found with the handy tables, we must allow for the possibility of an error of one day. Where such an error is not permissible, recourse should be had to the crescent tables.

Schoch has also constructed tables for the rapid computation of the disappearance and reappearance of Venus at Babylon. Here he has adopted 5·2° as the minimum value of γ at western setting, 5·7° at eastern rising, and 6·0° at eastern setting and western rising. These values are considerably higher than those which result from the autumn and winter observations, and one of the neo-Babylonian April eastern settings gives a lower value than Schoch assumes. But the values would appear to be too small for spring and summer observations. The daily change in the value of γ ranges from 0·4° to 2·0° near inferior conjunction (i. e. at western setting and eastern rising) and from 0·1° to 0·4° near superior conjunction (i. e. at eastern setting and western rising).

When we allow for the possibility of an error of one day in the computed day of the lunar month and for one day or more in the computed date of the first or last phase of Venus near inferior conjunction, we must be prepared for frequent errors of one day in the computed lunar dates of the phenomena and for a certain number of errors of two days, occasionally more. Larger errors are possible near superior conjunction. On the whole, autumn and winter settings

[1] University Observatory, Oxford (1924), pp. 7–11.
[2] Pp. 7–12.
[3] Schoch's tables M and N in the present volume are computed on the same principle, but are made to agree generally with the chronology proposed by me.
[4] See Kugler, *Sternkunde und Sterndienst*, ii, T. 2, H. 2 (1924), 428.

and spring and summer risings should fall later than the computed dates, autumn and winter risings and spring and summer settings earlier than the computed dates.

Table I contains a comparison between the dates of western setting and eastern rising recorded on the tablets and the dates computed by Schoch for each of five hypothetical dates of the reign of Ammizaduga, 1977–1956 B.C., 1921–1900 B.C., 1857–1836 B.C., 1809–1788 B.C., and 1801–1780 B.C. The headings WS., Int., ER. indicate respectively the date of western setting, the interval between western setting and eastern rising, and the date of eastern rising. The observations are arranged in groups, so that those belonging to the same season of the year are thrown together. Throughout the table Roman numerals indicate Babylonian months. In computed dates the numerals are assigned on the assumption that the intercalations are to occupy the places attested by contracts or implied in the intervals between recorded dates of phenomena. Dates not recorded, but supplied arithmetically, are placed in brackets. As a rule the date which is best attested on the tablets is given in each case under the heading 'Tablets'. Where the evidence seems equally divided, alternative dates are given. The computed dates are reduced to the Gregorian calendar, and the day is reckoned from noon. This is essential. The Babylonians, reckoning the day from sunset, made observations at the beginning and end of the night belong to the same day. If we reckon the day from midnight, we have the inconvenience of having different Gregorian days to correspond to the same Babylonian day according as the observation is in the morning or in the evening. The Gregorian calendar permits ready comparison with observations made at the same season in other ages, and shows at a glance at what season of the year each of the five hypotheses would place the different Babylonian calendar months. The computed dates for the second and third hypotheses are based on computation of the actual crescent; for the other hypotheses they are computed with Schoch's handy tables. 5·6° has been taken as the minimum value of γ for an observation of Venus.

One of the most striking facts disclosed by the table is that observations separated by eight years rarely recur four days earlier in the Babylonian calendar month, as they ought to do on the astronomical theory. This failure is, no doubt, due in part to variations in the weather, but this is not a complete explanation, because there is not even an approximation to a four-days difference.

On the other hand, except in the corrupt date VII 11 for western setting in the fourteenth year, the total variation in the day of rising or setting in each group never exceeds fifteen days. We should have expected a maximum variation of eight or nine days. It might be tempting to explain this irregularity by supposing that our conclusion from other evidence that the Babylonian month was reckoned from actual appearance of the crescent was erroneous. If the beginning of the month was fixed arbitrarily in the neighbourhood of that appearance, it would explain a variation of a few days backwards and forwards as opposed to a regular four-days difference in eight years, but it would imply the same variation in eastern risings as in western settings, and there is no such consistency. We are therefore driven to the conclusion that quite apart from their consistency or inconsistency with any of the proposed solutions, the recorded dates are proved by their mutual inconsistency to contain numerous errors. How far the errors are copyists' mistakes and how far they are erroneous conjectures made to supply missing observations it is difficult to say. The repetition of 7-day and 15-day intervals in different groups looks suspicious, and it may be observed that seven days is the standard interval in the artificial system of Document N.

We can presumably place most reliance on those dates which show a difference of three, four, or five days in a recurrence after eight years, that is on the two first eastern risings of the third group, the two eastern risings of the fourth group, and the first two pairs of western setting and eastern rising in the fifth group. Of these the two first eastern risings of the third group appear to be best satisfied by the first and third solutions, of which the first satisfies one of the corresponding western settings and the third the other western setting. The two eastern risings of the fourth group are best satisfied by the second and third solutions, of which the second satisfies also the western setting corresponding to the first eastern rising. The two pairs of western settings and eastern risings in the fifth group are excellently satisfied by the first, second, and third solutions. If we treat an exact agreement or a difference of one day as an agreement with the recorded dates and examine all the dates by this criterion it will be found that the first solution shows 10 agreements, the second and third 11 each, the fourth 5 agreements, and the fifth 3 agreements. It is clear, therefore, that these observations are satisfied far better by the first three solutions than by the two last.

Table II exhibits the eastern settings and western risings treated in the same manner. The headings ES. and WR. indicate the dates of eastern setting and western rising respectively. The computation has been made with Schoch's handy tables, 6·0° being taken as the minimum value of γ for an observation. That this is approximately correct is evidenced by the good agreement between the computed and observed intervals of invisibility, the former varying between $1^m\,25^d$ and $2^m\,17^d$, and the latter, ignoring two exceptionally long intervals, varying between $2^m\,0^d$ and $2^m\,15^d$. Whether the computed or the observed interval is the longer appears to depend mainly on the season of the year. As the relative positions of the Sun, Venus, and the horizon near eastern setting and western rising vary but slowly from day to day, we cannot expect to compute the exact date of rising or setting with any accuracy, and, therefore, the four-day rule will hardly apply, though it is possible to find it in the third group. The difficulty in applying these observations to a chronological purpose is not, as in Table I, that there is any general discordance between observation and computation, but that all the solutions show a very fair agreement. But there are certain groups which are satisfied by some solutions better than by others. In the first group it will be observed that Venus reappears six days before the computed date in Year 4 according to the first and second solutions, but the third, fourth, and fifth solutions make her disappear nine, ten, or eleven days after the computed date both in Year 4 and in Year 20. It would seem, therefore, that this group favours the first and second solutions. In the second group the computed interval of invisibility falls according to each solution within the observed interval, so that it is impossible to base any preference on this group alone. In the third group the second pair gives a reappearance three days before the computed date according to the third solution, but this is of small importance. In the fourth group the first two disappearances are later than the computed dates in the earlier solutions and the reappearances earlier than the computed dates in the later solutions, the discrepancies being particularly noticeable in the fourth and fifth solutions. In the Year 13 in this group XI 21 in the texts is probably a mistake for XII 21, but it must be an ancient error for the omen is appropriate for Šabat. The intercalations can, as will be seen, be fixed with certainty with the aid of the contract-tablets. The observations of the 21st year seem to fall too late on all except the two last solutions. If the observations of the 8–9th year are rightly restored the date of disappearance is satisfied by all solutions, while the reappearance is rather early for all. The observations of the 16–17th year are satisfied by all. There would seem on the whole to be a marked superiority on the side of the first three solutions over the last two in this table as in Table I, and in the first group of observations a superiority of the first and second solutions over the third. But the evidence of these tablets does not appear to be decisive as between the first three solutions.

I shall endeavour to show later that the second solution alone satisfies certain other tests, and I have therefore thought it advisable to obtain from SCHOCH more detailed computations of the value of γ for each observation on that solution. This has involved a computation not only of the phases of Venus, but of the date of appearance of the lunar crescent.

Year of Ammizaduga.	*Class of observation.*	*Babylonian date.*	*Gregorian date.*	*Value of γ.*
1	WS.	XI 15	Feb. 27	6·6°
1	ER.	XI 18	March 2	5·6
2	ES.	VIII 11	Nov. 16	8·5
2	WR.	X 19	Jan. 22	6·6
3	WS.	VI 23	Sept. 19	9·2
3	ER.	VII 13	Oct. 9	4·0
4	ES.	IV 2	June 20	6·2
4	WR.	VI 3	Aug. 20	5·4
5	WS.	II 2	May 10	1·7
5	ER.	II 18	May 26	10·7
5	ES.	IX 25	Jan. 24	6·4
5	WR.	XI 29	March 28	6·0
6	WS.	VIII 28	Dec. 18	6·1
6	ER.	IX 1	Dec. 21	6·0
7	ES.	V 21	Sept. 3	7·3
7	WR.	VIII 2	Nov. 12	6·3
8	WS.	IV 25	July 28	−12·0
8	ER.	V 2	Aug. 4	14·2
8	ES.	XII 25	March 22	6·2
9	WR.	(III 2)	May 25	3·9
9	WS.	XII[1] 11	Feb. 25	6·5
9	ER.	XII 15	March 1	7·0
10	ES.	VIII 10	Nov. 16	7·7
10	WR.	X 16	Jan. 20	6·8
11	WS.	VI 26	Sept. 23	4·7
11	ER.	VI b 8	Oct. 5	0·8
12	ES.	I 9	April 30	11·5
12	WR.	VI 25	Oct. 12	12·0
13	WS.	II 5	May 15	−10·0
13	ER.	(II 12)	May 22	9·5
13	ES.	X 20	Jan. 21	6·5
13	WR.	(XII) 21	March 22	5·0
14	WS.	VII 11	Nov. 3	33·0
14	ER.	VIII 27	Dec. 19	6·6
15	ES.	V 20	Sept. 4	6·9
15	WR.	VIII 5	Nov. 17	7·0
16	WS.	IV 5	July 10	5·2
16	ER.	IV 20	July 25	4·6

[1] III in text.

Year of Ammizaduga.	*Class of observation.*	*Babylonian date.*	*Gregorian date.*	*Value of γ.*
16	ES.	XII 15	March 12	7·8
17	WR.	(III 24)	June 18	8·9
17	WS.	XII 11	Feb. 26	1·25
17	ER.	XII 15	March 2	10·0
19	WS.	VI b 1	Aug. 31	15·2
19	ER.	VI b 17	Sept. 16	−23·6
20	ES.	III 25	June 17	6·0
20	WR.	(VI 1)	Aug. 21	5·9
21	WS.	I 26	May 8	−1·1
21	ER.	II 3	May 15	5·8
21	ES.	(X 28)	Jan. 31	4·0
21	WR.	XII 28	March 31	7·2

It will be seen from the figures in the last column that some of these dates are impossible and some others highly improbable, but on the whole the values of γ are in good accord with the values found above in the neo-Babylonian observations. It will be observed that in a large majority of instances the settings show a larger value of γ than the risings. This is contrary to what we discovered in the case of the neo-Babylonian observations and to what we should naturally expect, and it is found both at inferior (WS. and ER.) and at superior (ES. and WR.) conjunction. Had no empirical acceleration been introduced into the computation, the excess of the value at settings over that at risings would be markedly greater, and to that extent these observations are evidence of the existence of an acceleration of the motion of Venus. The explanation of the greater success of the observers in picking up the reappearing Venus than in retaining the disappearing Venus in view is perhaps that greater pains were taken to watch the rising than the setting. It is possible that in some instances the date of eastern rising has been taken erroneously for the date of western setting. If in the 8th year we take IV 25 as the date of eastern rising, we find $\gamma = 5·0°$; if in the 13th year we take II 5 as the date of eastern rising, we find $\gamma = 4·7°$, and, if in the 17th year we take XII 11 as the date of eastern rising, we find $\gamma = 6·3°$.

WESTERN SETTING AND EASTERN RISING OF VENUS — TABLE I

Year of Ammi-zaduga.	Tablets. WS.	Tablets. Int.	Tablets. ER.	1977–1956 B.C. WS.	1977–1956 B.C. Int.	1977–1956 B.C. ER.	1921–1900 B.C. WS.	1921–1900 B.C. Int.	1921–1900 B.C. ER.
5	II 2	15	II 18	May 23 I 27	14	June 6 II 11	May 7 I 29	12	May 19 II 11
13	II 5	7	(II 12)	May 20 I 23	14	June 3 II 7	May 5 I 25	12	May 17 II 7
21	I 27/26	7/6	II 3	May 18 I 18	14	June 1 II 3	May 4 I 22	11	May 15 II 3
8	IV 25	7	V 2	July 27 IV 5	18	Aug. 14 IV 23	July 12 IV 9	17	July 29 IV 26
16	IV 5	15	IV 20	July 25 IV 1	18	Aug. 12 IV 19	July 10 IV 5	16	July 26 IV 21
3	VI 23	20	VII 13	Oct. 16 VI 30	12	Oct. 28 VII 12	Sept. 25 VI 29	16	Oct. 11 VII 15
11	VI 26	11/12	VI b 7/8	Oct. 13 VI 26	12	Oct. 25 VI b 9	Sept. 22 VI 25	16	Oct. 8 VI b 11
19	VI b 1	15	VI b 17	Oct. 11 VI b 22	13	Oct. 24 VII 5	Sept. 19 VI b 20	17	Oct. 6 VII 8
6	VIII 28	3	IX 1	Jan. 4 VIII 27	2	Jan. 6 VIII 29	Dec. 18 VIII 28	3	Dec. 21 IX 1
14	VII 11	$1^m 17^d$	VIII 27	Jan. 2 VIII 23	2	Jan. 4 VIII 25	Dec. 16 VIII 24	3	Dec. 19 VIII 27
1	XI 15	3	XI 18	March 17 XI 15	4	March 21 XI 19	Feb. 27 XI 15	3	March 2 XI 18
9	(III) 11	$(9^m) 4^d$	XII 15	March 14 XII 11	4	March 18 XII 15	Feb. 26 XII 12	2	Feb. 28 XII 14
17	XII 11	4	XII 15	March 12 XII 7	4	March 16 XII 11	Feb. 23 XII 8	3	Feb. 26 XII 11

EASTERN SETTING AND WESTERN RISING OF VENUS — TABLE II

Year of Ammi-zaduga.	Tablets. ES.	Tablets. Int. (m. d.)	Tablets. WR.	1977–1956 B.C. ES.	1977–1956 B.C. Int. (m. d.)	1977–1956 B.C. WR.	1921–1900 B.C. ES.	1921–1900 B.C. Int. (m. d.)	1921–1900 B.C. WR.
4	IV 2	2 1	VI 3	July 12 IV 5	2 4	Sept. 13 VI 9	June 21 IV 3	2 6	Aug. 26 VI 9
12	I 9/8	5 16/17	VI 25	July 10 III 1	2 4	Sept. 11 V 5	June 19 II 29	2 6	Aug. 23 V 5
20	III 25	2 6	VI 24	July 8 III 27	2 4	Sept. 8 VI 1	June 17 III 25	2 6	Aug. 21 VI 1
7	V 21	2 11	VIII 2	Sept. 28 V 27	1 29	Nov. 25 VII 26	Sept. 12 V 30	2 0	Nov. 10 VII 30
15	V 20	2 15	VIII 5	Sept. 26 V 23	1 29	Nov. 22 VII 22	Sept. 10 V 26	2 0	Nov. 8 VII 26
2	VIII 11	2 7	X 19	Dec. 12 VIII 19	1 26	Feb. 5 X 15	Nov. 26 VIII 21	1 25	Jan. 19 X 16
10	VIII 10/(8)	2 6/8	X 16	Dec. 10 VIII 15	1 26	Feb. 3 X 11	Nov. 23 VIII 17	1 25	Jan. 16 X 12
18	...	...	...	Dec. 8 VIII 11	1 26	Feb. 1 X 7	Nov. 21 VIII 13	1 25	Jan. 14 X 8
5	IX 25	2 4	XI 29	Feb. 7 IX 20	2 7	Apr. 14 XI 27	Jan. 26 IX 27	2 3	March 29 XI 30
13	X 20	2 0	XI 21	Feb. 4 X 16	2 7	Apr. 12 XII 23	Jan. 24 X 23	2 3	March 27 XII 26
21	(X 28)	2 0?	XII 28	Feb. 3 X 13	2 6	Apr. 9 XII 19	Jan. 22 X 19	2 3	March 25 XII 22
8–9	XII 25	2 7	(III 2)	Apr. 9 XII 25	2 17	June 23 III 12	March 23 XII 27	2 16	June 6 III 13
16–17	XII 15	3 9	III 24?	Apr. 6 XII 21	2 17	June 21 III 8	March 20 XII 24	2 15	June 3 III 9

TABLE I — WESTERN SETTING AND EASTERN RISING OF VENUS

1857–1836 B.C. WS.	1857–1836 B.C. Int.	1857–1836 B.C. ER.	1809–1788 B.C. WS.	1809–1788 B.C. Int.	1809–1788 B.C. ER.	1801–1780 B.C. WS.	1801–1780 B.C. Int.	1801–1780 B.C. ER.	Year of Ammi-zaduga.
Apr. 21 I 29	8	Apr. 29 II 7	Apr. 7 II 5	7	Apr. 14 II 12	Apr. 6 II 2	6	Apr. 12 II 8	5
Apr. 18 I 25	8	Apr. 26 II 3	Apr. 6 II 2	6	Apr. 12 II 8	Apr. 3 I 27	6	Apr. 9 II 4	13
Apr. 16 I 21	8	Apr. 24 I 29	Apr. 3 I 27	6	Apr. 9 II 4	Apr. 1 I 24	6	Apr. 7 I 30	21
June 26 IV 8	15	July 11 IV 23	June 13 IV 16	15	June 28 V 1	June 12 IV 12	15	June 27 IV 27	8
June 23 IV 5	15	July 8 IV 20	June 12 IV 12	15	June 27 IV 27	June 10 IV 8	14	June 24 IV 22	16
Sept. 4 VI 24	18	Sept. 22 VII 13	Aug. 20 VI 29	19	Sept. 8 VII 18	Aug. 19 VI 25	18	Sept. 6 VII 14	3
Sept. 2 VI 20	18	Sept. 19 VI b 8	Aug. 19 VI 25	18	Sept. 6 VI 21	Aug. 16 VI 21	19	Sept. 4 VI b 11	11
Aug. 30 VI b 16	18	Sept. 17 VII 4	Aug. 16 VI b 21	19	Sept. 4 VII 11	Aug. 13 VI b 18	18	Aug. 31 VII 6	19
Nov. 29 VIII 24	6	Dec. 5 VIII 30	Nov. 12 VIII 29	8	Nov. 20 IX 7	Nov. 11 VIII 25	8	Nov. 19 IX 4	6
Nov. 26 VIII 21	5	Dec. 1 VIII 26	Nov. 11 VIII 25	8	Nov. 19 IX 4	Nov. 8 VIII 21	8	Nov. 16 VIII 29	14
Feb. 11 XI 15	3	Feb. 14 XI 18	Jan. 28 XI 23	2	Jan. 30 XI 25	Jan. 27 XII 18	2	Jan. 29 XII 20	1
Feb. 8 XII 11	3	Feb. 11 XII 14	Jan. 27 XII 18	2	Jan. 29 XII 20	Jan. 24 XII 15	2	Jan. 26 XII 17	9
Feb. 6 XII 7	3	Feb. 9 XII 10	Jan. 24 XII 15	2	Jan. 26 XII 17	Jan. 22 XII 11	2	Jan. 24 XII 13	17

TABLE II — EASTERN SETTING AND WESTERN RISING OF VENUS

1857–1836 B.C. ES.	1857–1836 B.C. Int. (m. d.)	1857–1836 B.C. WR.	1809–1788 B.C. ES.	1809–1788 B.C. Int. (m. d.)	1809–1788 B.C. WR.	1801–1780 B.C. ES.	1801–1780 B.C. Int. (m. d.)	1801–1780 B.C. WR.	Year of Ammi-zaduga.
May 25 III 22	2 12	Aug. 4 VI 4	May 6 III 23	2 16	July 19 VI 9	May 5 III 20	2 15	July 18 VI 5	4
May 23 II 18	2 12	Aug. 2 IV 30	May 5 II 20	2 15	July 18 V 5	May 2 II 15	2 17	July 16 V 2	12
May 21 III 14	2 12	July 30 V 26	May 2 III 15	2 17	July 16 VI 2	Apr. 30 III 11	2 17	July 16 V 28	20
Aug. 20 V 24	2 2	Oct. 20 VII 26	Aug. 6 V 29	2 3	Oct. 6 VIII 2	Aug. 5 V 25	2 3	Oct. 5 VII 28	7
Aug. 18 V 20	2 2	Oct. 18 VII 22	Aug. 5 V 25	2 3	Oct. 5 VII 28	Aug. 2 V 21	2 3	Oct. 3 VII 24	15
Nov. 7 VIII 19	128	Jan. 3 X 17	Oct. 25 VIII 25	1 27	Dec. 19 X 22	Oct. 23 VIII 21	1 28	Dec. 18 X 19	2
Nov. 5 VIII 15	1 28	Jan. 1 X 13	Oct. 23 VIII 21	1 28	Dec. 18 X 19	Oct. 20 VIII 17	1 28	Dec. 15 X 15	10
Nov. 3 VIII 12	1 27	Dec. 29 X 9	Oct. 20 VIII 17	1 28	Dec. 15 X 15	Oct. 18 VIII 13	1 28	Dec. 15 X 11	18
Jan. 13 IX 30	2 0	March 13 XI 30	Dec. 31 X 9	1 26	Feb. 26 XII 5	Dec. 30 X 4	1 28	Feb. 24 XII 2	5
Jan. 10 X 26	2 0	March 10 XII 26	Dec. 30 XI 4	1 28	Feb. 24 I 2	Dec. 27 X 30	1 28	Feb. 22 XII 28	13
Jan. 8 X 22	2 0	March 8 XII 22	Dec. 27 X 30	1 28	Feb. 22 XII 28	Dec. 26 X 26	1 28	Feb. 21 XII 24	21
March 6 XII 27	2 14	May 18 III 11	Feb. 27 I 9	2 9	May 6 III 18	Feb. 25 I 5	2 9	May 4 III 14	8–9
March 5 XII 24	2 13	May 16 III 7	Feb. 25 I 5	2 9	May 4 III 14	Feb. 22 I 1	2 9	May 2 III 10	16–17

CHAPTER IX

RESTORATION OF THE BABYLONIAN CALENDAR BY MEANS OF ATTESTED INTERCALATIONS

WHEN once we have fixed the position of the Babylonian months in the solar year, expressed for us in terms of the Gregorian calendar, for the reign of Ammizaduga, we may attempt to do the same right back to the beginning of the dynasty, and in fact for the Dynasty of Ellasar that coincided with the first part of it. The clue to this is provided by the numerous contract-tablets, dated in intercalary months, by means of which we are able to place a large number of Babylonian leap years. Twelve lunar months contain rather more than 354 days, just about 11 days less than a solar year. It follows that a Babylonian calendar year following an ordinary year begins 11 days earlier than its predecessor, while a year following a leap year begins 19 days later than its predecessor. If the intercalation were guided purely by astronomical considerations the beginning of the calendar year would fluctuate by about 30 days, while the beginning of the calendar leap year would fluctuate by about 11 days in the solar year. Now, if we can fix the date of Ammizaduga, then, since the lengths of all the reigns in the First Dynasty of Babylon and in the Dynasty of Ellasar are known, we can identify each year, and since every month began shortly after the true new moon, we can select by conjecture the date of beginning of each month. But we can do more than this. If we find that the attested leap years are all years when new moons fall within a comparatively narrow range of days in the solar year, it is unlikely that two different groups of such days separated by a month were beginnings of leap years. We must assume that one group only represents leap years, and that that group does not suddenly change its position in the solar year. For instance, if we find that all Babylonian leap years begin in the first half of the month in the Gregorian calendar, that half may be the first half of March or the first half of April, but we are not to expect some leap years to begin in the first half of March and others in the first half of April, if there are none in the second half of March. Now the earliest new year's days must necessarily be those of leap years and the latest must necessarily be those of years succeeding leap years. The total range of new year's days in any reign or group of reigns will therefore be from the beginning of the earliest leap year to 19 days later than the beginning of the latest leap year. If in any solar year there is only one new moon in this interval, that gives us the Babylonian new year's day with certainty, but if there are two, some uncertainty attaches to the determination of the Babylonian date, unless the particular year or one in its immediate vicinity is known to have been a leap year.

Intercalation was made by inserting a second Ulul or a second Adar. Ammizaduga shows a distinct preference for second Ulul; one second Ulul, one second Adar, and one second Nisan are found under Abeshu'; Samsuiluna is known to have inserted a second Ulul five times and a second Adar seven times, and second Ulul would appear to have been inserted three times under Hammurabi. But except in the reign of Ammizaduga there is a presumption in favour of intercalation having been made by inserting a second Adar. Second Nisan is very rare, being found once under Abeshu' and once under Samsuditana.[1]

[1] The principal authority for intercalary months is UNGNAD's paper *Zur Schaltungs-Praxis in der Hammurabi-Zeit*, OLZ. 13 (1910), 66, 67. Some additional dates are given by JOHNS, PSBA. xxxiv (1912). I have received valuable additions and comments from SCHNABEL and others.

Every intercalary month in the reign of Ammizaduga has been found on some contract or other. The list is as follows. In accordance with KUGLER's practice I use * for a year with second Adar, and ** for a year with second Ulul.

- 4* VS. vii 76 (VAT. 6238) = HG. 557.
- 5** Two examples from unpublished contracts, communicated to me by SCHNABEL.
- 10** Ranke 106 (CBM. 437) = HG. 120; VAT. 633 (UNGNAD, *Beitr. zur Assyriol.* vi, 3 [1907], p. 32).
- 11** CT. viii 3ª (88–5–12, 12) = HG. 74.
- 14** An unpublished contract, communicated to me by SCHNABEL.
- 19** In an unpublished contract of Ammizaduga belonging to the year which UNGNAD styles '17+a', twelve months are reckoned from the second Ulul of the previous year to Ab of the year *mu urudu ki-lugal-gub-ba-a ib-dirig-ga*.
  From this it follows that the year preceding '17+a' contained a second Ulul, and since we know from HG. 164 and other contracts that '17+a' contained a second Adar, these two years must be Ammizaduga 19 and 20, for the Venus tablets show that Ammizaduga 19 contained a second Ulul and that Ammizaduga 20 contained either a second Ulul or a second Adar. They also show that there was no intercalation between the 14th and the 19th year. I owe this reference and the identification of the year '17+a' to SCHNABEL.
- 20* M. 9 (88–5–12, 454) = HG. 164; VAT. 5895, 5898, 5907, 5928, 5931, 5949, 5978 (UNGNAD, *ubi supra*, p. 35).

If in the 13th year of Ammizaduga we place the eastern setting in Tebit with Rm. II 531, and the western rising in Adar against the readings of K. 160 and Rm. II 531, all the dates on the Venus tablets are consistent with the intercalations attested by the contracts. If, however, with K. 160 and Rm. II 531 we retain Šabat as the month of western rising in the 13th year, and supply Kislev for the month of eastern setting, against the reading of Rm. II 531, we shall be compelled to make the 13th year intercalary with second Ulul instead of the 14th, thus leaving an interval of six years between two successive intercalations and producing a discord between the contracts and the Venus observations. I have no hesitation, therefore, in reading Tebit and Adar in the Venus texts for this year. The intercalations as thus restored give us twice over an interval of five years, viz. between second Ulul in the 5th year and second Ulul in the 10th year, and between second Ulul in the 14th year and second Ulul in the 19th year. On three occasions Ammizaduga intercalated in two consecutive years, the intercalary months being separated by half a year, a complete year, and a year and a half on the different occasions. In fact the 14th year was the only leap year in his reign which did not form one of a pair.

With these data it is easy to reconstruct a detailed calendar of the reign of Ammizaduga. In the following table I give the Gregorian date of Nisan 1 and Tešrit 1 for each year on the assumption that the second solution is correct. The Gregorian date is that which agrees with the Babylonian date during the daytime. The computation is made with SCHOCH's handy tables.

Year of Ammizaduga.	B.C.	*Nisan 1.*	*Tešrit 1.*
1	1921	April 24	Oct. 19
2	1920	April 14	Oct. 8
3	1919	April 3	Sept. 28
4*	1918	March 24	Sept. 17

Year of Ammizaduga.	B.C.	*Nisan 1.*	*Tešrit 1.*
5**	1917	April 10	Nov. 3
6	1916	April 29	Oct. 24
7	1915	April 19	Oct. 13
8	1914	April 8	Oct. 3
9	1913	March 27	Sept. 21
10**	1912	March 17	Oct. 10
11**	1911	April 5	Oct. 29
12	1910	April 24	Oct. 18
13	1909	April 12	Oct. 6
14**	1908	April 1	Oct. 25
15	1907	April 20	Oct. 15
16	1906	April 10	Oct. 4
17	1905	March 29	Sept. 22
18	1904	March 18	Sept. 12
19**	1903	March 8	Sept. 30
20*	1902	March 27	Sept. 20
21	1901	April 15	Oct. 9

On the first solution each year should begin 19 days later, on the third solution 16 or 17 days earlier, on the fourth solution 36 days earlier, and on the fifth solution 34 days earlier than on the second solution, on which this table is constructed.

It will be observed that the beginning of the year varies from March 8 to April 29, 52 days, while the beginning of Tešrit varies by the same amount between September 12 and November 3. The beginnings of leap years vary from March 8 to April 10, 33 days.

In the thirty-seven years of Ammiditana we have eight attested intercalary months as compared with the seven of Ammizaduga. These are as follows:

4* Ranke 91 (CBM. 723) = HG. 110.
11* Unpublished.
22* Johns, PSBA. xxxiv (1912), 24.
26* CT. vi 39ᵃ (91–5–9, 734) = HG. 1249.
27* P. 109.
33* P. 112.
36* Chiera, PBS. viii 2, no. 202, erroneously identified by Chiera with Ammiditana 32.
37* Unpublished.

In six of these years there is only one new moon falling within the range of leap year dates of the reign of Ammizaduga. The exceptions are the 26th and 37th years. The 26th is the earlier of two consecutive years, both leap years, and we are bound to accept the earlier new moon falling within the range, if the beginning of the next year is also to fall within the range. The 37th is the second of two similarly placed leap years. In this case the relation of the calendar to the solar year is determined by the Venus tablets, which begin in the following year, and the determination of the beginning of this year carries with it the determination of the beginnings of the 33rd and 36th years, for it is inconceivable that either the 34th or 35th year can have been a leap year.

We thus get for Nisan 1:

Ammiditana	4 March 12	Ammiditana	27 March 28
	11 March 25		33 March 22
	22 March 23		36 March 19
	26 March 9		37 April 7

It will be observed that the total range of the beginnings of these leap years is only 29 days, March 9 to April 7, and with one exception they fall within the narrower range, March 9 to March 28, showing a distinct preference for the earlier part of the range which Ammizaduga permitted himself. It will also be observed that all leap years from the 22nd year of Ammiditana to the end of the reign of Ammizaduga are known with the exception of one falling between the 27th and 33rd years of Ammiditana.

There are no intercalary months in the reign of Abeshu' which we can assign to particular regnal years.

In the reign of Samsuiluna there are twelve such:

2* Unpublished.
5** TD. 114 = HG. 1103.
8** Warka 69 = HG. 334.
9** Unpublished.
10* Unpublished.
16** Unpublished.
17** Unpublished.
20* P. 53.
23* CT. viii 32ᵃ (91–5–9, 2503) = HG. 365.
27* Johns, PSBA. xxxiv 24.
28* Unpublished.
37* Johns, PSBA. xxxiv 24.

In Years 5, 16, and 27 there are two new moons within the range permitted by Ammizaduga. But to accept the later date for 5 would involve placing the beginning of 10 thirty-four days later than the last day within the range, while to accept the earlier date for 5 involves nothing worse than placing the beginning of 8 one day earlier than the first day within the range and the beginning of 10 four days later than the last day within the range. Similarly, if we accept the later dates for 16 and 27, we must place the beginning of 17 sixteen days and the beginning of 28 fourteen days after the end of the range. We therefore adopt the earlier date in each of these cases, and reconstruct the beginnings of leap years as follows:

Samsuiluna	2 March 14	Samsuiluna	17 March 28
	5 March 11		20 March 24
	8 March 7		23 March 22
	9 March 26		27 March 8
	10 April 14		28 March 26
	16 March 9		37 March 17

The total range is 38 days, March 7 to April 14, five days longer than under Ammizaduga. But with one exception all dates fall within the narrower range, March 7 to March 28, practically the same range as that found for the reign of Ammiditana. Our reconstruction also implies that all the leap years of the first 28 years of Samsuiluna are known.

In the reign of Hammurabi we have the following leap years:

3 VS. vii 96 (VAT. 943) = HG. 881. Intercalary month, name not given.
10* Unpublished.
15* VS. viii 131–3 (VAT. 1028, 922) = HG. 858, 859; also in unpublished tablets of which Schnabel has informed me, from which we learn that this year contained a second Adar.
16* P. 70 = HG. 989.

17* M. 71, VS. ix 6 (VAT. 974/75) = HG. 505.
23* Unpublished: communicated by SCHNABEL.
24* Unpublished.
25* Unpublished. See also JOHNS, PSBA. xxxiv 24, whose Year 42 is really 25.
30* Unpublished.
33* Bu. 88-5-12, 739. See KING, *Letters*, iii, p. 13, note 1.
36** Unpublished: *mu e-me-te-ur-sag*, i. e. Year 36, not 41.
39** Unpublished: *mu kur su-bir* [ki].
40** 32 in JOHNS, PSBA. xxxiv 24, identified by SCHNABEL, perhaps from the same tablet.

From the Year 10 to the end of the reign we have here a complete series of leap years continuous with those which we have just found for the reign of Samsuiluna. We may date the beginnings of these leap years as follows:

Hammurabi	3 March 27	Hammurabi	25 April 23
	10 April 10		30 March 30
	15 March 15		33 March 26
	16 April 3		36 March 23
	17 April 22		39 March 20
	23 March 17		40 April 8
	24 April 5		

The total range is 39 days, March 15 to April 23, rather more than the widest range known to us in any other reign. It will be observed that the earliest date falls eight days later and the latest nine days later than under Samsuiluna.

In dealing with the reign of Rim-Sin I follow LANGDON and UNGNAD and equate his 32nd year with the 1st year of Hammurabi. This date does not affect the identification of his leap years with years before Christ, but only the place which they are to occupy in relation to the date of his accession. The regnal years given by MISS GRICE are in consequence diminished by one.

The known leap years are as follows. In each instance the intercalary month is second Adar.

7 G. 176 (YBC. 8761), G. 210 (YBC. 4413), G. 212 (YBC. 7476).
16 VS. xiii 59 (VAT. 3977) = HG. 1536.
18 Communicated by SCHOCH: I have failed to find this.
32 EG. 61 = HG. 1505.
49 PSBA. xxxiv, Pl. X, No. VII (Ash. 1911-279) = HG. 1824.

In each of these years there is only one new moon within the range in which leap years began under Ammizaduga. We can therefore fix the beginnings of these years as follows:

Rim-Sin	7 March 26	Rim-Sin	32 March 20
	16 March 17		49 March 13
	18 March 24		

These give a total range of 13 days only, and agree excellently with the dates adopted in this discussion for the reigns of Samsuiluna and Ammiditana. It may be noted that the 18th year of Hammurabi, which corresponds to the 49th of Rim-Sin, was not a leap year at Babylon. On the other hand, the 18th year of Rim-Sin, which coincided with the 7th year of Sinmuballit, was a leap year both at Ellasar and at Babylon.

In the reign of Sinmuballit of Babylon we have three recorded leap years.

7 VS. viii 26 (VAT. 700) = HG. 806. Intercalary month not named.
9* VS. viii 30 (VAT. 1489) = HG. 875.
19 TD. 72 = HG. 1224. Intercalary month not named.

If we suppose that these years began within the same limits as the leap years of Ammizaduga we obtain the following new year's days.

Sinmuballit	7 (= Rim-Sin 18)	March 24
	9	April 2
	19	March 12 or April 10

The selection of April 10 for the 19th year gives a narrower range of dates than the selection of March 12 and agrees better with the run of the calendar under Hammurabi.

The only recorded intercalation under the First Dynasty of Babylon before Sinmuballit is that in the 5th year of Sumulailum, RFH. 39 (= AJSL. 33, 243), HG. 1776, which contained a second Adar and which ought to have begun on March 18, well within the normal range of beginnings of leap years.

In Ellasar before Rim-Sin the following leap years are known:

Abisarê 1* RA. xiv (1897), p. 153.
Siniribam 1* G. 133 (YBC. 8755), G. 157 (YBC. 5093).
Sinikisham 1* G. 62 (YBC. 4851).
Warad-Sin 9* G. 119 (YBC. 5686).

Adopting the chronology shown in the List of Kings in this volume, we get the following dates:

King.	*Regnal Year.*	*Interval to Rim-Sin 1.*	*Gregorian date of Nisan 1.*
Abisarê	1	83	March 19
Siniribam	1	21	March 24
Sinikisham	1	19	March 31
Warad-Sin	9	4	March 16

Three of these are within the range which was found applicable to Rim-Sin, so that the nine identifiable leap years of Ellasar range from March 13 to March 31 only, and the calendar therefore approximates to strict regularity, for in any lunisolar calendar the beginning of leap year must range by at least 10 or 11 days.

It is now possible to make a conjectural table, showing the beginning of each year on the hypothesis that what is here called the second solution is correct. The narrow range of intercalations under Rim-Sin and the abundance of known leap years from the 10th year of Hammurabi to the end of the reign of Samsuiluna leave little doubt as to the correct new moons to assume for Nisan during those periods. Recorded leap years are indicated by B, assumed leap years by *B*. BB indicates a year known to have contained a second Ulul.

				B.C.				
Rim-Sin	1	April 2		2098				
	2	March 21	*B*	2097				
	3	April 9		2096				
	4	March 30		2095				
	5	March 19	*B*	2094				
	6	April 6		2093				
	7	March 26	B	2092				
	8	April 14		2091				
	9	April 4		2090				
	10	March 23	*B*	2089				
	11	April 11		2088				
	12	March 31		2087	Sinmuballit	1	March 31	*B*
	13	March 21	*B*	2086		2	April 19	
	14	April 7		2085		3	April 7	
	15	March 28		2084		4	March 28	*B*
	16	March 17	B	2083		5	April 16	
	17	April 5		2082		6	April 5	
	18	March 24	B	2081		7	March 24	B
	19	April 12		2080		8	April 12	
	20	April 2		2079		9	April 2	B
	21	March 22	*B*	2078		10	April 20	
	22	April 9		2077		11	April 9	
	23	March 29		2076		12	March 29	*B*
	24	March 19	*B*	2075		13	April 17	
	25	April 7		2074		14	April 7	*B*
	26	March 26		2073		15	April 24	
	27	March 15	*B*	2072		16	April 14	
	28	April 3		2071		17	April 3	*B*
	29	March 24	*B*	2070		18	April 22	
	30	April 10		2069		19	April 10	B
	31	March 31		2068		20	April 29	
	32	March 20	B	2067	Hammurabi	1	April 19	
	33	April 8		2066		2	April 8	
	34	March 27		2065		3	March 27	B
	35	March 17	*B*	2064		4	April 15	
	36	April 5		2063		5	April 5	*B*
	37	March 25	*B*	2062		6	April 24	
	38	April 12		2061		7	April 12	
	39	April 1		2060		8	April 1	*B*
	40	March 22	*B*	2059		9	April 20	
	41	April 10		2058		10	April 10	B
	42	March 29		2057		11	April 27	
	43	March 18	*B*	2056		12	April 17	
	44	April 6		2055		13	April 6	
	45	March 27		2054		14	March 27	
	46	March 15	*B*	2053		15	March 15	B
	47	April 3		2052		16	April 3	B
	48	March 23		2051		17	April 22	B
	49	March 13	B	2050		18	May 11	
	50	March 30		2049		19	April 29	
	51	March 20	*B*	2048		20	April 19	

				B.C.				
Rim-Sin	52	April 8		2047	Hammurabi	21	April 8	
	53	March 28		2046		22	March 28	
	54	March 17	*B*	2045		23	March 17	B
	55	April 5		2044		24	April 5	B
	56	March 25	*B*	2043		25	April 23	B
	57	April 13		2042		26	May 12	
	58	April 1		2041		27	May 1	
	59	March 22	*B*	2040		28	April 20	
	60	April 10		2039		29	April 10	

B.C.				
2038	Hammurabi	30	March 30	B
2037		31	April 17	
2036		32	April 6	
2035		33	March 26	B
2034		34	April 13	
2033		35	April 3	
2032		36	March 23	BB
2031		37	April 11	
2030		38	March 31	
2029		39	March 20	BB
2028		40	April 8	BB
2027		41	April 27	
2026		42	April 16	
2025		43	April 4	
2024	Samsuiluna	1	March 25	
2023		2	March 14	B
2022		3	April 2	
2021		4	March 21	
2020		5	March 11	BB
2019		6	March 30	
2018		7	March 19	
2017		8	March 7	BB
2016		9	March 26	BB
2015		10	April 14	B
2014		11	May 3	
2013		12	April 21	
2012		13	April 11	
2011		14	March 31	
2010		15	March 21	
2009		16	March 9	BB
2008		17	March 28	BB
2007		18	April 16	
2006		19	April 5	
2005		20	March 24	B
2004		21	April 12	
2003		22	April 2	
2002		23	March 22	B
2001		24	April 9	
2000		25	March 29	
1999		26	March 19	

B.C.				
1998	Samsuiluna	27	March 8	B
1997		28	March 26	B
1996		29	April 14	
1995		30	April 3	
1994		31	March 24	
1993		32	March 12	*B*
1992		33	March 31	
1991		34	March 20	*B*
1990		35	April 8	
1989		36	March 27	
1988		37	March 17	B
1987		38	April 5	
1986	Abeshu'	1	March 25	
1985	(No attested intercalations)	2	March 13	*B*
1984	(All leap years conjectural)	3	April 1	
1983		4	March 22	*B*
1982		5	April 10	
1981		6	March 29	
1980		7	March 18	*B*
1979		8	April 6	
1978		9	March 27	
1977		10	March 15	*B*
1976		11	April 3	
1975		12	March 23	
1974		13	March 13	*B*
1973		14	March 30	
1972		15	March 20	*B*
1971		16	April 8	
1970		17	March 28	
1969		18	March 17	*B*
1968		19	April 5	
1967		20	March 25	
1966		21	March 14	*B*
1965		22	April 1	
1964		23	March 22	*B*
1963		24	April 10	
1962		25	March 30	
1961		26	March 18	*B*

B.C.				
1960	Abeshu'	27	April 6	
1959		28	March 26	
1958	Ammiditana	1	March 16	*B*
1957		2	April 3	
1956		3	March 23	
1955		4	March 12	B
1954		5	March 31	
1953		6	March 20	*B*
1952		7	April 8	
1951		8	March 28	
1950		9	March 17	*B*
1949		10	April 4	
1948		11	March 25	B
1947		12	April 13	
1946		13	April 2	
1945		14	March 21	*B*
1944		15	April 9	
1943		16	March 30	
1942		17	March 19	*B*
1941		18	April 6	
1940		19	March 26	
1939		20	March 16	*B*
1938		21	April 4	
1937		22	March 23	B
1936		23	April 11	
1935		24	March 31	
1934		25	March 21	
1933		26	March 9	B
1932		27	March 28	B
1931		28	April 16	

B.C.				
1930	Ammiditana	29	April 5	
1929		30	March 24	
1928		31	March 14	*B*
1927		32	April 2	
1926		33	March 22	B
1925		34	April 9	
1924		35	March 29	
1923		36	March 19	B
1922		37	April 7	B
1921	Ammizaduga	1	April 24	
1920		2	April 14	
1919		3	April 3	
1918		4	March 24	B
1917		5	April 10	BB
1916		6	April 29	
1915		7	April 19	
1914		8	April 8	
1913		9	March 27	
1912		10	March 17	BB
1911		11	April 5	BB
1910		12	April 24	
1909		13	April 12	
1908		14	April 1	BB
1907		15	April 20	
1906		16	April 10	
1905		17	March 29	
1904		18	March 18	
1903		19	March 8	BB
1902		20	March 27	B
1901		21	April 15	

CHAPTER X

COMPARISON OF THE RESTORED BABYLONIAN CALENDAR WITH CONTRACTS BEARING ON AGRICULTURAL OPERATIONS

THE Babylonian calendar as restored for each year in the last chapter is approximately correct for our second solution of the Venus observations. The first solution, as has been remarked, requires an addition of 19 days to each date, the third a subtraction of 16 or 17 days, the fourth a subtraction of 36 days, and the fifth a subtraction of 34 days approximately. As was seen in the first chapter, KUGLER, with the material at his disposal, attempted to decide between certain solutions by the seasons of the year at which they would place dated contracts bearing on agricultural operations. The criterion is sound and there is sufficient evidence to enable us to apply it.

The most crucial test appears to be supplied by the contracts for division of dates between landlord and tenant. The practice was for the unripe dates to be counted some time before date-harvest and for a contract to be signed by which the tenant undertook to supply by a given day, generally the last day of Tešrit, or first day of Araḫsamna, a given quantity of ripe dates determined by the estimated number of unripe dates. From this we may infer that the dates would be expected to be harvested before the day named on the contract, and that any solution of the calendar which makes that day fall before the completion of date-harvest could be expected, must necessarily be false. On the other hand, a solution which interposes an unnecessary interval between date-harvest and the division is improbable.

In answer to an inquiry from LANGDON, MR. J. F. WEBSTER of the Agricultural Directorate, Baghdad, wrote on 1924 November 16 as follows:

'Since the date-export to America started the demand has been for *early* maturing types, and date-picking began this year in the Basrah gardens in the last week in August.

'The bulk of the crop was picked in September, and late varieties which are valued locally, as they are table delicacies, extended well into October, and there is one variety which is not picked until November.

'It is probable that for your purpose mid-September to mid-October should be taken as the month of date-harvest, since I doubt if the very early varieties existed in any great quantity before the specialized demand for them arose.'

In response to a further inquiry from me, MR. WEBSTER wrote again on 1925 January 15:

'My statement that date-harvest extends from mid-September to mid-October was intended to cover the bulk of the crop.

'I should certainly change this to the month of October were the inquiry confined to Hillah District.'

Even more important for our purpose are the neo-Babylonian contracts relating to date-harvest. Thanks to KUGLER's industry and ingenuity we have in his *Sternkunde und Sterndienst*, ii, T. 2, H. 2 (1924), 435–8, 461–3, a restoration of the Babylonian calendar from 573 B.C. to 1 B.C., and we can with great confidence convert any Babylonian date into the corresponding Gregorian date within those limits. There are also other contracts for payments in dates, for payments in kind were quite common both in early and in late Babylonian times, but although these are often required to be made at the time of date-harvest, they are also found scattered over the rest of the year and are therefore of less weight than contracts for division of the harvest.

In BE. viii 39, p. 32, in the accession year of Nabuna'id, in a contract signed on Ayar 15 (May 18 Gregorian), a debtor promises to pay 3 kors of dates, the equivalent of 2 shekels of silver, on Tešrit 7 (October 5). It looks as if this date was selected because it was expected that new dates would be available at that time. The quantity is small and it is conceivable that payment was to be made before the end of date-harvest. This may also explain the selection of the 7th rather than the usual last day of the month. On the other hand, the date may have been selected for some reason which had no connexion with harvest.

An interesting contract is KB. iv (1896), p. 229 = BM, S + 76, 11–17, 261, also in STRASSMAIER, ZA. iv 128, 152. This is dated at Babylon in the first year of Barzta, the pseudo-Smerdis, 522 B.C., Tešrit 1, September 14 of our calendar. The owner gives the recipient an order to receive from his servant at the picking in Arahsamna a certain quantity of dates 'still on the tree'. Arahsamna began that year on October 13. So it would appear that on September 14 the picking was expected to take place on or after October 13.

KB. iv, pp. 309, 311 (VAT. 78), contains a similar order of the 36th year of Darius I (486 B.C.), signed on Ulul 13 (September 19), which gives the right to receive a specified quantity of dates 'still on the tree' at the picking in Tešrit, which in that year began on October 7. In this case we infer that on September 19 the picking was expected to take place on or after October 7.

A document, CT. iv 34d, of the 10th year of Xerxes (476 B.C.), signed on Arahsamna 24 (November 7), demanding a payment of dates in Kislev (ending December 12), may be disregarded, since it was made after harvest. The same probably applies to BE. x 68, signed at Nippur on Tešrit 2 (October 8) in the 3rd year of Darius II (B.C. 421), requiring payment in Arahsamna, which in that year ended on December 4, except that this contract appears to have been signed during, rather than after, harvest. A contract, VS. iii 183, of the 16th year of Xerxes (470 B.C.), signed at Nippur on Ulul 5 (September 14), requires a delivery of dates in Arahsamna, which in that year ended on December 7. Otherwise the contracts regularly require payment in Tešrit. As the day of Tešrit is not stated, it would appear that payment might be made at any time up to the last day of that month. Examples of contracts for payments of dates to be made in Tešrit are the following. In each case the year given is the year in which payment was to be made.

BE. ix 9	Artaxerxes I	28
BE. ix 7	,,	29
BE. ix 19, 22	,,	31
BE. ix 31	,,	33
BE. ix 36, 37, 38	,,	34
BE. ix 62, 63	,,	38
BE. ix 91, 92, 93, 95, 97, 103, 104, 105	,,	41
BE. x 8, 16, 27, 38, 51	Darius II	1

We also have in BE. ix 48, signed on the 2nd of Tešrit of the 36th year of Artaxerxes I (429 B.C. October 6), a contract to pay rent in dates annually in the month of Tešrit for 60 years, and in BE. x 61, signed on Tebit 18 in the 2nd year of Darius II (421 B.C. January 2), a contract to pay rent in dates annually in the month of Tešrit for 3 years. Within the range of years

covered by these contracts, including the 60 years from 429 B.C., the last day of Tešrit would range from October 14 to November 15. As the system of intercalation had nothing to do with the lateness or earliness of date-harvest in the solar year, it may be inferred that the contractors considered it normally possible to deliver the landlord's supply of dates on October 14, though a period of grace may have been given when the harvest was late and Tešrit early. And we have no reference to any demand for a delivery of dates earlier than October 5, if so early. It would, however, be rash to suppose that if the calendar had been so arranged that the last day of Tešrit sometimes fell a few days earlier than October 14 or later than November 15, the contracts would have named some other month instead of Tešrit. Judging from the modern time of date-harvest and from the contracts for delivery of dates in neo-Babylonian times, we should look with suspicion on any restoration of the calendar which places any contract for delivery of dates to a landlord much before October 14, but we should expect the earliest day for delivery to be not far distant from October 14.

Till recently there were very few published contracts for the delivery of dates to landlords in or near the time of the First Dynasty of Babylon. We owe to the courtesy of M. THUREAU-DANGIN a series of contracts for delivery of dates to landlords, belonging to the latter years of Hammurabi, which have now been published by JEAN.[1] Including those only where the year can be identified and the date of delivery is preserved, we have:

No.	*Reference.*	*Year.*	*Date of Contract.*	*Contracted Date of Delivery.*
1	VS. xiii 18 (=VAT. 6076) = HG. 1724	Hammurabi 23	Ulul 17	Kislev
2	Ao. 8397, J. 144	,, 32		Tešrit
3	Ao. 8382, J. 147	,, 33	Ab 18	Tešrit
4	Ao. 8386, J. 157	,, 33[2]	Ab 20	Tešrit 30
5	Ao. 8385, J. 150 (=RA. xxi, pp. 2, 3)	,, 35	Ulul 21	Tešrit 30
6	Ao. 8400, J. 160	,, 38		Tešrit
7	Ao. 8383, J. 170	,, 39	Ulul	Tešrit
8	Ao. 8384, J. 169	,, 39	Ulul	Tešrit
9	Ao. 8394, J. 175	,, 40	Ulul 20	Tešrit 30
10	Ao. 8402, J. 186	,, 42		Tešrit
11	Ao. 8399, J. 180	,, 43	Ulul 8	Tešrit
12	Ao. 8395, J. 187	,, 43	Ulul 9	Tešrit
13	Ao. 8392, J. 182	,, 43	Ulul 10	Tešrit
14	TD. 138 = HG. 1187	Samsuiluna 19	Ulul 23	Arahsamna 1
15	TD. 143 = HG. 1189	,, 24	Ab 22	Arahsamna 1

In reducing these to Gregorian dates, I assume that a contract for delivery in a particular month is equivalent to a contract for delivery on the last day of that month. I show the Gregorian date of contract and delivery on each of the five solutions discussed for the Venus observations.

No.	*Solution I.*		*Solution II.*		*Solution III.*		*Solution IV.*		*Solution V.*	
	Date of Contract.	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*
1	Sept. 15	Dec. 25	Aug. 28	Dec. 7	Aug. 10	Nov. 19	July 21	Oct. 30	July 23	Nov. 1
2		Nov. 17		Oct. 29		Oct. 12		Sept. 22		Sept. 23
3	Aug. 28	Nov. 6	Aug. 9	Oct. 18	July 23	Oct. 1	July 2	Sept. 11	July 4	Sept. 13
4	Aug. 30	Nov. 6	Aug. 11	Oct. 18	July 25	Oct. 1	July 4	Sept. 11	July 6	Sept. 13

[1] *Textes Cunéiformes*, xi, Larsa 2 (1926).

[2] JEAN in error gives 36.

No.	*Solution I.*		*Solution II.*		*Solution III.*		*Solution IV.*		*Solution V.*	
	Date of Contract.	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*	*Date of Contract.*	*Date of Delivery.*
5	Oct. 6	Nov. 13	Sept. 18	Oct. 26	Sept. 1	Oct. 9	Aug. 11	Sept. 18	Aug. 13	Sept. 20
6		Nov. 11		Oct. 23		Oct. 6		Sept. 16		Sept. 18
7	Sept. 2–Oct. 1	Nov. 29	Aug. 15–Sept. 12	Nov. 10	July 28 Aug. 26	Oct. 24	July 8–Aug. 6	Oct. 4	July 10–Aug. 7	Oct. 5
8	Sept. 2–Oct. 1	Nov. 29	Aug. 15–Sept. 12	Nov. 10	July 28–Aug. 26	Oct. 24	July 8–Aug. 6	Oct. 4	July 10–Aug. 7	Oct. 5
9	Oct. 10	Dec. 18	Sept. 22	Nov. 29	Sept. 5	Nov. 12	Aug. 15	Oct. 23	Aug. 17	Oct. 24
10		Nov. 26		Nov. 8		Oct. 22		Oct. 2		Oct. 3
11	Sept. 25	Nov. 15	Sept. 6	Oct. 27	Aug. 20	Oct. 10	July 31	Sept. 20	Aug. 1	Sept. 21
12	Sept. 26	Nov. 15	Sept. 7	Oct. 27	Aug. 21	Oct. 10	Aug. 1	Sept. 20	Aug. 2	Sept. 21
13	Sept. 27	Nov. 15	Sept. 8	Oct. 27	Aug. 22	Oct. 10	Aug. 2	Sept. 20	Aug. 3	Sept. 21
14	Oct. 11	Nov. 17	Sept. 22	Oct. 29	Sept. 5	Oct. 12	Aug. 17	Sept. 22	Aug. 18	Sept. 23
15	Sept. 14	Nov. 20	Aug. 26	Nov. 2	Aug. 9	Oct. 16	July 20	Sept. 26	July 22	Sept. 27

It will be seen that No. 1 on which UNGNAD relied as showing that date-harvest would fall too late on the first solution, and which requires delivery not later than the last day of Kislev instead of on the last of Tešrit or first of Araḫsamna, gives a Gregorian date falling later than any of the others. But, as has been noticed earlier,[1] this contract requires the delivery not only of dates, but of planks of palm wood and even of 10 talents of palm branches blown down by the wind, an obligation which could not be fulfilled before the winter storms had begun. The date of signature is within the range given by other contracts. If we ignore this contract, the date of delivery varies from November 6 to December 18 according to the first solution, from October 18 to November 29 according to the second, from October 1 to November 12 according to the third, from September 11 to October 23 according to the fourth, and from September 13 to October 24 according to the fifth. The September deliveries found on the fourth and fifth solutions are quite inconsistent with the evidence of the Persian period and of modern times. In six out of ten years the third solution gives deliveries in the first twelve days of October contrary to the same evidence. The dates on the second solution fall entirely within the range given by contracts of the Persian period, except in the case of No. 9, where delivery is not required till November 29, but the custom of requiring delivery in Tešrit was obviously well established, and this would explain the naming of Tešrit in the contract even when a delivery in Ulul II was possible. The first solution would imply that the date of delivery was generally fixed a month later than was necessary. It may also be observed that on the first solution, contracts Nos. 9 and 14 in this table, where the dates are distinctly described as green, were not signed till October 10 and 11 respectively. This would imply great delay in signing the contracts, for the actual enumeration of the green dates must have taken place long before those dates. On the second solution the latest dated contracts belong to September 22, and the earliest to August 9. The third, fourth, and fifth solutions imply an enumeration of unripe dates as early as July.

It may be taken, therefore, that the evidence of date-harvests excludes all solutions except the second.

Next in importance to the date-harvest is the barley-harvest. Here we have a number of contracts dealing with the employment of labourers. On the present date of harvest MR. WEBSTER wrote to LANGDON as follows:

[1] p. 40.

'*Barley-harvest* begins in the area specified [between Basrah and Baghdad] about the middle of April and ends about the middle of May. There are of course seasonal variations, but these may be taken as average dates. *Wheat-harvest* commences about the beginning of May and ends with the end of the month.

'Native varieties of barley exist having 2, 4, and 6 rows of seed.'

In his supplementary letter to me, MR. WEBSTER wrote:

'The harvest of all crops is certainly not at the same time from Basrah to Baghdad. It may be taken as a general rule that the harvests at Basrah are about fifteen days earlier than those of Baghdad.

'Hillah harvests are almost synchronous with those of Baghdad.

'My statement that barley-harvest begins about the middle of April and ends about the middle of May was intended to cover the chief barley-growing districts.

'If the area is confined to the Babylon-Nippur district it would remain unmodified, as these tracts are the chief barley-producing areas. As a matter of fact the latest date we have for barley-harvest in that region is May 15th, and the earliest April 10th.'

We have numerous examples of barley being regarded as the medium for payment of debt, but the date at which such debts were to be paid would be evidence of the customary season for settling accounts rather than of the date of harvest. I note, however, two late Babylonian contracts for payment of rent in barley. Both contracts run for three years and stipulate for payment in Ayar.

The contracts are BE. ix 45, belonging to Ab 20 in the 36th year of Artaxerxes I, and BE. ix 89, belonging to the 41st year of the same reign. The last day of Ayar in the three years following the first of these contracts should on KUGLER's restoration of the calendar fall on May 28, June 16, June 6 respectively, and in the three years following the other contract on June 2, May 22, June 10 respectively. These dates accord well with the modern date of harvest varying from April 10 to May 15. Since the contracting parties could not foresee the weather, the date in the contracts would have to be consistent with a late as well as with an early harvest.

In the following contracts of the First Dynasty, labourers are engaged for the harvest. The dates are converted on the assumption that the second solution is correct.

VS. ix 3 (VAT. 1090), HG. 1003, Hammurabi 17, Kislev	Dec. 14–Jan. 12
VS. vii 60 (VAT. 6392), HG. 555, Ammiditana 34, Kislev 30	Dec. 30
CT. vi 44[c], HG. 541, Hammurabi 30, Šabat 10	Jan. 28
Ga. 59, HG. 1010, Hammurabi 38, Šabat 15	Feb. 4
VS. vii 58 (VAT. 6337), HG. 554, Ammiditana 30, Adar 4	Feb. 15
Ga. 60, HG. 1011, Hammurabi 38, Šabat	Jan. 21–Feb. 18
P. 115, HG. 1022, Ammiditana 37, Adar 5	Feb. 29
W. 47, HG. 1678, Ammiditana 2, Adar 14	March 6
P. 116, HG. 1023, Ammiditana 37, Adar 21	March 16
VS. ix 109, 110 (VAT. 641), HG. 1007, Hammurabi 35, Adar 30	March 22
(In this case the contract is for the harvest month.)	
P. 119, HG. 1024, Ammizaduga 2, Adar 18	March 22
M. 22 (VAT. 630), HG. 559, Ammizaduga 8, Adar 25	March 22
TD. 176, HG. 1171, Samsuiluna 5 (?), Adar	Feb. 28–March 29
(One woman engaged as harvester for one month.)	
VS. vii 76 (VAT. 6238), HG. 557, Ammizaduga 4, Adar II 30	April 10

Ranke 111 (CBM. 381), HG. 563, Samsuditana, Ayar 14

(If the position of Ayar in the solar year fluctuated between the same limits under Samsuditana as under Ammizaduga this contract cannot belong to a date earlier than April 19.)

Here then, we have fifteen contracts for hiring labourers for harvest, most probably for barley-harvest, for in the time of this dynasty we hear far more of barley than of all other kinds of grain. One of these contracts was made as early as December, but they become more numerous as the date of harvest draws near, and the latest are signed about or shortly after the earliest date of barley-harvest under modern conditions. If we were to adopt the first solution, all the dates would fall nineteen days later. The contracts computed for March 22 would have been dated April 10, the earliest date reported by Mr. Webster for barley-harvest, while the contract computed for April 10 would fall on April 30, and the contract dated Ayar 14 would hardly be older than May 8. That means that two of the contracts would have been made close to the time of a late harvest.

Another group of contracts seems to contain lists of labourers who have presented themselves for the harvest.

In TD. 123, 124, HG. 1373, Samsuiluna 8, Nisan 25 and Ayar 2, March 31 and April 7 of our calendar, we have the name of a single harvester.

In VS. vii 57, HG. 1380, Ammiditana 30, Nisan 13, April 5 of our calendar, we have a list of twenty-nine harvesters.

In CT. vi 23^{b}, HG. 1382, Nisan 20 of an unknown year of Ammizaduga, not earlier than March 27 nor later than May 18 of our calendar, we have a similar list of sixteen harvesters.

These lists are of course quite inconsistent with the adoption of any solution except the first two of the present discussion, for on any other solution the first three of them would fall long before harvest. The second solution assumes that they assembled shortly before the earliest possible date for barley-harvest, the first solution that they arrived well within the range of harvest dates, though not necessarily after the beginning of harvest in the particular year.

Next we have a group of documents, which Ungnad takes as acknowledgements of work done, which the workmen or their foremen received on the completion of their labour. Two of these belong to the first year of Rim-Sin. One of these, BRM. iii 18^{b}, HG. 1787, is dated Nisan 11, our April 12; the other, BRM. iii 18^{a}, HG. 1789, is dated Ayar 4, May 4 of our calendar. This seems a wide difference between harvest dates in the same district and suggests that the later acknowledgement is for a different kind of grain. It will be observed that it is for one day's work by one harvester; the earlier is for work by five harvesters.

VS. ix 25, HG. 1411, Hammurabi 27, Nisan 12, May 12 of our calendar, is a note of a harvester, who may have worked that day.

VS. xiii 19 (VAT. 6438), HG. 1979, Hammurabi 29, Nisan 27, May 6 of our calendar, is a note of ten harvesters, who appear to have come five times for the harvest, which must therefore have begun and which was probably completed.

From the reign of Samsuiluna we have:

BRM. iii 182, HG. 1864, Samsuiluna 4, Nisan, March 21–April 19.

Pinches, *Berens Collection* 96 (19^{b}), HG. 1868, Samsuiluna 6, Ayar 11, May 8.

In the former of these there are seven labourers, but the duration of work is not specified; in the latter there are eleven labourers, who have worked for $13\frac{2}{3}$ days. This agrees excellently with an acknowledgement signed about the end of the season of barley-harvest.

There remains an acknowledgement dated Ayar 5 in an unknown year of Ammiditana, a date which may fall anywhere from April 11 to May 19, and an acknowledgement dated Nisan 9 in an unknown year of an unknown king, BRM. iii 188, 185, HG. 1875, 1877.

Altogether these acknowledgements agree excellently with our second solution. On that solution they range from April 12 to May 12, almost precisely the range of harvest dates given by Mr. Webster. The first solution would make them range from May 1 to May 31, the third from March 26 to April 25, and in the case of HG. 1868 it would imply that $13\frac{2}{3}$ days' work had been done in the harvest-field ending on April 21.

The documents dealing with barley-harvest appear, therefore, to be conclusive in favour of the second solution, and to be in excellent accord with those dealing with date-harvest.

A caution may be inserted here about certain documents which are taken by Ungnad to refer to fields standing in ear. In HG. 1700 such a field is mentioned on Ayar 16, and in HG. 1717 such a field is mentioned in Nisan, but in HG. 1720 we find it in Ab, and in HG. 1710 it is found in Ulul. The phrase is regularly contrasted with uncultivated land, and Langdon assures me that it should be translated 'cultivated', not 'standing in ear'.

CHAPTER XI

CONTROL OF THE BABYLONIAN CALENDAR BY MEANS OF MONTHS OF THIRTY DAYS

As has been seen, the beginning of each Babylonian month appears to have been based on astronomical observation. A record of the length of the month is, therefore, a record of the interval between two astronomical observations. Where a contract is dated on the 30th day of a Babylonian month, we know that 30 days elapsed between two successive appearances of the Moon. If the calendar is sufficiently restored to enable us to identify the months, we can determine by computation the length of the months in which such contracts are dated, and a comparison of the computed and recorded durations of the months is a good test of the accuracy of any restoration of the calendar. I owe the idea of this test to Schoch, who amplified Kugler's collection of attested months of 30 days, and computed the lengths of these months astronomically. Since the mean length of a lunation is 29·53 days, it follows that 53 per cent. of lunar months should contain 30 days, and therefore a false restoration of the chronology may be expected to satisfy about 53 per cent. of months known to have contained 30 days. It has been seen in Chapter VI that Schoch's tables have been made to satisfy 95 per cent. of the dates accepted for the beginning of the month in neo-Babylonian times. It is reasonable to suppose that the first appearance of the Moon was less accurately timed in early ages, and in testing any theory we have to allow for the fact that as our series of leap years is imperfectly restored, the identification of the months is to a small extent conjectural. But, if we are right in supposing that the early Babylonians, like their descendants, determined the beginning of the month by the actual appearance of the crescent, we should, when every allowance has been made, find that the correct solution should satisfy a great deal more than 53 per cent. of the months known to have contained 30 days. In the following table I show the Gregorian date of beginning and end of each month in which a contract is dated on the 30th day. The identification of the month is based on Chapter IX of this work. I assume the correctness of the second solution. The day given is that which was current at sunset, when the Babylonian day began.

The length of each month is given for each of the five solutions. Nearly all computations were made by Schoch with his crescent tables, though a few were made by me with Schoch's tables. Wherever the year to which a contract belonged appeared to be in doubt, I consulted Langdon. Where two lengths are given, the former is that which results from the tables, but the astronomical conditions are near the margin that separates 29-day months from 30-day months.

Reference.		*Reign, Year, and Month.*			*Solution II.* *Beginning.*	*End.*	*No. of Days.*	*Solution.* *I. Days.*	*III. Days.*	*IV. Days.*	*V. Days.*
	G. 171	Rim-Sin	6	IV	July 3	Aug. 2	30	29	30	30	29
	G. 194	"	10	II	April 21	May 20	29	30	30	30	29
	G. 192	"	10	XII	Feb. 10	March 12	30	29	30	29	29
VS. xiii 64 a,	HG. 1646	"	30	XII	Feb. 28	March 30	30	29	29/30	30	29
EG. 35,	HG. 1652	"	32	X	Dec. 10	Jan. 9	30	29	29	30	30
	G. 95	"	32	XII	Feb. 7	March 8	29	30	30	30	30
Warka 9,	HG. 709	"	35	XII	Feb. 4	March 6	30	30/29	29/30	30	29
Warka 13, 14,	HG. 277	"	42	VII	Sept. 22	Oct. 22	30	30	30	30	29
VS. xiii 82 a,	HG. 1657	"	44	XI	Jan. 26	Feb. 25	30	30/29	30/29	30	29
EG. 66,	HG. 1733	"	58	II	April 30	May 30	30	29	29/30	29	29
VS. xiii 92,	HG. 1676	"	59	V	July 17	Aug. 16	30	29	30	30	29
CT. viii 18 b,	HG. 286	Hammurabi	4	I	April 14	May 14	30	30	29	29	30
Ranke 25,	HG. 91	"	7	XII	March 2	April 1	30	30/29	30	29	30
TD. 87,	HG. 1099	"	26	V	Sept. 7	Oct. 6	29	29	29	29	30
VS. xiii 20,	HG. 1575	"	30	X	Dec. 20	Jan. 19	30	29	29	30	29
	F. 13	"	32	VIII	Oct. 29	Nov. 28	30	30/29	29	30	29
*F. 12,	HG 1374	"	32	XI	Jan. 26	Feb. 25	30/29	29	30/29	30	29
VS. ix 57,	HG. 1006	"	34	XII	March 3	April 2	30	30	29	30	29
VS. ix 148,	HG. 899	"	39	VIII	Nov. 11	Dec. 10	29	29	30	29	29
VS. ix 138,	HG. 964	"	41	XII	March 17	April 15	29	29	30	29	30
VS. ix 109, 110	HG. 1007	"	42	XII	March 5	April 4	30	29	30	29	29
Ranke 33,	HG. 520	"	43	XI	Jan. 23	Feb. 22	30	29	30	30	30
Warka 68, M. 66,	HG. 513	Samsuiluna	1	VIII	Oct. 17	Nov. 15	29	30	29/30	29	30
RA. xv 191,	HG. 1949	"	5	III	May 7	June 6	30	29	30/29	30	29
BIN. ii 75,	HG. 1425	"	7	IV	June 14	July 14	30	30	29/30	30	30
Warka 49,	HG. 333	"	7	IX	Nov. 9	Dec. 9	30	29	29	30	29
*F. 12,	HG. 1374	"	9	XI	Feb. 13	March 15	30	30	29	30	29/30
C. 91,	HG. 1628	"	28	IX	Nov. 16	Dec. 16	30	30	29/30	29	30
CT. vi 26 b,	HG. 1250	Ammiditana	1	XII	Feb. 3	March 3	29	29	30	29	30
CT. xxxiii 47 b,	HG. 1874	"	4	VIII	Oct. 4	Nov. 3	30	30	30	30	29
Ranke 91,	HG. 110	"	4	XII b	March 1	March 30	29	29	30	30	29
Ranke 82,	HG. 772	"	5	XII	Feb. 18	March 19	30	30	29/30	29	29
TD. 153,	HG. 1248	"	24	VII	Sept. 24	Oct. 23	29	29	30	30	29
VAT. 5912,	Ku.[1] 246	"	26	VI	Aug. 3	Sept. 2	30	29	29/30	30	30
VAT. 5806,	Ku.[1] 246	"	26	IX	Oct. 31	Nov. 29	29	29	29/30	29/30	29
Ranke 83,	HG. 650	"	31	II	April 11	May 11	30	29	30	29	29
Ranke 84,	HG. 9	"	31	XII	Jan. 31	March 2	30	29	29	30	29
VS. vii 60,	HG. 555	"	34	IX	Nov. 30	Dec. 30	30	29	30	30	29
VS. vii 68,	HG. 631	Ammizaduga	1	VIII	Nov. 16	Dec. 16	30	30/29	29	30	29
VS. vii 73,	HG. 115	"	3	VI	Aug. 28	Sept. 27	30	29	30	29	30
VS. vii 76,	HG. 557	"	4	XII b	March 10	April 9	30	29	30	30	30
VS. vii 139,	HG. 640	"	13	XII	March 1	March 31	30	29	30	30	29
CT. ii 18,	HG. 1308	"	15	XII	March 10	April 8	29	29	29	30	29
M. 107,	HG. 75	"	16	I	April 8	May 8	30	30	30	29	30
CT. ii 8,	HG. 639	"	16	V	Aug. 5	Sept. 4	30	29	30	30	29
VAT. 5925, 5938,	Ku.[1] 246	"	16	XI	Jan. 29	Feb. 27	29	30	29	29	30
VS. vii 121,	HG. 770	"	16	XII	Feb. 27	March 28	30	29	30	30	29
VS. vii 133,	HG. 1263	"	20	XI	Jan. 15	Feb. 13	29	29	30	29	29

* It is uncertain whether this contract belongs to Hammurabi 32 or to Samsuiluna 9.

[1] Kugler, *Sternkunde* ii.

The agreement between theory and practice is represented in the different solutions as follows:

	No. of computed months of 30 days.	*No. of actual months of 30 days.*	*Percentage of agreements.*
Solution I	17 or 18*	47	36 or 38*
„ II	34	47	72
„ III	27 or 26*	47	57 or 55*
„ IV	29	47	62
„ V	16	47	34

Combining the five solutions, we get agreement in 123 out of 235 instances, i.e. in 52 per cent. of the whole number; while if we combine solutions I, III, IV, and V, we get agreements in 89 out of 188 instances, i.e. in 47 per cent. of the whole number. As has been seen above, 53 per cent. of all lunar months should contain 30 days each. When, therefore, we combine a number of solutions of which one only can be correct, the agreement between theory and practice is found to be no greater than it would be if the months were selected at haphazard. It will be noticed that the second solution, which has been found superior on other grounds, satisfies as large a proportion of the attested months of 30 days as we could expect. In this respect it is far more successful than any of the other theories. The preponderance of computed months of 30 days appears in this solution in each of the five reigns. No other solution shows so disproportionate a distribution of months in either direction.[1]

The final conclusion of this discussion is that the Venus tablets, date-harvest contracts, barley-harvest contracts, and attested 30th days of months unite in supporting our second solution, on which the detailed reduction of dates in Chapter IX is based.

* According as we place F. 12 in Hammurabi 32 or Samsuiluna 9.

[1] KUGLER's note in *Sternkunde*, ii 627, on the failure of the second solution to satisfy the recorded 30-day months of the reign of Ammizaduga is based on a misunderstanding of a letter from SCHOCH.

CHAPTER XII

THE BABYLONIAN SOLAR AND STELLAR CALENDAR

BEFORE leaving the subject it may be well to discuss the attempts made by WEIDNER and KUGLER to establish a change in the position of the Babylonian months in the solar year by means of the tablets belonging to the astrological series Mul Apin. In these tablets the month names of the Babylonian calendar are used, but each month is given a fixed position in the solar year, so that a definite calendar date is given to each year-point and to the heliacal rising of each of the principal fixed stars. KUGLER, followed by WEIDNER, has assumed that this fixed position of the month is the mean position of the month in the civil calendar at the time when the astronomical data exhibited in the tablets were collected. Now this is merely an assumption. That the solar Nisan belonged roughly to the same season as the calendar Nisan may be taken as certain, but I see no reason for supposing that there was in the minds of the early Babylonians any conception of a mean position of Nisan. They had no fixed rule of intercalation, and, if they had, they might just as easily have had regard to the earliest possible position of Nisan as to the mean position of Nisan. The Nisan of the Christian paschal calendar is always defined not by its mean position, but by its earliest possible position, and the rule holds that Nisan must never be so placed as to make the vernal equinox fall later than its 14th day. In the tablets in question the four year-points are made to fall on the 15th day of Nisan, Tammuz, Tešrit, and Tebit respectively, and our study of the intercalations has shown that the vernal equinox or March 21 was the earliest possible date permitted for Nisan 15 under the First Dynasty of Babylon.[1] It appears that so early a date was not favoured in neo-Babylonian times, but the calendar Nisan 15 was permitted to fall before the equinox as late as 564 and 537 B.C. (See the table in KUGLER's *Sternkunde*, ii, 1924, p. 435.) I do not wish to press the suggestion that Nisan 15 was regarded as the latest possible calendar date of the equinox. It is just as easy to suppose that the calendar was arranged without reference to the year-points and that the placing of the year-points in the middle of their respective months is mere schematism.

It appears, moreover, to me that the astronomical data contained in the tablets in question are of far later date than the First Dynasty. If we treat the heliacal risings apart from the year-points, we may compare the intervals between those risings with the intervals computed for different epochs in SCHOCH's *Arcus Visionis*, p. 6 (published by the University Observatory, Oxford, 1924). Treating the months of the Babylonian document as of 30 days each, we have the following table:

	Text.	*Computation.*			
		−3000	*−2000*	*−1000*	*0*
α Arietis-Capella	19 d	17 d	15 d	16 d	15 d
Capella-Pleiades	11 }	20 } 37	22 } 37	21 } 35	20 } 33
Pleiades-Aldebaran	19 }	17 }	15 }	14 }	13 }
Aldebaran-Bellatrix	30	29	27	25	23
Bellatrix-Sirius	25	33	30	28	26
Sirius-Regulus	20	7	12	17	23
Regulus-Arcturus	40	33	39	44	46
Arcturus-Spica	10	18	13	9	7
Spica-α Librae	20 } 50	24 } 58	24 } 54	24 } 50	25 } 45
α Librae-Vega	30 }	34 }	30 }	26 }	20 }
Vega-Altair	30	27	29	31	34

[1] According to our restoration March 21 is found for Samsuiluna 8 and March 22 for Samsuiluna 27 and Ammizaduga 19.

Now it is clear that the date given for the heliacal rising of the Pleiades is not in agreement with SCHOCH's computation, and it may therefore be best to treat the interval between the risings of Capella and Aldebaran as a single interval. Similarly the intervals seem to show a discordance from SCHOCH's computations in the date of the heliacal rising of α Librae.

Perhaps the best way of treating these observations is by the mathematical principle of least squares. We compare each computed interval in turn with the recorded interval and square the difference. Then we sum the squares of the differences for each epoch separately, and find by interpolation the epoch which will give the smallest sum.

In this way I get the following sums of squares of differences:

	−3000	*−2000*	*−1000*	*0*	*Resultant epoch.*
Including all stars	477	278	227	378	−1250
Excluding Pleiades and α Librae	473	190	95	170	− 940

Instead of taking individual intervals, we may, if we prefer, group the intervals. It will be observed that from α Arietis to Sirius the interval diminishes with the time. From Sirius to Arcturus it increases. From Arcturus to Vega it diminishes again, and from Vega to Altair it increases. We thus have four natural groups of intervals as follows:

	Text.	*Computation.* −3000	−2000	−1000	0
α Arietis-Sirius	104	116	109	104	97
Sirius-Arcturus	60	40	51	61	69
Arcturus-Vega	60	76	67	59	52
Vega-Altair	30	27	29	31	34
Sum of squares of differences		809	156	3	210

This analysis gives us by interpolation −1075 as the epoch which will best satisfy the intervals between the different heliacal risings. The three analyses just made seem to indicate 1100 B.C. as the approximate epoch of the astronomical system contained in these tablets.

A more accurate result can be obtained by forming one equation of condition for the determination of two unknown quantities from each of the heliacal risings whose recorded dates have been used above.

For the two unknowns I take

x = Interval in days from Nisan 1 of Mul Apin series to April 6 Julian.

y = Interval in years from − 1000 to epoch of the astronomy contained in the series of heliacal risings. Then, comparing the recorded dates with those tabulated by SCHOCH, we have

		Residual.	*Residual, omitting Pleiades.*
(1)	$x+0.006\,y = 0$;	+0.6	−0.0
(2)	$x+0.007\,y = +3$;	+3.8	+3.1
(3)	$x+0.006\,y = -7$;	−6.4	
(4)	$x+0.005\,y = -2$;	−1.5	−2.1
(5)	$x+0.003\,y = +3$;	+3.1	+2.7
(6)	$x+0.001\,y = 0$;	−0.2	−0.4
(7)	$x+0.006\,y = +3$;	+3.6	+3.0
(8)	$x+0.010\,y = -1$;	+0.3	−0.7
(9)	$x+0.006\,y = 0$;	+0.6	−0.0
(10)	$x+0.006\,y = -4$;	−3.4	−4.0
(11)	$x+0.002\,y = 0$;	−0.0	−0.3
(12)	$x+0.004\,y = -1$;	−0.7	−1.2

Solving in the usual way, I get $x = +0.391 \pm 1.46$

$$y = -172 \pm 258$$

The residuals left after adopting these values are shown in the penultimate column above. The conclusion is that the epoch of the astronomy contained in these heliacal risings is −1172, subject to a probable error of ±258 years. It will be observed, however, that the cluster of the Pleiades makes its appearance according to the tablets 6.4 days before it ought to be due according to this solution. This discordance greatly exceeds all others, and suggests that SCHOCH's tables do not correctly represent the date at which the Babylonians were able to gain their first sight of this cluster. If we omit the third equation and solve the remaining equations, we get

$$x = +0.505 \pm 1.11$$
$$y = -81 \pm 198$$

The residuals are shown in the last column above. We now have for the epoch of the heliacal risings −1081, subject to a probable error of ±198 years. It seems probable, therefore, that the epoch of these heliacal risings falls within two or three centuries on one side or the other of 1100 B.C.

But this renders it impossible to bring the recorded dates of heliacal risings into agreement with the recorded dates of the year-points. It seems not unreasonable to suppose that the dates of heliacal risings were reduced on the assumption that the heliacal rising of α Arietis, the star of Nisan, was to be taken as fixing the beginning of the stellar Nisan. But we have to go back to the neighbourhood of −2500 if we wish to have the heliacal rising of α Arietis falling 14 days before the equinox, which these tablets place on Nisan 15. As this epoch is excluded by the analysis of the dates of heliacal risings, there would appear to be no alternative but to suppose that the dates of the year-points are determined independently of the dates of the heliacal risings in the Mul Apin series. The range of the calendar months found in the present work is such that from time to time the year-points would fall approximately on the days of the civil calendar bearing the same names as the days to which they are assigned in the Mul Apin series, and similarly the heliacal risings would from time to time fall approximately on the days of the civil calendar bearing the same names as the days to which they are assigned in that series, but these two series of coincidences would not be realized in the same year in the neighbourhood of 1100 B.C.

I conclude that we cannot use the dates of the Mul Apin series for the reconstruction of the calendar under the First Dynasty (1) because there is no indication of the relation of its stellar and solar months to the calendar months whose names they bear, and (2) because an analysis of the dates of the heliacal risings contained in that series shows that their epoch is approximately 1100 B.C., long after the time of the First Dynasty.

CHAPTER XIII

SOURCES FOR THE RECONSTRUCTION OF THE LIST OF KINGS

THE principal source for the reconstruction of the dynasties before the First Babylonian Dynasty is the *Weld-Blundell Prism* in the Ashmolean Museum, edited by LANGDON, *Oxford Editions of Cuneiform Texts*, Vol. II, Oxford University Press, 1923, where the various duplicates from Nippur and other chronological sources are given. For the dynasty of Ellasar, the two principal sources are (1) the Louvre Prism, 7025, originally containing a list of the year dates of the 14 kings of Ellasar; edited by F. THUREAU-DANGIN, *La Chronologie des Dynasties de Sumer et d'Accad*, Paris, 1918, and (2) a small tablet giving only the names of the 14 kings with lengths of their reigns; edited by A. T. CLAY, *Miscellaneous Inscriptions*, Yale, 1915, No. 32, pp. 30 ff. Since these lists join up with the names of the First Dynasty, the entire system depends upon the date of this dynasty and, as our succeeding records in both Assyria and Babylonia do not permit a dead reckoning, I am forced to depend upon FOTHERINGHAM'S astronomical reckoning, whose results are confirmed by SCHOCH and SCHNABEL. I have no longer any doubt concerning the correctness of my colleague's brilliant calculation; for it is confirmed by the Babylonian calendar, the historical sources (which can be adjusted to this date only, without violently discrediting their testimony) and by SCHOCH'S astronomical reckoning for the destruction of Ur and the end of the reign of Ibi-Sin, based upon the lunar eclipse of the 14th of Adar, CHAS. VIROLLEAUD, *L'Astrologie chaldéenne, Sin*, xxxiii 79–82. This date is fixed by him in 2283 B.C.,[1] night of March 8/9 (Julian = Gregorian Feb. 17/18).

The omen preceded the year of the event and hence 2282 B.C. would be the year of the Fall of Isin, or 19 years later than the date in my list.[2] But contemporary documents all tend to prove that Ibi-Sin was a contemporary of Išbi-Girra of Isin; for dated tablets, in the kingdom of Ur, suddenly cease early in the reign of Ibi-Sin, everywhere except at Ur itself. This is a very decisive confirmation of FOTHERINGHAM'S reckoning. I have not deducted 19 years from all dates before 2301, but have retained the statement of the Weld-Blundell Prism. I have, however, no doubt but that Ibi-Sin reigned contemporaneously with Išbi-Girra of Isin and Naplanum of Ellasar for 19 years.

For the subsequent dynastic lists, the sources are: (1) King list A, *Cuneiform Texts in the British Museum*, Vol. xxxvi, 24–5; (2) King list B, HUGO WINCKLER, *Untersuchungen zur altorientalischen Geschichte*, 145 (BM. 38122); (3) dynastic Assyrian lists in OTTO SCHROEDER, *Keilschrifttexte aus Assur verschiedenen Inhalts* (= KAV.), Nos. 10–11–12–13–182 (synchronistic Assyrian–Babylonian), 9–14+18–15 (Assyrian only); (4) the Assur tablet 4128 is the most important of all synchronistic lists. Ass. 4128 really refers to a photo of Ass. 14616 c, but I have retained the photo number, the museum number being unknown to me when my manuscript

[1] CARL SCHOCH, *Die Ur-Finsternis* (eine Hypothese!), privately printed at Berlin-Steglitz 31, December 1927.

[2] Ašurbanipal restored the statue of Nanā of Erech, which had been taken to Elam by Kudurnanhundi 1635 years before Ašurbanipal's eighth campaign, and his second campaign against Elam. This occurred *circa* 642–639 B.C. (v. STRECK, *Assurbanipal*, i, p. cccxxxvi), giving a date *circa* 2277 for the Elamitic invasion of Sumer by Kudurnanhundi. Undoubtedly the Fall of Ur was due to the same invasion, when Ibi-Sin was taken captive to Elam, VIROLLEAUD, Supplement ii, p. 95, 13; LANGDON, BE. xxxi 7, 5. See also for 1635 as interval between Kudurnanhundi and the sack of Susa by Ašurbanipal, ESSAD NASSOUHI, *Mitteilungen der Altorientalischen Gesellschaft*, iii 35. FOTHERINGHAM'S calculation alone agrees with SCHOCH'S calculation for the Fall of Isin.

was printed. The text is published by E. F. WEIDNER, *Mitteilungen der Vorderasiatischen–Aegyptischen Gesellschaft*, 1912, part 2, 67–70, with corrections in *Archiv für Orientforschung*, iii 70–1. (5) C. 8836 refers to the valuable Assur tablet in Constantinople, published by ESSAD NASSOUHI, *Archiv für Orientforschung*, iv 1–11; Assyrian list with regnal years. The *Synchronous History* (= *Syn. Hist.*) is published in CT. xxxiv 38–42 and edited by PEISER and WINCKLER, *Keilinschriftliche Bibliothek*, ii 194–203. The *Babylonian Chronicle* is published in CT. xxxiv 43–50 and lastly edited by FRIEDRICH DELITZSCH, *Die Babylonische Chronik*, Leipzig, 1906. *Chronicle P(inches)*, first discovered by T. G. PINCHES and translated in *Records of the Past*, 2nd ed., 106 ff., is published by HUGO WINCKLER, *Altorientalische Forschungen*, Leipzig, 1897, *Erste Reihe*, 298–303, and lastly edited by DELITZSCH, *ibid.*, pp. 43–6; see also L. W. KING, *Records of the Reign of Tukulti-Ninib* I, London, 1904, p. 157 and pp. 96–100.

A few comments on the views of the writer of the dynastic list should be added, to avoid misunderstandings. The last year of Ibi-Sin is made contemporary with the first year of Ishbi-Girra, and with this exception the list actually represents the statements of the Sumerian chroniclers themselves, back to the beginning of the Akšak dynasty. My own chronology for all reigns from Ibi-Sin upward is obtained by subtracting 19 from each date. In regard to SCHOCH'S astronomical reckoning for the Fall of Ur (2282), and the statement that this alone agrees with FOTHERINGHAM'S solution, it should be stated that there is *astronomically* an alternative date 94 years later, which would agree approximately with WEIDNER'S low dates. There is astronomically no alternative. But WEIDNER'S system is proved to be erroneous on astronomical and calendrical grounds and by the impossibility of making Ulamburiyaš (p. 88) the immediate successor of Ea-ga-mil. This not only violates the clear evidence of the Assur synchronous list, Ass. 4128, but it does not follow from the text adduced to prove it; for the chronicle, BM. 96152, published by L. W. KING, states that Ulamburiyaš became king 'after him', i. e. after Ea-ga-mil, which by no means necessarily implies an immediate event. This chronicle has long gaps between historical events entered in it, and even were the usual translation of *arki-šu* 'after his death' adopted (KING'S translation 'in pursuit of him' was erroneous), there is no reason for violating the evidence of the mace-head inscription of *U-la-bu-ra-ri-ya-áš mar Bur-na-bu-ra-ri-ya-áš šarri*, published by WEISSBACH. Here his father, Burnaburiyaš, is distinctly described as 'king', and there was no king by this name until long after *Ea-ga-mil*.

CHAPTER XIV

LIST OF THE KINGS AND DYNASTIES OF SUMER AND ACCAD, BABYLONIA AND ASSYRIA

Ten Mythical Kings Before the Flood.

Ellasar Tablet.		*Weld-Blundell Prism.*		*Berossos.*	
28800.	Alulim. Eridu.	67200.	Alulim. Ḫabur.	36000.	Alorus = Alulim. Babylon.
36000.	Alagar. „	72000.	Alagar. „	10800.	Alaparos = Alagar. „
43200.	Enmenluanna. Badtibira.	72000.	. . . kidunnu-šakinkin. Ellasar.	46800.	Amēlōn = Enmenluanna. Badtibira.
28800.	Enmengalanna. „	21600.	. . . uk? ku? Ellasar.	43200.	Ammenōn.
36000.	Dumuzi-sib. „	28800.	Dumuzi-sib. Badtibira.	64800.	Megalaros = Enmengalanna. Badtibira.
28800.	Ensibzianna. Larak.	21600.	Enmenluanna. „	36000.	Daôzos = Dumuzi. Badtibira.
21000.	Enmenduranna. Sippar.	36000.	Ensibzianna. Larak.	64800.	Euedorachos = Enmenduranna. Badtibira.
18600.	Ubardudu. Suruppak.	72000.	Enmenduranna. Sippar.	36000.	Amempsinos = Ensibzianna. Larak.
		28800.	Aradgin. Suruppak.	28800.	Opartes = Ubardudu. Larak.
		36000.	Ziûsudra. „	64800.	Xisuthros = Ziûsudra.
	Total 241200.		Total 456000.		Total 432000.

The Flood.

Northern Kingdoms.	Erech.	Kish. First Dynasty.[1]	Ur.
		Ga-ur.	
		Gulla-Nidaba-anna.	
		....	
		....	
		Baba.	
		Bu-Sin.	
		Galibum.	
		Kalumumu.	
		Duggagib.	
	First Dynasty of Erech.[2]	Atab.	
	Circa 4500–3150.	Atabba.	
	Meskemgašer.	Arpium.	
	Enmerkar.	Etana.	
	Lugalbanda.	Baliḫ.	
	Dumuzi.	Enmenunna.	
	Gilgamish.	Melam-Kiš.	
	Ur-Nungal.	Barsalnunna.	

[1] OECT. II 9, I 42–II 45. The Weld-Blundell Prism assigns 24,510 years to this semi-mythical kingdom.
[2] Ibid. II 11, II 46–III 36. This dynasty is also called *Eanna*, name of the temple at Erech. Cf. *kur é-an-na*, 'Land of Eanna', with Sutium, Gutium, PBS. V 75, Rev. IV 11. The sources assign 2,310 years to this semi-mythical kingdom.

Northern Kingdoms.	Erech.	Kish.	Ur.
	First Dynasty (*continued*).	First Dynasty (*continued*).	
	Utulkalamma.	Tupzaḫ.	
	Labašer.	Tikkar.	
	Ennunnadanna.	Ilku.	
Dynasty of Awan.[1]	..........ḫede.	Iltasadun.	
....	Melamanna.	Enmenbaragigur.	First Dynasty of Ur.[2]
....	Lugalkiaga.	Agga.	*Circa* 3150–3000.
Ku-ul........ *Circa* 3100.		(*Enbi-Aštar.*) *Circa* 3170.	80. Mesannipadda.[3] (A-an-ni-pad-da.)[5]
Dynasty of Ḫamasi.[6]	Second Dynasty of Erech.[4] *Circa* 3150–3090.		36. Meskem-Nannar.
Ḫadaniš.[7] *Circa* 3090.	Enugduanna = (Enšagkušanna?)		25. Elulu.
	Lugalkigubnilaḫ.		36. Balulu.
	Lugalkisalsi.		
Dynasty of Maer.[8]	Dynasty of Adab.[9]	Second Dynasty of Kish.[10]	Second Dynasty of Ur.[11]
30. Ansir. 3087–3058.	Lugalmundu.	Laḫ...	*Circa* 3000–2900.
25? [Lugaltar]zi. 3057–3033.	Mebasi.	Dadasig.	Four names broken away on the Weld-Blundell Prism and Nippur tablets.
		Kalbum.	
30. ......lugal. 3032–3003.	Lugaldalu.	Umuše.	
20. ......lù-gal. 3002–2983.		......nunna.	
30. ......bi-im. 2982–2953.		Ibiniš?	
9. ......bi. 2952–2944.		Lugalmu.	
Dynasty of Akšak.[12]			
30. Unzi. 2943–2914.			
6. Undalulu. 2913–2908.		Third Dynasty of Kish.	
6. Urur. 2907–2902.		Kug-Bau.[13]	
20. Gimil-Šaḫan. 2901–2882.		Ur-Nina at Lagash.	
24. Išu-il. 2881–2858.			
7. Gimil-Sin. 2857–2851.			
		Patesis of Lagash.	Fourth Dynasty of Kish.
		Eannatum.	25. Gimil-Sin. 2850–2826.
		Enannatum.	$6\frac{2}{3}$. Ur-Zamama. 2825–2818.
		Entemena.	30. Zimudar. 2817–2788.
		Ennatum II.	7. Uṣiwatar. 2787–2781.
			11. Ašdarmuti. 2780–2770.
		Enetarzi.	11. Išme-Šamaš. 2769–2759.
		Lugalanda.	

[1] OECT. II 13, IV 6–16. Prism assigns 356 years to this kingdom.
[2] Ibid. II 13, III 39–IV 4.
[3] d-Mesannipad, ZA. 7, 29 IV 11; RA. 22, 116.
[4] OECT. II 14, IV 43–8.
[5] Son of Mesannipadda, *Ur Excavations*, I, Pl. XL, TO. 160; 287; U. 26; TO. 286. Written *Annani*, PBS. V 6, 10, and *Nanni*, PBS. XIII 48, II 2.
[6] OECT. II 14, IV 36–42.
[7] Sources assign 90 years to this kingdom.
[8] OECT. II 15, V 23–32.
[9] OECT. II 15, V 16–22. Sources assign 90 years to this kingdom.
[10] Ibid. II 13, IV 18–35. From this point upward I regard the various city kingdoms of Kish, Ur, and Erech as consecutive, and not to be divided by insertions of other city kingdoms as on the Weld-Blundell Prism and Nippur tablets. The sources assign a period of 3,195 years to the Second Dynasty of Kish, which is impossible.
[11] Ibid. II 14, V 1–15.
[12] Ibid. II 15, V 43–VI 5.
[13] Mother of Gimil-Sin, first king of the Fourth Dynasty of Kish. She is said to have reigned 100 years.

DYNASTY OF AGADE.[1]

56. Sargon. 2751–2696.
9. Rimuš. 2695–2687.
15. Maništusu. 2686–2672.
38? Narâm-Sin. 2671–2634.
24? Šargališarri. 2633–2610.

Period of anarchy.
3 { Igigi. Imi. 2606–2604. Nani. Elulu. }
21. Dudu. 2603–2583.
15. Gimil-durul. 2582–2568.

THIRD DYNASTY OF ERECH.[2]

25. Lugalzaggisi. 2776–2752.

FOURTH KISH DYNASTY (*continued*).

7. Nanniyaḫ. 2758–2752.

FOURTH DYNASTY OF ERECH.[3]

7. Urnigin. 2567–2561.
6. Urgigir.[4] 2560–2555.
6. Kudda. 2554–2549.
5. Gimil-ili. 2548–2544.
6. Ur-Babbar. 2543–2538.

DYNASTY OF GUTIUM.[5]

34. Period of no king. 2538–2505.
3. Imtâ. 2504–2502.
6. Inkišu. 2501–2496.
6. Nikillagab. 2495–2490.
6. Šulmê. 2489–2484.
6. Elulumeš. 2483–2478.
5. Inimabikeš. 2477–2473.
6. Igešauš. 2472–2467.
15. Yarlagab. 2466–2452.
3. Ibate. 2451–2449.
3. Yarlagaš. 2448–2446.
1. Kurum. 2445.

DYNASTY OF GUTIUM (*continued*).

3. ……nedin. 2445–2443.
2. ……ra-bu-um. 2442–2441.
2. Irarum. 2440–2439.
1. Ibranum. 2438.
2. Ḫablum. 2438–2437.
7. Gimil-Sin. 2436–2430.
7. Yarlaganda. 2429–2423.
7. …………[6] 2422–2416.
Tirigan (forty days). 2415.

FIFTH DYNASTY OF ERECH.[7]

7. Utuḫegal. 2415–2409.

THIRD DYNASTY OF UR.[8]

18. Ur-Nammu. 2408–2391.
46. Dungi. 2390–2345.
9. Bur-Sin. 2344–2336.
9. Gimil-Sin. 2335–2327.
26. Ibi-Sin. 2326–2301.[9] [2282, p. 82]

ASSYRIA.	ISIN.[10]	ELLASAR.[11]
Ušpia.[12]	33. Išbi-Girra. 2301–2269.	21. Naplanum. 2301–2281.
Kikia.[13]	10. Gimil-ili-šu. 2268–2259.	28. Emiṣum. 2280–2253.

[1] OECT. II 17, VI 31–VII 12.
[2] For Lugalzaggisi contemporary of last three kings of the Fourth Dynasty of Kish, and of *Urukagina* of Lagash, v. LANGDON, *Excavations at Kish*, I, p. 2.
[3] OECT. II 18, VII 15–23.
[4] Cf. RA. 20, 5.
[5] OECT. II 18, VII 24–51. On Weld-Blundell Prism 91 years is the actual total of 20 reigns given by the scribe. Total for the entire dynasty 125 or 124 years, ibid. 19 n. 5. Consequently 34 years are allowed for the 'period of no king'.
[6] Possibly *I-ti-ti* son of Yakulaba, AB. 2 = KAH. II 1, whose inscription was found at Assur. LEGRAIN, PBS. XIII 1, VIII 17, has a king ……*ti* near the end of this dynasty.
[7] OECT. II 19, VIII 1–6; JRAS. 1926, 684–8.
[8] OECT. II 19, VIII 9–20.
[9] Text of Prism, 24 years. See ibid. 20 n. 5.
[10] OECT. II 26.
[11] CLAY, *Miscellaneous Inscriptions*, No. 32; Louvre Prism, 7025 in THUREAU-DANGIN, *Chronologie des Dynasties de Sumer et d'Accad*.
[12] AB. 121, 33, mentioned by Šalmanasar I; KAH. I 51, II 13 (Asarhaddon). Probably a Gutean.
[13] AB. 35, XIV 5, mentioned by Ašurrîmnišêšu, and ibid. 36 n. 3, by Šalmanasar III.

ASSYRIA (*continued*).

Ititi. *Circa* 2422.[1]
ZARIKUM.[2] *Circa* 2346–2336.
Puzur-Ašur I.[3]
Šalim-aḫum.[4]
Ilušuma.[5]
Erišum I.[6]
Ikunum.[7]
Šarru-ki-en I.[9]
Puzur-Ašur II.[9]
Aḫi-Ašur.[10]
Rîm-Sin.[11]
Erišum II.[12]
Bêlikbi.[13]
Šamši-Adad I.[15]
Išme-Dagan I.[16]
………as-kur.[17]
Rimu[š].[20]

BABYLONIA.

14. Sumu-abum.[5] 2169–2156.
36. Sumu-la-ilum. 2155–2120.
14. Zabum. 2119–2106.
18. Apil-Sin. 2105–2088.
20. Sinmuballiṭ. 2087–2068.
43. Hammurabi. 2067–2025.
38. Samsu-iluna. 2024–1987.
28. Abi-ešuḫ. 1986–1959.
37. Ammiditana. 1958–1922.
21. Ammizaduga. 1921–1901.
31. Samsuditana. 1900–1870.

11 kings of Babylon. 300 years.

ISIN (*continued*).

21. Idin-Dagan. 2258–2238.
20. Išme-Dagan. 2237–2218.
11. Lipit-Ishtar. 2217–2207.
28. Ur-Ninurta. 2206–2179.
21. Bur-Sin. 2178–2158.
5. Lipit-Enlil. 2157–2153.
8. Girra-imitti. 2152–2145.
24. Enlilbani. 2144–2121.
3. Zambiya. 2120–2118.
4. Iter-pi-ša. 2117–2114.
4. Urdukugga. 2113–2110.
11. Sinmagir. 2109–2099.
23. Damiḳilišu. 2098–2076.

15 kings of Isin. 226 years. End of dynasty in 12th year of Sinmuballit.

ŠEŠ-KUG or Sea Dynasty (at Isin?)

60. Iluma-ilu.[18] 2007–1948.
56. Itti-ili-nibi.[19] 1947–1892.
36. Damiḳ-ili-šu (II). 1891–1856.

ELLASAR (*continued*.)

35. Samûm. 2252–2218.
9. Zabâya. 2217–2209.
27. Gungunûm. 2208–2182
11. Abisarê. 2181–2171.
29. Sumu-ilum. 2170–2142.
16. Nûr-Immer.[8] 2141–2126.
6. Sinidinnam. 2125–2120.
2. Siniribam. 2119–2118.
6. Sinikîšam. 2117–2112.
1. Šilli-Immer. 2111.
12. Warad-Sin. 2110–2099.
61. Rîm-Sin. 2098–2038.[14]

[1] Probably one of the kings of the Gutium dynasty. See p. 86 n. 6.
[2] Contemporary of Bur-Sin of Ur and also mentioned on unpublished tablet of the Rylands Library, in 46th year of Dungi.
[3] KAV. 18 I 1; AB. 4, 4.
[4] KAV. 18 I 2.
[5] KING, *Chronicles*, II 14. KAV. 18 I 3, has Šamši-li-[šu-ma?]!
[6] Ass. 4128 IV 17–20. KAV. 18 I 4. Contemporary of Sumu-la-ilum.
[7] KAV. 18 I 5.
[8] Identical with *Immerum*, CT. 4, 50 A; PSBA. 1910, 281.
[9] KAV. 18 I 6–7.
[10] Ibid. 18 I 8; 14, 1; 15, 2; C. 8836 I 27.
[11] KAV. 14, 2; 18 I 9; 15, 4. Probably not Rîm-Sin of Ellasar.
[12] Ibid. 14, 3; C. 8836 I 29. Here, ll. 31–6, *two* kings, between Erišum II and Šamši-Adad I. Text wholly uncertain and unusable.
[13] RANKE, BE. VI 18, 3–4, *d.Be-el- DA-bi*, with Sinmuballiṭ in the oath formula. For *da* = *ḳabû*, v. *Sumerian Grammar*, 207. Var. *d.*Bêl- *KA-bi*, father of Šamši-Adad, KAH. I 51, II 22. Omitted on KAV. 14. Here perhaps C. 8836 I 35.
[14] Rîm-Sin conquered by Hammurabi in the 30th year of the latter's reign. Louvre Prism has 60 years for Rîm-Sin.
[15] KAV. 14, 4. With Hammurabi in oath formula, VAB. V 284, 11, 10th year of Hammurabi. C. 8836 I 37–40. Son of I-*ri*-kapkapu. From photo of C. 8836, *Karduniaš* is hardly to be discovered on the tablet.
[16] KAV. 14, 4; son of Samši-Adad, AB. 32 XII 7–8.
[17] KAV. 14, 5.
[18] Contemporary of Samsu-iluna and Abi-ešuḫ, KING, *Chronicles*, II 20–1; POEBEL, BE. VI, p. 119; CHIERA, PBS. VIII, p. 66; in King-list A. I 4; B. Rev. 1.
[19] A. I 5; B. Rev. 2.
[20] KAV. 14, 5.

Assyria (*continued*).	Babylonia (*continued*).	Šeš-Kug Dynasty (*continued*).
A[da-si].[1] *Circa* 1870–1856.	[Damik-ilišu (II)] (14 years at Babylon).	
Bêl-ba-ni.[2]	15. Iškibal.[2] 1855–1841.	15. Iškibal. 1855–1841.
Lu(?)-ba-ai.	24. Šušši. 1840–1817.	24. Šušši. 1840–1817.
Šarma-Adad I.	55. Gulkišar. 1816–1772.	55. Gulkišar. 1816–1772.
21. Lilkud-Šamaš.[3]	............*en*.[4]	
Bazāya.[5]		50. Pešgaldarameš.[6] 1762–1713.
Lullāya.[7]		28. Adarakalamana.[8] 1712–1685.
Ši-Ninūa.[9]		26. Ekur-du-anna.[10] 1684–1659.
Šarma-Adad.[11]		7. Melamkurkurra.[12] 1658–1652.
		9. Ea-ga-mil.[13] 1651–1643.
Erišu III.[14] *Circa* 1651–1627.		11 kings (+......*en* Ass. 4128 I 5). 368 years[15] of *ŠEŠ-KUG*[16] dynasty.
		16. Ga-an-du-uš.[17] 1642–1627.
		22. Agum-maḫrû.[18] 1626–1605.
		22. Kaštilyaši I.[19] 1604–1583.
		Abirataš.[20]
		(Kaštilyaši).[21]
Šamši-Adad II.[22] *Circa* 1626–1576.		Tazzigurumaš.[23]
		Ḫurbašipak.[24]
		Tiptakši.[25]
		Agūm II.[26]
16. Išme-Dagan II.[27] *Circa* 1575–1560.		Burnaburiyaš I.[28] *Circa* 1545–1530.
15. Šamši-Adad III.[29] *Circa* 1559–1545.		........................[29]
26. Ašurnirari I.[30] *Circa* 1544–1519.		Kaštilyaši II.[31] *Circa* 1510–1491.
14. Puzur-Ašur III.[32] 13. Enlilnaṣir I.[33] 12. Nur-ili.[34] Ašur-šad-ṣabê.[37] } [34] *Circa* 1518–1470.		[34] Ulamburiyaš.[35] *Circa* 1490–1456.

[1] Ass. 4128 I 1. Restored from VS. I 78, Rev. 17, &c. See Weidner, MVAG. 1915, 4, p. 30. KAV. 14, after Rimuš, omits 7 names here, Adasi to Lullâ. Above Adasi on Ass. 4128, break for 11–12 names.
[2] Ass. 4128 I 2; King-list A. I 7; B. Rev. 4.
[3] C. 8836 II 15–16; C. 8836 II 16, 21 years?
[4] Ass. 4128 I 5. A. B. omit.
[5] Ass. 4128 I 6; C. 8836 II 17–18.
[6] Ass. 4128 I 6; King-list A. I 10; B. Rev. 7.
[7] Ass. 4128 I 7; C. 8836 II 19–20.
[8] Ass. 4128 I 7; A. I 11; B. Rev. 8.
[9] Ass. 4128 I 8; KAV. 14, 6.
[10] Ass. 4128 I 8; B. Rev. 9, *A-kur-dú-an-na*; A. I 12, *Ekurdú*.
[11] Ass. 4128 I 9; KAV. 14, 6.
[12] Ass. 4128 I 9; B. Rev. 10; *Me-lam-é*, A. I 13.
[13] Ass. 4128 I 10. *d.E-a-ga-mil*, B. Rev. 11; King, *Chronicles*, II 22, 11. A. I 14, *d.BAD-ga-mil*; Ass. 4128 I 10, *d.𒁹-ga-mil*. KAV. 14, 7.
[14] Ass. 4128 I 10; KAV. 14, 7. Omitted on C. 8836.
[15] So A. I 15.
[16] So B. Rev. 12; but A. I 15, *ŠEŠ-ḪA*.
[17] Ass. 4128 I 10; A. I 16, Ga-an-diš.
[18] King-list A. I 17; Ass. 4128 I 11.
[19] A. I 18; Ass. 4128 I 12. Here Ušši or Duši of A. is omitted.
[20] Ass. 4128 I 13.
[21] Ass. 4128 I 14. Omitted on A. and clearly a repetition here.
[22] Ass. 4128 I 11–18.
[23] Ass. 4128 I 15.
[24] Ass. 4128 I 16.
[25] Ass. 4128 I 17.
[26] Ass. 4128 I 18. Son of Taššigurumaš, VR. 33 I 2.
[27] Ass. 4128 I 19; C. 8836 II 27; KAV. 14, 8.
[28] Ass. 4128 I 19.
[29] Ass. 4128 I 20; KAV. 14, 8; C. 8836 II 29–31.
[30] Ass. 4128 I 21; C. 8836 II 32–3. Son of Išme-Dagan.
[31] Ass. 4128 I 21.
[32] KAV. 14, 9; C. 8836 II 34.
[33] Ç. 8836 II 36.
[34] Ass. 4128 I 22–5.
[35] Son of Burnaburiyaš and called *šar mat tamtim*, Weissbach, *Miscel.*, p. 7. Brother of Kaštilyaš, King, *Chronicles*, II 23, 12. Apparently from King, ibid. 24, 14, an *Agum*, son of Kaštilyaš, succeeded Ulamburiyaš.
[36] C. 8836 II 38; KAV. 14, 10.
[37] C. 8836 II 40.

Assyria (*continued*).	Babylonia (*continued*).
Ašur[nirari] II.[1] *Circa* 1470–1461.	[Agum III?]. *Circa* 1455–1443.
[Puzur-Ašur IV],[1] son of Ašurnirari II.[2] *Circa* 1460–1451.	
En[lil-našir II],[1] son of Puzur-Ašur IV.[3] *Circa* 1450–1436.	Enlil-á-maḫ ?.[4] *Circa* 1442–1435.
[Ašur-rabi I].[5] *Circa* 1435–1426.	Kadašman-Enlil I.[6] *Circa* 1434–1415.
Ašur-[nirari III]. *Circa* 1425–1416.	[Burnabu]riyaš II.[6] *Circa* 1414–1410.
Ašurbêlnišêšu.[7] *Circa* 1415–1407.	Kara-indaš I.[7] *Circa* 1409–1391.
6. Ašur-rîm-nišê-šu.[8] *Circa* 1406–1401.	
Ašurnādinaḫi.[9] *Circa* 1400–1396.	[Kurigalzu I].[10] *Circa* 1390–1384.
Eriba-Adad.[11] *Circa* 1395–1384.	
Puzur-Ašur V.[12] *Circa* 1383–1377.	27. Burnaburiyaš III.[12] *Circa* 1383–1357.
Ašuruballiṭ.[14] *Circa* 1376–1336. (Son of Eriba-Adad.) {	Kara-indaš II.[13] } Kadašmanḫurbe I.[15] } *Circa* 1356–1352.
Enlilnirari.[16] *Circa* 1335–1321.	24. [17] Kurigalzu (*ṣiḫru*) II.[16] *Circa* 1351–1328.
Arikdînili.[18] *Circa* 1320–1307.	
10+? Adadnirari I.[19] *Circa* 1306–1290.	26. Nazimarattaš.[20] *Circa* 1327–1302.
20+? Salmanasar I.[21] *Circa* 1289–1261.	18. Kadašmanturgu.[22] *Circa* 1301–1284.
	7? Kadašman-Enlil II.[23] *Circa* 1283–1275
	8. Kudur-Enlil.[24] *Circa* 1274–1267.
	13. Šagaraktišuriyaš.[25] *Circa* 1266–1254.
30+? Tukulti-Ninurta I.[26] *Circa* 1260–1225.	8. Kaštilyaš III.[27] *Circa* 1253–1246.
4. Ašurnādinapli.[29] *Circa* 1224–1221. {	1½. Enlilnādin(*zākir* ?)šumi.[28] 1½. Kadašmanḫurbe II.

[1] KAV. 14, 11–12.
[2] AB., pp. 30–2.
[3] AB. 32 XII; KAV. 11, 1.
[4] PBS. VIII 160 (seventh year).
[5] KAV. 14, 13. Father of Ašurnirari III, AB. 34 XIV 4.
[6] Placed here provisionally. Inscription in BE. I 68, I 6–15, Burnaburiyaš son of Kadašman-Enlil.
[7] KAV. 11, 2; *Syn. History*, I 1–4; C. 8836 III 9–10.
[8] KAV. 11, 3; C. 8836 11–12.
[9] KAV. 11, 4; C. 8836 III 13–14.
[10] Knudtzon, *Amarna Letters*, 9, 19, a Kurigalzu was father (*abu*) of Burnaburiyaš and in correspondence with Amenophis III, but in 10, 8–9, Kara-indaš is father (*abbu*) of Burnaburiyaš. It is probable that *abbu* means 'grandfather' here. In this case Kadašman-Enlil I, Kara-indaš I, and Kurigalzu I were all correspondents of Amenophis III. Kurigalzu *ṣiḫru* is then grandson of Burnaburiyaš III, and this is the meaning of *Kurigalzu mar Burnaburiyaš* in Nies and Keiser, *Historical Texts*, No. 15; Hilprecht, OBI. 35–36–39–40.
[11] KAV. 11, 4; C. 8836 III 15–16.
[12] *Syn. Hist.* I 5–7; PBS. II 2, p. 64. C. 8836 III omits Puzur-Ašur. 700 years after Hammurabi, VAB. IV 239, 21; 245, 4–5.
[13] *Syn. Hist.* I 8, grandson of Ašuruballiṭ.
[14] *Syn. Hist.* I 8–17; *Chronicle P.* Col. I; C. 8836 III 17–18.
[15] *Chron. P.* I 5, son of Kara-indaš and grandson of Ašuruballiṭ. But v. note 13; the two accounts not reconcilable. No dated documents from Kara-indaš and Kadašmanḫurbe.
[16] KAV. 11, 5; but *Chronicle P.* III 20 has Adadnirari I. C. 8836 III 19–20; *Syn. Hist.* I 18–23; *Chronicle P.* II–III.
[17] (Grand)son of Burnaburiyaš III, *Syn. Hist.* I 16, and son of Kara-indaš. Highest date 24th year, BE. XIV, p. 3; PBS. II 2, p. 63; A. II 1.
[18] KAV. 11, 7; C. 8836 III 21–2.
[19] C. 8836 III 23–4; *Syn. Hist.* I 24–31.
[20] A. II 2; PBS. II 2, p. 64; *Syn. Hist.* I 24–31; *Chronicle P.* III 23.
[21] C. 8836 III 23–6. 586 years before Asarhaddon, KAH. II 125, 24. 580 on KAH. II 126, III 12. According to KAH. II 126, III 6 and KAH. I 51, II 24 only 434 years after Šamši-Adad I, which is impossible on any system of chronology.
[22] A. II 3; PBS. II 2, p. 64.
[23] A. II 4 has 11 years. Latest known date 7, PBS. II 2, p. 64.
[24] A. II 5; PBS. XIII, p. 100; II 2, p. 64.
[25] A. II 6; PBS. II 2, p. 64. 800 years before 552! (*sic*): read 700, VAB. 229, 27.
[26] Ass. 4128 II 1; C. 8836 III 27–8; *Chron. P.* Col. IV, *Syn. Hist.*, CT. 34, 42, Sm. 2106, 9–10. 600 years before Senecherib, King, *Tukulti-Ninib*, 108.
[27] A. II 7; *Chron. P.* IV 1.
[28] A. II 8. *Chron. P.* IV 14, and in l. 9, a predecessor, *Ramman-šum-uṣur*!
[29] Ass. 4128 II 3; C. 8836 III 30–1; *Chron. P.* IV 10 has *Ašur-na-ṣir-apli*!

Assyria (*continued*).	Babylonia (*continued*).
6. Ašurnirari IV.[1] } *Circa* 1220–1215. 5. Enlilkuduruṣur.[1] } *Circa* 1214–1210.	6. Rammanšumnaṣir.[2] *Circa* 1243–1238.
13. Ninurta-apil-ekur.[4] Son of Nabu-dān. *Circa* 1209–1197.	30. Ramman-šum-iddina.[3] *Circa* 1237–1208. 15. Melišipak.[5] *Circa* 1207–1193. 13. Mardukapiliddin I.[6] *Circa* 1192–1180.
36. Ašurdān.[8] *Circa* 1196–1161.	1. Zamamašumiddin.[7] } *Circa* 1179–1176. 3. Bêlnādinšumi[9] }
	36 kings of Cassite dynasty. 576 years[10] on A. II 16.
Ninurta-tukulti-Ašur. } [11] *Circa* 1160–1154. Mutakkil-Nusku. }	17. Marduk-šapik-zēri.[12] 1175–1159.
Ašur-rêš-iši.[14] *Circa* 1153–1134.	[14] 6. Ninurta-[nadin-šumi].[13] 1158–1153. Nabukudur-uṣur.[15] 1152–1139. Enlil-nadin-apli.[16] *Circa* 1138–1124.
27? Tukulti-apil-ešarra I.[17] *Circa* 1133–1107. 3. Ninurta-apil-ekur.[18] *Circa* 1106–1104.	Marduknadinaḫi.[17] *Circa* 1123–1113. [18] Itti-Marduk-balaṭi.[19] *Circa* 1112–1105. Marduk-šapik-zēr-māti.[20] –1102.
38. Ašur-bêl-kala.[22] *Circa* 1103–1066. Eriba-Adad II.[25] *Circa* 1065–1058.	22. Ramman-apil-iddin-na.[21] 1101–1080. $1\frac{1}{2}$. Marduk-aḫê-eriba.[23] 1080. 12. Marduk-zer-[*ibni*].[24] 1079–1068. 8. Nabu-šum-libur.[26] *Circa* 1067–1060.
	11 kings of *PA-ŠE*[27] dynasty. $132\frac{1}{2}$ years.
Šamši-Adad IV.[28] *Circa* 1057–1042. 19. Ašur-naṣir-apli I.[31] *Circa* 1041–1023.	18. Šimmaš-šipak.[29] *Circa* 1059–42? $\frac{5}{12}$. Ea-mukîn-zēri.[30] ? 3. Kaššû-nādin-aḫi.[32] 1025–1023.

[1] Ass. 4128 II 5–6; KAV. 15, Rev. 1–4 = C. 8836 III 32–5; *Syn. Hist.* II 3–5.
[2] A. II 10; but Ass. 4128 must be in error in making Ašurnirari contemporary with Rammanšumnaṣir.
[3] *Chron. P.* IV 17; Ass. 4128 III 7; *Syn. Hist.* II 3–5.
[4] Ass. 4128 II 7–9; KAV. 10 I 1; *Syn. Hist.* II 5–8; C. 8836 III 36–8 = KAV. 15 R. 5.
[5] A. II 12; Ass. 4128 II 8. [6] A. II 13; Ass. 4128 II 9.
[7] Ass. 4128 II 10; *Syn. Hist.* II 9–12; A. II 14.
[8] Ass. 4128 II 10; KAV. 10 I 2; *Syn. Hist.* II 9–12; C. 8836 III 41–2.
[9] Ass. 4128 II 11; A. II 15.
[10] This figure is clearly too high by at least 100 years. On A. I 16–II 15, the total for 19 names is only 165 years. It is impossible to assign 411 years to the remaining Cassite kings. The period, 466 years, allowed for this dynasty in my list presumes that the figures in A. II 16 are $9 \times 50 + 16$, not $9 \times 60 + 36$.
[11] Ass. 4128 II 12–13; KAV. 10 I 3–4; *Chron.* P. IV 12; C. 8836 III 44–6 + IV 1–3.
[12] Ass. 4128 II 12. [13] Clay, *Miscel.* 45, 30.
[14] Ass. 4128 II 14–16; KAV. 10 I 5.
[15] *Syn. Hist.* II 1–13. But KAV. 12, Nebuchadnezzar contemporary of Ninurta-tukulti-Ašur, Mutakkil-Nusku, Ašur-rêš-iši. This surely correct. See MVAG. 1921, 2, p. 38. [16] KAV. 12 I 4.
[17] KAV. 10 I 6; 12 II 5; Ass. 4128 II 17; *Syn. Hist.* II 14–23; C. 8836 IV 6–7.
[18] Ass. 4128 II 18; KAV. 12, 6; 10 I 7; C. 8836 IV 8–9; KAV. 21 III 13–15.
[19] King, *Chronicles*, II 59, 8. [20] Ass. 4128 II 20.
[21] Ass. 4128 II 21; A. III 1; King, *Chronicles*, II 59; Gadd, in *Tallquist, Studia Orientalia*, 27.
[22] C. 8836 IV 10–11; Ass. 4128 II 20–4; KAV. 10 I 8.
[23] Ass. 4128 II 22; A. III 2.
[24] Ass. 4128 II 23; A. III 3.
[25] Ass. 4128 III 1; C. 8836 IV 12–13.
[26] Ass. 4128 II 24; A. III 4. [27] Certainly for *Isin*.
[28] Ass. 4128 III 3; C. 8836 IV 14–18.
[29] Ass. 4128 III 1; A. III 6.
[30] Ass. 4128 III 3; A. III 7; King, *Chronicles*, II 52, 5.
[31] C. 8836 IV 19–20; KAV. 21, IV 4.
[32] Ass. 4128 III 4; A. III 8; King, *Chronicles*, II 53, 7.

Assyria (*continued*).	Babylonia (*continued*). 21 years and 5 months. 3 kings of the Sea Country.[1]
12. Šalmanasar II.[2] *Circa* 1022–1011. 6. Ašurnirari V.[4] *Circa* 1010–1005. [28?] Ašur-rabi II.[6] *Circa* 1004–977.	17. Ulmaš-šākin-šumi.[3] *Circa* 1022–1006. 2. Ninurta-kudur-uṣur.[5] *Circa* 1005–1004. $\frac{1}{4}$. Širiktu-Šuḳamuna.[7] *Circa* 1004.
	3 kings of dynasty of the sons of Bazi. 20 years.[8]
[13?] Ašur-reš-iši II.[9] *Circa* 976–964.	[?] Mar-biti-apil-uṣur.[10] *Circa* 1003–970.
	1 king, descendant of Ši...... of Elam. King, *Chronicles*, II 55, 13.
33 Tukulti-apil-ešarra II. *Circa* 963–931.[12]	Nabu-mukîn-apli.[11] 955–? Ninurta-kudur-uṣur.[13] Mar-biti-aḫi-iddin.[14]
Ašurdân II.[15] } *Circa* 930–890. Adadnirari II.[17] } Adadnirari II.[18] } 7. Tukulti-Ninurta II.[20] } 889–883. 24. Ašurnāṣirapli II.[21] 882–859. 35. Šalmanasar III.[23] 858–824.	Šamši-mudammiḳ.[16] *Circa* 910–896. Nabu-šum-ukîn(*iškun*).[19] *Circa* 895–880. Nabu-apil-iddin.[22] *Circa* 879–855. [11+?] Marduk-zākir-šumi.[24] (*Mardukbêlusāti*, brother.)[25] *Circa* 854–840.

[1] If the synchronisms of Ass. 4128 III 1–3 are correct, it is impossible to assign less than 19 years to *Eamukîn-zēri* and *Kaššû-nādin-aḫi*, although the figures $\frac{5}{12}$ and 3 are supported by King, *Chronicles*. Ass. 4128 is invariably supported by the *Synchronous History*; the evidence is against Ass. 4128, and the texts cannot be reconciled. On KAV. 21 III 15, end of *limus* of *Ninurta-apil-ekur*, to IV 4, end of Ašurnaṣir-apli, fall all the *limu* names of Ašur-bêl-kala, Eriba-Adad, Šamši-Adad, and at end of Col. III, 16 names for *Ašurnaṣirapli*! The space permits of no more than *40 years* for Ašurbêlkala, Eriba-Adad, Šamši-Adad, and Ašurnaṣirapli. It is, therefore, impossible to allow more than 24 years for Ašurbêlkala, Eriba-Adad, and Šamši-Adad! It is clear that Ass. 4128 makes Ašurbêlkala contemporary with 5 kings who must have reigned more than 18 years, and the *limu* list cannot be depended upon here. King, *Chronicles*, II 53, 8, has 23 years for the fifth dynasty.
[2] Ass. 4128 III 5; KAV. 21 IV 5–17.
[3] King, *Chronicles*, II 54, 9 has 15 years; A. III. 10, 17 years. See also King, ibid. 61, 14. Var. E-ulmaš-šākin-šumi.
[4] Ass. 4128 III 6; C. 8836 IV 21–2; KAV. 21 IV 18–22.
[5] King, *Chronicles*, II 54, 10, 2 years; A. III 11, 3 years.
[6] Ass. 4128 III 7; C. 8836 IV 23–4; KAV. 21 IV 23 + 22 Col. IV. [7] A. III 12; Ass. 4128 III 7.
[8] A. III 13; King, *Chronicles*, II 55, 13.
[9] Ass. 4128 III 8; KAV. 182 III 5; 10 II 1; C. 8836 IV 25–6. In the break on KAV. 21 IV 23–V 1, were the reigns of Ašur-rabi II and Ašur-rêš-iši II, *circa* 41 years.
[10] Ass. 4128 III 8; A. III 14 has only 6 years, which is impossible if Ass. 4128 is correct. KAV. 10 II 2.
[11] A. III 15, 20? + 8? years. KAV. 182 III 6; King, *Chronicles*, II 62, 17.
[12] Ass. 4128 III 9–11; KAV. 22 V 24; C. 8836 IV 27–8.
[13] KAV. III 182 7. A. III 16 has 8 months and 12 days.
[14] KAV. 182 III 8; 10 II 5.
[15] Ass. 4128 III 14. *Limu* list, KAV. 22 V 25 to 21 VI *circa* line 22 including Adadnirari.
[16] Ass. 4128 III 14–15; *Syn. Hist.* III 1–9; KAV. 10 II 6; 182 III 9.
[17] Ass. 4128 III 15; *Syn. Hist.* III 1–7.
[18] *Syn. Hist.* III 10–21.
[19] KAV. 10 II 7; Ass. 4128 III 16; *Syn. Hist.* III 10–21; King, *Chronicles*, II 64, 2.
[20] Ass. 4128 III 16. *Limu* list. King, *Chronicles*, II 64, 2. [21] Ass. 4128 III 18; KAV. 22 VI 13.
[22] Ass. 4128 III 18; KAV. 182 III 11; 10 II 8. King, *Chronicles*, II 64, 3.
[23] Ass. 4128 III 20. Contemporary of Nabu-apla-iddin and Marduk-zākir-šumi, *Syn. Hist.* III 22–35. *Limu* list.
[24] KAV. 10 II 9; 182 III 12; year-date 11, VS. I 35.
[25] Rebel who controlled part of Babylonia for a time, *Syn. Hist.* III 28–30; King, *Chronicles*, II 65, 4–5, reading *Marduk-bêl-û-še* ......

ASSYRIA (*continued*).	BABYLONIA (*continued*).
	Marduk-balaṭsu-iḳbi.[1] *Circa* 839–820.
14. Šamši-Adad V.[2] 823–810.	Bau-aḫi-iddin.[3] *Circa* 819–816.
(Semiramis.)	(Interregnum.)[4]
	....
28. Adadnirari III.[5] 809–782.	d. Mar-biti ?................[6]
10. Šalmanasar IV.[7] 781–772.	Marduk-bêl-zēri.[8]
	Marduk-apla-uṣur.[9]
18. Ašurdân III.[10] 771–754.	Eriba-Marduk.[11]
	(Interregnum.)[12]
8. Ašurnirari VI.[13] 753–746.	Nabu-šum-iškun.[14] 760–746.
19. Tukulti-apil-ešarra III.[15] 745–727.	14. Nabunaṣir.[16] 747–734
(Pûlu.)[17]	2. Nadinu.[18] 733–732.
	1/12. Nabušumukîn.[19] 732.
	22 reigns[20] from *Nabu-mukîn-apli* to Nabušumukîn. 955–732.
	3. Mukîn-zēri. 731–729.[21]
	2. Pûlu. 728–727.[22]
5. Šalmanasar V.[23] 726–722.	5. Ululāi=Šalmanasar V.[23] 726–722.
17. Sargon. 721–705.	12. Marduk-apil-iddin II.[24] 721–710.
	5. Sargon.[25] 709–705.
24. Sin-aḫê-eriba. 704–681.[26]	2. Sin-aḫê-eriba.[27] 704–703.
	1 month. Marduk-zakir-šumi.[28]
	8 months. Marduk-apil-iddin.[29]
	3. Bêl-ibni.[30] 702–700.

[1] Son of Mardukzākiršumi, RA. 16, 130; KAV. 182 III 13; *Syn. Hist.* CT. 34, 43, Sm. 2106, Rev. 6–9; KING, *Chronicles*, II 65, 6.
[2] RA. 16, 120; *Limu* list; *Syn. Hist.* CT. 34, 43, Sm. 2106, Rev. 6–9.
[3] *Syn. Hist.* IV 1–14; KAV. 182 III 14.
[4] KING, *Chronicles*, II 66, 7; for the remainder of Šamši-Adad's reign the king, Bau-aḫi-iddin, was not in the land, i.e. was captive in Assyria.
[5] *Syn. Hist.* IV 15–22; *Limu* list.
[6] CT. 34, 41, 15 = KAV. 13, 1? WEIDNER's collation of KAV. 13, 1, confirms SCHROEDER's copy, and seems to have *AN–PA* . . . . . ., i.e. *Nabu-*. . . . . .
[7] *Limu* list.
[8] KAV. 13, 2; JOHNS, *Assyrian Deeds*, 881, 1?; CLAY, JAOS. XLI (1921), 413.
[9] KAV. 13, 3; JOHNS, ibid. 3.
[10] *Limu* list.
[11] KAV. 13, 4; CLAY, *Miscel.* 40, 13; KING, *Chronicles*, II 66–8.
[12] A. IV 1, 10-year interregnum?, when an Assyrian king ruled Babylonia, KING, *Chronicles*, II 69, 18.
[13] *Limu* list. KAV. 23 VIII 9, *ten* years!
[14] A. IV 2; KAV. 13, 5; highest known date, 13th year, CLAY, *Morgan Collection*, I 3.
[15] *Limu* list; KAV. 23 VIII 10–21 VIII 16.
[16] Ptolemaic Canon, 1; A. IV 3; *Babylonian Chronicle*, I 1–12.
[17] As king of Babylonia.
[18] So *Bab. Chron.* I 12–13, and Ptolemaic Canon, 2. But A. IV 4, *Nabû-nādin-zēri.*
[19] *Bab. Chron.* I 16–17; here called *Šum-ukîn* (2 months); A. IV 5.
[20] A. IV 5. No records of the period were available for this period of anarchy, and the compiler of King-list A gives only 22 *bal* or families who were temporarily in power. Some are called *Kaldu*, and some are said to be from the Sea Land, JOHNS, *Assyrian Deeds*, 888.
[21] A. IV 7; *Bab. Chron.* I 19–23; Ptolemaic Canon, 3, Chinzēr. Called *Nabû-mukîn-zēri*, CLAY, *Morgan Collection*, I 22 (fourth year).
[22] A. IV 8; *Bab. Chron.* I 24–6.
[23] *Bab. Chron.* I 27–30; A. IV 9.
[24] Merodachbaladan; A. IV 10; *Bab. Chron.* I 32–II 4.
[25] A. IV 11; *Bab. Chron.* II 5–10.
[26] *Limu* list; Ass. 4128 IV 1–10.
[27] A. IV 12.
[28] A. IV 13; *Bab. Chron.* II 17.
[29] *Bab. Chron.* II 20. Ass. 4128 IV 1–5, 'three dynasties of *Bit-* . . . . . .'. For the 2 years + 9 months from Sargon to Belibni, the Ptolemaic Canon has 2 'kingless' years.
[30] A. IV 15; *Bab. Chron.* II 23–9.

ASSYRIA (*continued*).	BABYLONIA (*continued*).
	6. Ašur-nādin-šumi.[1] 699–694.
	1. Nergal-ušêzib.[2] 693–692.
	4. Mušêzib-Marduk. 691–688.[3]
	7. Sin-aḫê-eriba.[4] 687–681.
12. Ašur-aḫi-iddin.[5] 680–669.	12. Ašur-aḫi-iddin. 680–669.[5]
43. Ašur-bāni-apli.[6] 668–626.	20.[7] Šamaš-šum-ukîn.[6] 668–649.
	23. Kandalānu.[8] 648–626.
4? Ašur-eṭil-ilāni.[9] 625–622?	21. Nabu-apla-uṣur.[10] 626–604.
1? Sin-šum-lîšir.[11] 622?	
10? Sin-šarra-ukîn.[12] 621?–612.	(Fall of Nineveh.)
Ašur-uballiṭ.[13] 611–?	
(End of Assyrian Empire.)	
	43. Nabu-kudur-uṣur. 604–562.
	2. Amel-Marduk. 561–560.
	4. Nergal-šarra-uṣur. 559–556.
	3? months. Labaši-Marduk.
	17. Nabu-na'id. 555–538.[14]

[1] A. IV 16. Son of Senecherib, *Bab. Chron.* II 30; Ass. 4128 IV 6, called *aššurāia*, Assyrian.
[2] A. IV 17. 1 year and 6 months, *Bab. Chron.* III 5. Ass. 4128 IV 7. An Elamite.
[3] A. IV 18; Ass. 4128 IV 8; *Bab. Chron.* III 12–27.
[4] A. IV 19; Ass. 4128 IV 10. Ptolemaic Canon describes the reign of Senecherib as eight 'kingless' years. Also S. SMITH, BH. 13, Rev. 8, eight years.
[5] A. IV 20; Ass. 4128 IV 12; *Bab. Chron.* III 39–IV 32; S. SMITH, BH. 13, Rev. 7; 23, 2. Ptolemaic Canon, 13 years. For astronomical reckoning of his first year, 680/679 (Gregorian), v. ZA. 37, 311.
[6] A. IV 21; Ass. 4128 IV 14; *Bab. Chron.* IV 33–8.
[7] Ptolemaic Canon, 20 years; also S. SMITH BH. 24, 3. Highest-dated tablet, year 20, CLAY, *Morgan Collection*, I 38.
[8] A. IV 22; Ass. 4128 IV 15. Ptolemaic Canon, 22 years. Highest-known date, 19, on Dilbat tablet (Oxford), but tablet from same group has date, Ašurbanipal, year 23. Hence Ašurbanipal and Kandalānu are the same persons, and the tablet of year 23 is the year 626/5. Clearly Ašurbanipal lived as late as 626.
[9] Highest-known date, year 4, at Nippur, CLAY, BE. VIII 5. At Dilbat, LANGDON, OECT. I 37; at Bit-Dakuri, CLAY, *Miscel.* 43.
[10] S. SMITH, BH. 24, Rev. 4; succeeds Kandalānu. Ptolemaic Canon, 21 years. A Chaldean, RA. 11, 142.
[11] Accessional year, BE. VIII 141; cf. CLAY, *Morgan Collection*, I 42, 19, and IV 50, 1–2, son of Ašurbanipal?
[12] GADD, *Fall of Nineveh*, l. 44. Latest-dated Babylonian tablets, 7th year, 10th month, ZA. 9, 398, *circa* 615, and JRAS. 1921, 387, 5th month, both dated at Erech. Hence Nabupalassar lost control of southern Babylonia until 615. But an Erech tablet dated in 5th year of Nabupalassar, RT. 36, 15, i.e. 621!
[13] Gadd, ibid. 49–75.
[14] Ass. 4128 IV 19–20 reckons 98 Accadian kings from *Sumu-la-ilu* to *Kandalānu*. In the above list there are 100 kings in this period, omitting the Assyrian kings who ruled in Babylonia, i.e. Pulu, Ululai, Sargon, Senecherib, Asarhaddon, and Kandalānu. But the suggestion for introducing *Mar-biti* . . . . . ., contemporary of Adadnirari in the 8th dynasty raises the number to 101. In any case it is impossible to account for as many as 22 kings in the 8th dynasty. This would raise the number of names to 105, from *Sumu-la-ilu* to *Kandalānu*. From *Erišum*, son of Ilušuma, to Ašurbanipal, Ass. 4128 gives 82 Assyrian kings, which exactly corresponds to the list above. It is probable that Kadašmanḫurbe of the Cassite dynasty was not mentioned; his existence rests upon doubtful authority.

CHAPTER XV

ASTRONOMICAL AND CALENDARIAL TABLES

Introduction and Elements

THESE tables treat the heliacal risings and settings of the Moon and the five planets known to the ancients, the former from -3500 to $+1300$ and the latter from -2100 to the year 0, computed in each case for the horizon of Babylon ($\lambda = 44{\cdot}40°$, $\phi = 32{\cdot}50°$). But the figures hold approximately for any terrestrial latitude between $31{\cdot}5°$ and $33{\cdot}5°$ (e. g. Jerusalem, Borsippa, Sippara, Dilbat, Kish, Nippur, Isin, and less exactly for Erech, Ellasar, and Alexandria), because in the lower latitudes the figures are not greatly changed by a difference of one degree in latitude. Particular attention is given to the most important phenomenon, the appearance of the crescent (i. e. the heliacal rising of the Moon in the evening), namely, the first moment after new moon, when the fine, small lunar crescent becomes visible in the evening to a sharp-sighted man. This moment was the beginning of a new month to most ancient oriental peoples, especially the Babylonians. To determine the evening when this phenomenon takes place very accurate tables of new moon are required, because the visibility of the crescent depends on the age of the Moon, i. e. on the time expressed in tenths of an hour which has elapsed from the moment of true new moon to 6^h the following evening. But there are no tables in existence which give the time of new moon with the necessary accuracy (error = $\pm\frac{1}{4}$ hour).[1] I have, therefore, constructed new-moon tables on the model of SCHRAM'S *Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse* (1885), where, however, the Period Table contains those new moons only, which are connected with a solar eclipse, about two in the mean for each year. I have adopted as the basis of my tables OPPOLZER'S monumental *Syzygien-Tafeln für den Mond* (1881), introducing modern elements of the Moon and Sun. With my tables it is the work of a few minutes to receive the time of true new moon with an error of $\pm 3^m$ between -2000 and $+2000$. Before -2000 the error can reach 5^m. Furthermore, the computation is far simpler than with NEUGEBAUER'S tables, because in Tables A and B the intervals of Argument II are so small that they are practically tables of single, not of double, entry. I have, of course, avoided the use of the cumbrous Julian day, which compels any one who works with OPPOLZER'S tables to perform the entire computation with a ten-figure quantity, T. I give the day of the month in a small Table C, p. [VIII]. No knowledge of astronomy is required for the use of any of my tables; any one can work with them who is able to interpolate between given table values.

I use the following elements:

For the Moon, epoch 1800 Jan. 0, Greenwich noon:

$L =$	335°	43′	24·37″	+	1732	564	394·50″	s	+	12·200″	s^2	+	0·0066″	s^3
$\Omega =$	33	16	22·57	−	6	962	920·90	s	+	7·489	s^2	+	0·0075	s^3
$\pi =$	225	23	50·37	+	14	648	593·70	s	−	37·033	s^2	−	0·0440	s^3
$D =$	55	48	34·74	+	1602	961	629·95	s	+	9·572	s^2	+	0·0066	s^3

[1] GRATTAN GUINNESS, *Creation Centred in Christ*, ii (1896), gives new moons back to -1621 with an error of ± 4 hours. The new moons computed with SCHRAM'S *Hilfstafeln für Chronologie* (1883), reprinted in his *Kalendariographische und chronologische Tafeln* (1908), have in antiquity an error of ± 1 hour, and those of NEUGEBAUER, *Tafeln zur astronomischen Chronologie*, ii (1914), also an error of ± 1 hour.

For the Sun, Mercury, Venus, Mars, epoch 1900 Jan. 0, Greenwich noon:

$L' =$	279°	41′	48·48″	+	129	602	769·81″	s	+	2·628″	s^2				
$\pi' =$	281	13	14·32	+		6	183·62	s	+	1·680	s^2	+	0·010″	s^3	
$L =$	178	10	45·7	+	538	106	660·8	s	+	7·30	s^2				Mercury
$=$	342	46	1·9	+	210	669	165·5	s	+	3·55	s^2				Venus
$=$	293	44	14·4	+	68	910	103·9	s	+	1·92	s^2				Mars

where s denotes the Julian centuries elapsed since the epoch and the longitudes are reckoned from the real equinox. All other elements of Mercury, Venus, and Mars are taken from NEWCOMB'S tables, and the elements of Jupiter and Saturn are taken wholly from GAILLOT'S tables.

The most important term for my purpose, the s^2 term in $L - L' = D$, affecting T (the time of conjunction), and amounting to 9·6″ approximately, I have derived (as well as Ω) from ancient eclipses.

The s^2 term in the Moon's L, 12·20″, which implies a term of 11·09″ s^2 in the Moon's motion compared with the fixed stars, I have derived from the only useful observation in all antiquity, the observation made by Timocharis at Alexandria -282 Nov. 9, when Spica in the morning touched the north cusp of the Moon after the Moon had risen over the horizon. Since 1919 I have made similar observations with Spica, Regulus, and Aldebaran (which are near the ecliptic and are all of magnitude $+1{\cdot}2$ approximately) at Heidelberg and Berlin and have found that Spica could not on that morning have been visible earlier than 22^m after moonrise, having regard to extinction of light by proximity to the horizon and invisibility through the diffusion of moonlight. That is the lower limit. The upper limit is 38^m after moonrise, because a later moment could not be described by the phrase 'after the Moon had risen over the horizon'. For the mean, 30^m after moonrise or $2^h\ 56^m$ a.m. Alexandria time, I have computed the apparent longitude of the Moon with the s term above and have found for the s^2 term a value of 12·20″, the most important result for the sidereal motion of the Moon within 2,300 years, because the error of time is only $\pm 8^m$. All other occultations in the *Almagest* were useless for my purpose because the time is given in seasonal hours measured with water-clocks, which could be in error by more than one hour.

The visibility of the crescent is given by my small Table K, in which Δ denotes the difference in azimuth of the Sun and Moon at the moment when the centre of the Sun sets, and h the altitude of the Moon over the horizon at the same moment, both terms being computed without regard to refraction and parallax. The crescent should be visible if h is equal to, or greater than, the figure shown in the column headed h in Table K. This problem is treated at large with historical examples in my *Planeten-Tafeln für Jedermann*, Linser-Verlag, Berlin-Pankow, 1927. I have derived Table K from more than 400 Babylonian observations from -500 to the year 0 confirmed by observations from -2095 to -1900. I have also made more than 100 observations of the crescent myself during 34 years. How well Table K agrees with modern observations can be seen by comparing it with the computations given by FOTHERINGHAM in *The Observatory*, 1921, pp. 308–11.

TABLE K

Δ	h	Δ	h
°	°	°	°
0	10·7	10	9·4
1	10·7	11	9·1
2	10·6	12	8·8
3	10·5	13	8·4
4	10·4	14	8·0
5	10·3	15	7·6
6	10·1	16	7·3
7	10·0	17	7·0
8	9·8	18	6·7
9	9·6	19	6·3

For the planets I have twice differentiated the difference in the equations of the centre (Planet minus Sun) and have thus obtained the transition from mean to true conjunction or opposition. Because from – 2100 to 0 the mean anomaly, g', of the Sun differs by a constant from that of the planet, g, at the moment of mean conjunction or opposition, it was possible to tabulate one mean anomaly only, called I. The eccentricity of the Sun and planets is taken for – 700, secular variations being neglected except in the case of the inferior conjunction of Venus. For the *arcus visionis* which I have used for the planets reference should be made to my *Planeten-Tafeln*, where they are deduced from ancient and modern observations.

I cannot accept NEUGEBAUER's statement[1] that the heliacal phenomena of the planets and fixed stars are uncertain by several days. I have found an uncertainty of one day only, corresponding to a change of 0·8° in γ, as well for Mercury, Venus, Jupiter, and Saturn, as for Procyon, Aldebaran, and Betelgeuse. Mars alone can differ by about six days, because at times his γ changes very slowly. If the observed γ is greater than mine, the sky was not clear, or the observer had not sharp eyes or was not skilful. For Venus at Babylon the stellar magnitude is taken as m = – 3·3 for heliacal phenomena and the corresponding γ as 5·3°. But for northern latitudes the m for e last can reach – 4·2, as on 1927 August 21, when HERR STILLHART at St. Gall saw e last with γ = 3·8°. In these latitudes, therefore, γ can be much less than 5·3°. Allowing for cloudiness, it is to be expected that the sky should be clearer on winter and spring nights than on summer nights with their heat mist. Only in the most favourable circumstances can γ have a smaller value than I have adopted. The Egyptian observations are not relevant, because the Egyptian sky is far worse than the Babylonian.[2]

PRECEPTS FOR USE.

The Julian calendar is used throughout these tables, except for modern times (1904 onwards), where the Gregorian is used. Years are enumerated in the astronomical method in which the year 1 B. C. is styled 0, and other years B. C. are expressed by a minus sign followed by the number of the year diminished by one. Hence 2067 B. C. (first year of Hammurabi) is styled – 2066. The time is always Babylon mean time (Bb), except for modern times, where Greenwich mean time (Gr) is used. Times from midnight to noon are indicated by a (*ante meridiem*) and from noon to midnight by p (*post meridiem*). Each set of tables includes a Cycle Table, in which the left-hand column contains the astronomical year with its fraction. To convert the day of the month into a fraction of the year use the first table on p. [I], where the fraction of the year is given in the second column for positive years and in the third column for negative years. Thus we have – 2168 April 22[3] = – 2168·70; – 522 (Cambyses 7) Oct. 23 = – 522·19; but 1928 Oct. 13 = 1928·78.

(*a*) *Computation of New Moon.* Pages [I] and [II] contain the Cycle and Period Tables for new moon. For this purpose the quantities I, II, and T are required. I and II are expressed in units of 0·001 of a circle. Hence when the sum of I or II exceeds 1,000, subtract 1,000. T is the number of days with three decimals of a day. Thus to find the time of new moon in – 2168 April. The fraction table gives for the middle of April – 2168·71. Take in the Cycle Table the last preceding cycle, – 2183·66. Take the period nearest to the difference, here 14·96. Write out the values of I, II, T corresponding to the cycle, and write below them the values of I, II, T

[1] *Tafeln zur astronomischen Chronologie*, iii (1922), xxxvii.

[2] See my article in *Sirius* (1926), Heft 10, and my *Planeten-Tafeln, passim.*

[3] At 6^h p on this day began the first of Nisan of the first year of the First Dynasty of Babylon.

corresponding to the period 14·96. Add each of the two columns I and II, diminishing the sum, if necessary, by 1,000. Enter Table A, p. [V], and interpolate with the vertical Argument I = 912 and the horizontal Argument II = 444 the value 623 for T and write it under the other two values of T. Enter Table B, p. [VII], and interpolate with the vertical Argument II = 444 and the horizontal argument, year – 2000, the value 261 for T and write it under the others. The unit of T in Tables A and B is the third decimal place. Then sum the column T, obtaining 1573·881. Table C, p. [VIII], which converts integral values of T into days of the month, gives for 1573 the date April 21. Table D, p. [VIII], gives for the fraction of T (0·881) the time 9^h 9^m p Bb. Table D is arranged like a logarithm table. In the first or second column the first two decimals of T stand as argument, while the third decimal stands over the other columns. If the first two decimals are in the first column, the time is in the morning, a, if in the second, the time is in the afternoon, p. The table values are hours and minutes. For modern times apply to T the small correction d T, which stands in the last column of the Period Table (here = – 1). Hence period T = 34·106.

Example 1.		I.	II.	T.
Cycle	– 2183·66	645	487	492·838
Period	14·96	267	957	1080·159
Year	– 2168·70	912	444	
Table A, Arg. I, II				623
Table B, Arg. II and Year				261
				1573·881

Table C gives April 21, Table D gives 9^h 9^m p Bb.

The next evening, April 22, at sunset was the beginning of the first Nisan of the First Dynasty.

Example 2. New Moon 1928 October.

		I.	II.	T.
Cycle	1904·69	10	687	253·413
Period	24·09	370	93	34·106
	1928·78	380	780	
		Table A		120
		Table B		24
				287·663

October 13^d 3^h 55^m p Gr.

Nautical Almanac gives 3^h 56^m p.

The agreement is very good.

Mean New Moon. If the mean new moon only is required, take from the Cycle and Period Tables T only, and add 0·610. Arguments I and II and Tables A and B are not required. Thus in Example I we have

T.
492·838
1080·159
0·610
1573·607 = April 21^d 2^h 34^m p Bb.

(*b*) *Computation of Crescent. General Considerations.* These tables are not to be used for this computation except for places whose latitude differs little from that of Babylon (32·5°). The tables are applicable from – 3507 to + 1289 and from 1904 onwards. A comparison of Babylon with a place in latitude 51° is interesting and instructive. Column *a* shows that if at a new moon in March the Moon is in perigee and her latitude (β) = + 5°, the minimum or necessary age at which the crescent can be visible is $16·5^h$. For latitude 51° the necessary age is $20·0^h$, the difference being only 3·5 hours. An instance of this will occur in 1937 March 13. Column *b*, on the other hand, shows that if at a new moon in September the Moon is in apogee and β = – 5°, the necessary age at Babylon is about $42·0^h$, while for latitude 51° it is $63·0^h$, a difference of 21 hours. In spring the mean anomaly of the Moon is of the same importance as her latitude, but in autumn her latitude is far more important.[1] I can say of the Babylonians, who were persistent observers of the crescent during 3,000 years, that not only their observations but their computations for ephemerides are

	a	*b*
	h.	h.
Babylon	16·5	42·0
51°	20·0	63·0

[1] See my detailed article in *Biblica*, Rome, 1928 January.

admirable. I have found only one large error in these, viz. the crescent of −273 Nov. 4, on which evening Araḫsamna 1 was made to begin. This is in contradiction to my own observations and computations of the crescent, according to which it was not visible that evening. These give as the necessary age of the Moon $22{\cdot}4^h$, and as the time elapsed since new moon 16^h only. KUGLER assumes that the time of appearance of the crescent was found by comparison with a year 18 years earlier. But this is impossible, because if we go back by the lunar cycle of 18 years, the Moon is about 8 hours older each evening. The only period which yields a good comparison is that of 19 years, after which the age, mean anomaly, and lunar latitude recur approximately with their former values. Both the Babylonians and the ancient Jews in determining the beginning of the month were interested only in observations made in the evening which closed the 29th day of the month. If the crescent was not seen, the day beginning at sunset was regarded as the 30th of the old month; if it was seen, that day was the 1st of the new month. The observation at the close of the 30th day had astronomical interest only, and had no bearing on the calendar. Since the synodic month contains 29·53 days (a little more than $29\frac{1}{2}$ days), the calendar months were generally of 29 and 30 days alternately, and at an average interval of sixteen months there should have been two 30-day months in succession. But since the length of the month depended on the crescent, not on the mean new moon, the variation in length was not so regular. Two successive months of 29 days were possible, especially in the season from Sabat to Ayar. Three successive months of 29 days were impossible, but two or even three successive months of 30 days could occur. The rule governing the last is: If in three successive months in the season from Ayar to Kislev, the Moon when new is near her apogee, and her latitude (β) is less at each new moon than at the preceding new moon, three successive months of 30 days are possible. This occurs about once in 10 years, was familiar to the Babylonians by observation, and is found in their ephemerides for −163, −75, and −10. The computation of the crescent is very complicated and is the most difficult exercise in ancient astronomy, because for a given place the necessary age of the Moon for the visibility of the crescent depends upon three variables, the longitude of the Sun, the mean anomaly of the Moon, and her latitude (β). KEPLER regarded the computation of the crescent as impossible. I have given in Tables G and H the transition from new moon to crescent. It will be noted that interpolation in Table H is more complicated than in Table G. But a larger and more convenient Table H would have involved a great expenditure of space.

The most valuable observations for my purpose are the most ancient, belonging to a time when the Babylonians were unable to compute the appearance of the crescent, i.e. the time from Rim-Sin to Ammizaduga and from Nebuchadnezzar to Xerxes. Within these two ranges I have collected about 80 months, which are known from contracts to have contained 30 days, including some which I have taken from KUGLER and UNGNAD. I find that these agree with the months which have 30 days according to my tables in about 80 per cent. of the cases. The remaining 20 per cent. must be explained by bad weather on the evening of the 29th day of the month or perhaps by a want of accuracy in my Tables G and H, which can easily be corrected in the future. The most important result historically is that these 30-day months confirm FOTHERINGHAM'S chronology for the First Dynasty, observation and computation agreeing in 80 per cent. of the instances, while for KUGLER'S original solution, in which the first year of Ammizaduga is −1976, agreement occurs in 40 per cent. only. From this it follows either that the last-named chronology is false or that the Babylonians of that age did not regulate the beginning of the month by the appearance of the crescent. From the reign of Xerxes to the year −7 I have computed

about 400 crescents and find that the recorded dates agree throughout with my tables in 80 per cent. of the instances.

Example 3. I select the oldest 30-day month known to me, Rim-Sin 2, Ab (Contract LX. 20). The year is −2096/5. Enter Tables M and N, pp. [XV], [XVI], and find there −2096 Ab 1 = August 4 Julian, −2096 Ulul 1 = September 2 Julian, the day beginning with midnight. (Precepts for the use of Tables M and N are given later.) We have to compute the crescents at the beginning and end of Ab.

		I.	II.	T.	L.	θ.
Cycle	−2107·74	982	404	463·073	357·67°	2·5°
Period	11·32	40	319	1212·275	114·94	218·9
Year	−2096·42	22	723	0·385	0·39	221·4
				0·012	113·00	111·0 ⊙
				1675·745	−2·04	332·4 u
					⊙ 110·96	

New Moon Aug. $1^d\ 5^h\ 53^m$ p = $5{\cdot}9^h$ p Bb.
To Aug. $2^d\ 6^h$ p there elapsed $24{\cdot}1^h$.
Table G gives with Arg. ⊙ = 111, and Arg. u = 332·4 — $26{\cdot}2^h$
Table H gives with Arg. ⊙, u, I the correction: — −3·0
Visible Aug. 2, evening. Necessary hours — 23·2

Interpolation in Table H.
Correction with

Arg. I = 22	⊙ = 60°	120°
Arg. u = 332°	−2·5	−3·1
For ⊙ = 111°	$-3{\cdot}0^h$	

		I.	II.	T.	L.	θ.
Cycle	−2107·74	982	404	463·073	357·67°	2·5°
Period	11·40	111	400	1241·816	144·05	220·5
Year	−2096·34	93	804	0·226	0·23	223·0
				0·017	141·95	140·0 ⊙
				1705·132	−1·98	3·0 u
					⊙ 139·97	

New moon Aug. $31^d\ 3^h\ 10^m$ a = $3{\cdot}2^h$ a Bb.
To Sept. $1^d\ 6^h$ p there elapsed $38{\cdot}8^h$. The Moon was certainly visible on Sept. 1.
The Babylonian days counted from midnight (contract-day) must have been as follows: {Ab 1 = Aug. 3, Ulul 1 = Sept. 2}. Therefore Ab had 30 days.

For the first crescent take from Cycle and Period Tables the quantities I, II, T, L, θ. Form by summation I, II, θ. (See *Example 1.*) With Arg. I = 22 and II = 723 enter Table A and take out the quantities T = 385, L = 39. Sum L and with Arg. II = 723 and the year −2100 enter Table B and take out the quantities T = 12, L = −2·04°. Write the latter under the sum of L and add algebraically. The result is the true longitude ⊙ of the Sun at the moment of new moon. It is also the true longitude of the Moon at that moment. Write ⊙ = 111·0° under θ = 221·4° and add. The result is the Moon's argument of latitude, u. Now sum the column T as in *Example 1*, obtaining 1675·745. With this value enter Tables C and D, p. [VIII], and obtain, new moon Aug. $1^d\ 5^h\ 53^m$ p = $5{\cdot}9^h$ p Bb. If the place of observation were Jerusalem, the Babylon time of new moon would have to be corrected by -37^m as in Table E, p. [VIII]. To 6^h p of the next day, Aug. 2, at Babylon there elapsed $24{\cdot}1^h$. Enter Table G, p. [IX], with Arg. ⊙ = 111·0°, u = 332·4°, and find by interpolation the necessary hours, $26{\cdot}2^h$. With the three Arguments ⊙, u, I, enter Table H, p. [IX], which has four sections, headed with the Argument ⊙. Enter the two sections between which lies the given value of ⊙, here 111°, in this case those headed ⊙ = 60° and ⊙ = 120°. Find in these two sections with vertical Argument I = 22 and horizontal Argument u = 332° the two values $-2{\cdot}5^h$ (for ⊙ = 60°) and

$-3{\cdot}1^h$ (for ⊙ = 120°). Then by interpolation for ⊙ = 111°, take out the value $-3{\cdot}0^h$. This correction, found from Table H, when added to the value given in Table G ($26{\cdot}2^h$) gives the necessary number of hours which must have elapsed from new moon to 6^h p for the crescent to become visible. If the number of hours which have actually elapsed is equal to, or greater than, the necessary number of hours, the crescent should have been visible that evening. In this example we have: hours elapsed $24{\cdot}1^h$, necessary hours $23{\cdot}2^h$. Therefore the crescent should have been visible on the evening of Aug. 2. Hence the first day of Ab began at that moment (at sunset), or, as we express it, Aug. 3 = Ab 1, reckoning both days by modern civil usage from midnight. For the second crescent the computation proceeds in the same way and gives: crescent visible on Sept. 1 evening, hence Sept. 2 = Ulul 1. The month Ab had, therefore, 30 days, in agreement with the evidence of the contract.

As the longitude ⊙ of the Sun and the longitude λ of the Moon are equal at the moment of new moon, we have for both 110·96°. The latitude β of the Moon at the moment of new moon is found from Table F, p. [VIII], which gives with Argument u = 332·4° the value $\beta = -2{\cdot}31°$. If, as in this case, Argument u is on the right hand, β is negative. The error of λ and β is $\pm$ 0·01° only. We can compare these values with the Babylonian computations, which often give λ and β of the Moon for the moment of new moon.[1]

In the two following examples, one crescent has been selected with a small age (March) and one with a great age (September). It is generally sufficient to take T in each table to two decimal places and L to one decimal place only, as in these two examples:

Example 4. Crescent −74 March 3, Bb.

	I.	II.		T.	L.	θ.
−75·00	972	89		733·37	278·8°	80·9°
0·16	143	162		59·07	58·2	3·1
−74·84	115	251	Tab. A	16	5	84·0
			Tab. B	38	+2·0	339·5 ⊙
				792·98	339·5 ⊙	64 u

New moon March 2^d $11{\cdot}5^h$ p Bb.
To March 3^d 6^h p there elapsed $18{\cdot}5^h$.
Visible on March 3 evening.
March 4 = Adar 1.

Necessary hours:
Table G $19{\cdot}6^h$
,, H −1·4
Necessary 18·2

Example 5. Cambyses 7, −522 Sept. 29, Bb.

	I.	II.		T.	L.	θ.
−545·22	892	876		1381·43	194·1°	345·7°
22·96	366	961		1081·70	346·3	84·1
−522·26	258	837	Tab. A	2	0	69·8
			Tab. B	4	−1·7	178·7 ⊙
				2463·19	178·7 ⊙	249 u

New moon Sept. 28^d $4{\cdot}6^h$ a Bb.
To Sept. 29^d 6^h p there elapsed $37{\cdot}4^h$.
Not visible on Sept. 29 evening.
October 1 = Tešrit 1.

Necessary hours:
Table G $36{\cdot}9^h$
,, H +0·9
Necessary 37·8

In this example, by taking a third decimal place in T, we should have obtained for the sum of T 2463·180, giving $4{\cdot}3^h$ a Bb as the time of new moon, from which $37{\cdot}7^h$ elapsed to Sept. 29^d 6^h p. The contracted computation is, therefore, confirmed, but the difference between the actual and necessary intervals is reduced from $0{\cdot}4^h$ to $0{\cdot}1^h$. Where the difference between the two intervals amounts to $0{\cdot}4^h$ or less, it is desirable to repeat the computation with the full number of places given in the tables.

[1] See, for example, Kugler, *Sternkunde*, Buch ii, Teil 2 (1924), p. 602.

These two examples illustrate the great difference between spring and autumn crescents.

Note. The enumeration of years in the Cycle and Period Tables is mathematically accurate except in one respect. There is a leap of one year in the enumeration between −1·00, the close of the year −1, and +0·00, the beginning of the year 0. In consequence for the 23 new moons, which fall in the years 0 and +1 before +1·92, which appears in the Cycle Table, it is necessary to substitute −16·11 for −17·11 as the year in the Cycle Table, in order to obtain the Period Year and corresponding values correctly.

(*c*) *Use of Tables* M *and* N (*Babylonian Calendar*). These tables are constructed on the same principle as those published in the *Arcus Visionis in the Babylonian Observations*, University Observatory, Oxford, 1924, in *Ammizaduga* (1925), and in *Planeten-Tafeln für Jedermann* (1927), and are accommodated to the system of Babylonian chronology adopted in this work, which was also adopted in *Planeten-Tafeln*, but not in the two earlier publications. The tables attempt to give as accurately as their size permits the beginning of each Babylonian month, having regard to inequalities in the date of that beginning so far as it depends on the season of the year. The first day of the month computed with these tables is in about 75 per cent. of cases identical with the first day astronomically computed. The identity of the calendar month is not so easily represented. From −382 onwards a 19-years cycle was in use and from this date the identity of the months is given with strict accuracy. Before that date intercalation was less systematic, but an attempt has been made to assign to each month its most probable position consistent with the use of tabular form. If in any particular year Nisan is known to have begun earlier or later than the date given in these tables the whole calendar should be shifted by one or two calendar months so as to bring it into its correct position, regard being had to the intercalation of a second Ulul where that is known to have taken place.

Conversion of Babylonian into Julian Dates. For this purpose it is necessary to know the Julian year to which the Babylonian year corresponds. A Babylonian year belongs partly to each of two successive Julian years. The first of these should be used. Take the Cycle Year standing next before the given year, and make a mental note of the table value standing opposite to it. The difference between the Cycle Year and the given year is the 'period'. With the period as vertical argument and the name of the Babylonian month as horizontal argument take out the value given in Table M. Sum the values given in the two tables, and add the day of the Babylonian month. Enter Table N with the value thus obtained. The name of the Julian month stands over the next preceding number and the difference between that number and the given value gives the number of the day in the Julian calendar. Thus for Nisan 1 in the first year of Sumuabum = −2168/7, we have Cycle Year −2203 with Day Number 9, Period 35 with Day Number under Nis. 0, 105 + Day of Month 1. Sum of Day Numbers 115, for which we get from Table N April 24. For the Julian date of Hammurabi 6, Šabat 28 − 2061/0, we have Cycle Year −2067, Period 6, with Day Numbers 5 + 26 + 28 = 59 = −2060 Feb. 28. It will be observed, however, that the tables give for Nisan 1 in the year −2061, April 11 = March 25 Gregorian, falling 30 days earlier than the date given by conjecture on p. 66. If we wish to adopt the beginning of the year as given on that page, we shall have to take Adar 28 instead of Sabat 28 from the table. We then have 5 + 55 + 28 = 88 = −2060 March 28.

Before – 382 Table M is constructed on the hypothesis that the intercalary month is always a second Adar. From that date onwards it was fixed by rule which years should have second Adar and which second Ulul. An asterisk is accordingly placed against each of the last five Cycle Years and an asterisk is also inserted in the column headed Adar b o in those years in which there was a second Ulul. Wherever an asterisk is found against the Cycle Year and also in this column, the name of the Babylonian months from Ulul b to Adar must be taken from the foot, not from the head of the column. Thus for – 274 Ulul b 25 we have Cycle Year – 295*, Day Number 4, Period 21*, Ulul b o (at foot), Day Number 988, Day of Month 25, sum 1017 = Oct. 13.

In the Period column the number 17 is printed in heavy type, because, if the intercalations are rightly restored, the Day Numbers to which this period serves as argument will when combined with the Day Numbers standing against the Cycle Year give the mean position of the Babylonian months in the Julian calendar, so long as the Day Number in the Cycle Table holds good. Thus, if it is desired to know the mean position of Nisan 1 from – 995 to – 928, we add the Day Numbers 3 + 824 + 1 and the sum 828 = April 7 is the mean date of Nisan 1 within that range of years.

Conversion of Julian into Babylonian Dates. The Cycle Year and Period are found as before. Find from Table N the Day Number corresponding to the Julian date. Deduct the Day Number corresponding to the Cycle Year. Seek the remainder in the period line. The vertical argument corresponding to the next smaller number gives the name of the month. Deduct this number, and the remainder is the day of the month. Thus for – 1477 June 1, we have Cycle – 1503, Period 26, Day Number 1248. Deduct the Cycle Number 9, and the remainder 1239 is Ayar 29 or Sivan o. The Day Number should always be selected so that when diminished by the Cycle Number it will be found against the period. If the date falls between December 31 Julian and the following Nisan 1, the Period Number will not be that corresponding to the actual Julian year, but to the preceding year in which the Babylonian year begins. Sometimes the Day Number of Table N is too small. In these cases add 1461 days.

Conversion of Julian into Gregorian Dates and vice versa. In accordance with astronomical usage the Julian calendar is used throughout these tables except for modern times. But for the benefit of readers who desire to connect each month with a fixed season of the year the Gregorian calendar has generally been used in the work itself. The difference between the two calendars remains constant for 100 or 200 years at a time. The accompanying table shows the correction in days to be applied to a Julian date to obtain the corresponding Gregorian date. This table indicates that from – 3700 March 1 to – 3500 February 29, a correction of – 29 days must be applied to a Julian date to obtain the Gregorian date. Similarly, from – 2700 March 1 to – 2600 February 29, a correction of – 22 days must be applied. To convert any Julian date in a year not shown in the table into a Gregorian date it is necessary to take the number of days standing in the table against the year coming next before the given date. Thus for 324 B.C. (= – 323) June 9 the next preceding year in the table is – 500, and the correction is – 5.

Year.	*d.*	*Year.*	*d.*	*Year.*	*d.*
– 3700	– 29	– 1900	– 16	– 200	– 3
3500	28	1800	15	– 100	2
3400	27	1700	14	+ 100	– 1
3300	26	1500	13	200	0
3100	25	1400	12	300	+ 1
3000	24	1300	11	500	2
2900	23	1100	10	600	3
2700	22	1000	9	700	4
2600	21	900	8	900	5
2500	20	700	7	1000	6
2300	19	600	6	1100	7
2200	18	500	5		
2100	17	300	4		

Therefore – 323 June 9 Julian = – 323 June 9 – 5 Gregorian = June 4 Gregorian. The correction changes on March 1 in years which are leap years in the Julian, but not in the Gregorian, calendar. In these years February 29 should not be included in the number of days added or subtracted. Thus – 1700 March 10 Julian, falling on or after March 1, requires a correction of – 14 days to reduce to the Gregorian calendar. The Gregorian date will be February 28 + 10 – 14 = February 24.

In order to convert from the Gregorian to the Julian calendar apply the given correction in the opposite direction. Thus – 323 June 9 Gregorian = – 323 June 9 + 5 Julian = June 14.

The Syzygy-Tables for the Planets

pp. [X]–[XIV]. These give from – 2100 (– 3000 for Venus) to the year 0 and for modern times the following general phenomena: conjunction, opposition, stationary points, greatest elongation, greatest brilliance of Venus, &c. They also give, but only for latitudes + 31·5° to + 33·5°, the heliacal risings and settings and the acronychal risings of the planets. The following nomenclature is used for heliacal phenomena:

e first = first } visibility in evening.
e last = last }

m first = first } visibility in morning.
m last = last }

These phenomena are computed approximately with an *arcus visionis* γ, shown in the following small table, based on ancient observations and my own observations.

Each planet is treated on a separate page. For all planets there are given a Cycle Table, a Period Table, and Table A. The Cycle and Period Tables, which give mean conjunction and mean opposition, are to be used in the same manner as the corresponding tables for new moon (pp. [I], [II]). Table A gives the transition from mean to true conjunction or opposition. The Babylonians gave also the zodiacal sign of the ecliptic in which such a phenomenon occurred. Accordingly the tables provide the means of computing the longitudes, λ, of Mars, Jupiter, and Saturn, but it should be noted that according to KUGLER the Babylonians from about – 300 to 0 placed the beginning of each sign about 4° earlier than the established usage would sanction, so that Aries extended along the ecliptic from 356° to 26°, Taurus from 26° to 56°, &c. The time used in these tables is Babylon mean time (Bb) in antiquity, Greenwich mean time (Gr) from + 1904 onwards.

Superior Conjunction	m last	e first
Mercury	9·5°	10·5°
Venus	6·0	6·0
Inferior Conjunction	e last	m first
Mercury	11·0	13·0
Venus	5·2	5·7
Conjunction	e last	m first
Mars	13·2	14·5
Jupiter	7·5	9·0
Saturn	10·0	13·0

MERCURY, p. [X]. Since the synodic period is 115·88 days, about three or four superior conjunctions and three or four inferior conjunctions occur in each year. The interval between superior and inferior conjunction is in the mean 58 days. At Babylon Mercury was visible to the naked eye between superior and inferior conjunction (i.e. from e first to e last) in the evening for an interval varying from about 42 days in spring (Adar to Ayar) to 15 days in autumn (Ulul to Araḫsamna). The possibility of the latter is denied by Ptolemy.[1] Between inferior and superior conjunction (i.e. from m first to m last) it was visible in the morning for an interval varying from about 36 days in autumn to 15 days in spring. Here the possibility of the spring visibility is denied by Ptolemy. In more northerly latitudes, e.g. with ϕ = 51°, it is difficult to see Mercury in the evening except in spring, and in the morning except in autumn

[1] *Math. Syn.*, ed. HEIBERG, ii. 602.

(1927 Nov. 28 it was visible about 70^m). The interval of invisibility at inferior conjunction at Babylon varies between 13 and 41 days.

Rough Computation. In −567 Ayar 10 e first is recorded. This falls near superior conjunction. Tables M, N, pp. [XV], [XVI], make Ayar agree roughly with May. Hence we have −567 May = −567·63 (fraction table, p. [I]). Take the next preceding Cycle, −577·44. The difference, 9·81, is the period. In the Period Table for superior conjunction the year 9·84 appears as a period for a superior conjunction. Hence the observation is correct. On −424 Kislev 25 m first is recorded. This falls near inferior conjunction. Tables M, N make Kislev agree roughly with December. For −424·05 we have Cycle −434·36, period 10·31 for inferior conjunction. Hence the observation is correct.

Accurate Computation. I select the year −424, fixed by KUGLER as the date of an ephemeris, by myself as that of an observation-tablet, full of heliacal events, of which we should have 24, were not 6 months' observations lost. Mercury is observed 6 times, and we may test by computation whether e last = Kislev 11, m first = Kislev 25 is correct. Both phenomena are near inferior conjunction. Take out from Cycle −434·36 and Period 10·31 for inferior conjunction the quantities I, T, L, and sum I. In all tables for the planets, if I exceeds 400, subtract 400. With I = 42 find in Table A under heading 'Inferior Conjunction' the values 5·2 for T, 7·7° for L and write them under the others. Then sum T and L (circumference 360°). On p. [XIV] Table N gives for T = 1806 the Julian date Dec. 10 for inferior conjunction, time 10^h a. The longitude ⊙ of the Sun at this moment is 254° (which is also the longitude λ of Mercury). With ⊙ = 254° enter Table C and find there for e last 8^d to subtract from the T of inferior conjunction (approximately 1806) and 6^d to add for m first. The result is 1798 = Dec. 2 for e last, 1812 = Dec. 16 for m first, according to Table N, p. [XIV]. We can directly convert the figures 1798 and 1812 into Babylonian dates by means of Table M, pp. [XV], [XVI], diminishing them by 1461, so that we have 337 for e last, 351 for m first. Table M gives the Cycle −447, Day Number 4, and the Period 23. The figures 337, 351, diminished by the Day Number 4, become 333, 347, and give in Period line 23 the Babylonian dates, Kislev 9 for e last[1], Kislev 23 for m first, one and two days respectively earlier than the observed date. m last and e first are computed in the same manner with the aid of Table B, using the first section of the Period Table headed 'Superior Conjunction'. For m last and e first the days shown in Table B with Arg. ⊙ must be applied to the T of superior conjunction. To show the use of Table D which gives the dates of greatest elongation and stationary points, both connected with inferior conjunction, I select the inferior conjunction

Example 6.	I.		T.	L.
Cycle −434·36	118		957·2	134·6°
Period 10·31	324		844·0	112·0
Year −424·05	42	Tab. A	5·2	7·7
Dec. 10^d 10^h a Bb.	Inferior conj.		1806·4	254 ⊙
Table C, Arg. ⊙			−8 +6	
Dec. 2, e last			1798 = Kislev 9	
Dec. 16, m first			1812 = Kislev 23	

Example 7.	I.		T.
Cycle 1924·20	307		65·9
Period 3·97	186		1448·5
Year 1928·17	93	Tab. A	2·4
Inf. conj. Feb. 24, 7^h p Gr			1516·8
Table D, gr. elongation			−16 ev. +27 mor.
Gr. elong., east, Feb. 9			1501
" " west, March 23			1544
Inf. conj.			1517
Table D, station.			−10 ev. +12 mor.
Stationary points Feb. 15			1507
Stationary points March 8			1529

[1] Kislev 10 in Babylonian phraseology, because the Babylonian day begins in the evening.

of 1928 Feb. 24, 3^h p Gr (*Nautical Almanac*). While in antiquity the error is only 2 hours, here in modern times it is 4 hours. The values from Table D are all taken with the Argument I = 93. The agreement with the *Nautical Almanac* is very good in each case. Finally I note that in the Cycle Table the well-known cycle of 13 years is used throughout. The luminosity of Mercury is very variable. It is at its greatest at superior conjunction. See *Planeten-Tafeln*, p. 12, from which the stellar magnitudes of all the planets are easily computed.

VENUS, p. [XI]. The synodic period of Venus is 583·921 days. Hence from superior to inferior conjunction the mean interval is 292 days, so that in each year there are usually one superior and one inferior conjunction. The 8-year period of Venus is well known. We have 8 Julian years = 2922^d, 5 synodic periods = $2919{\cdot}6^d$, or $2{\cdot}4^d$ less. But 8 Babylonian lunisolar years, including 3 intercalary months, are $2923{\cdot}5^d$, i. e. 4 days more than 5 synodic periods. From this it follows that in the Julian calendar the date of inferior conjunction recedes by 2·4 days in 8 years, while in the Babylonian calendar (with normal intercalation) it recedes 4 days in 8 years. For example, if in any year inferior conjunction is on May 31, 8 years later it will be on May 29 Julian. If in the former year it is on Ayar 21, it will in the latter be on Ayar 17. There are also the periods of 56, 64, and 120 years. If the last named has expired, the day of the Babylonian month is exactly the same, but the date has receded one month, as from Ayar 21 to Nisan 21.

Alternating cycles of 56 and 64 years have been selected in forming the Cycle Table, to show the similarity in the circumstances affecting heliacal phenomena as well as in those affecting the Babylonian month and day. The actual cycles shown in the Cycle Table have been selected so as to include the dates assigned on four solutions to the first year of Ammizaduga, viz. −1976, 1920, 1856, 1800.

The computation of the two phenomena connected with superior conjunction, viz. m last and e first, is very simple, Venus being invisible in the mean for 60 days at Babylon. For these computations it is sufficient to use one decimal place in T, and to take the sum of T in whole numbers, because in these cases the daily mean change in γ is 0·25° only. For inferior conjunction, i. e. for e last and m first, the conditions are quite different. Here the greatest accuracy is necessary. T must be taken to two decimal places, and the sum of T to one, so that the error in the time of inferior conjunction shall not exceed 3 hours. The interval of invisibility here depends only on the geocentric latitude β of Venus, which varies between +8·5° and −8·5°. The season (i. e. the Arg. ⊙) is of importance only for the distance of e last and m first from inferior conjunction. In the time of Ammizaduga (−1900) for the five different inferior conjunctions in each 8 years' period the intervals of invisibility at Babylon at the five different inferior conjunctions were: in Ayar about 11 days, in Tammuz 17 days, in Ulul 16 days, in Araḫsamna 3 days, in Adar 2 days. But these figures change even in 56 and 64 years through the motion of the node of Venus. So I have found that the observation in the sixth year of Ammizaduga: VIII 28/3/IX 1, a reading now confirmed by two copies of the text, is within the 3,000 years from −3000 to 0 possible only in January −1970 and −1914. See *Astronomische Nachrichten* (1924), 5306. At Babylon the stellar magnitude *m* at the heliacal phenomena is always about −3·2.

Computation at Superior Conjunction. Here the daily change in γ is small, and therefore it is not easy to deduce from m last and e first values of the *arcus visionis*. I choose the observation of the twelfth year of Ammizaduga (−1909): I 9/VI 25, or, freed from scribal errors:

II 29/V 5. The compiler or copyist has in the numbers of the months taken for m last one unit too little (I instead of II), and has added this quantity to the number of the month of e first (VI instead of V). By a similar error he has taken two tens too little in the number of the day for m last, and has added these to e first. Afterwards he has found the difference between the false dates of the two phenomena, an interval of invisibility of 5 months 16 days instead of the correct difference, 2 months 6 days. The observation, thus restored, is excellent and with Ammizaduga 5 the best at superior conjunction. Since Ammizaduga 12 begins with Nisan 1 = May 10 Julian, the two Julian dates correspond to Ayar 30 and Ab 6. And since Table B is computed with $\gamma = 6{\cdot}0°$, it is an easy matter to find the Babylonian γ of observation, adding or subtracting for each day 0·25°.

Example 8.		I.		T.	L.
Cycle	−1920·59	219		147·5	45·9°
Period	11·19	76		1165·5	68·8
Year	−1909·40	295	Tab. A	0·6	0·6
Sup. conj., Aug. 5, 2h p Bb				1313·6	115·3 ⊙
			Tab. B	−30	
			Arg. ⊙	+35	
Table N, p. [XIV] m last	July 7			1284	= Ayar 30
Table N, p. [XIV] e first	Sept. 10			1349	= Ab 6

Computation at Inferior Conjunction. Here the daily change in γ is great, sometimes as much as 2°, and the computation requires a corresponding degree of accuracy. If a tablet gives the interval of invisibility between e last and m first, the correct year can be quickly found. For example, in Ammizaduga 6, −1915/14 there is given the well-known interval of 3 days' invisibility. The season is about the end of December (end of Araḫsamna). In the accompanying small table there are shown for all five solutions the year Ammizaduga 6, the Period of the Period Table (for inferior conjunction), ⊙, and the interval of invisibility in days. For No. 2 the computation proceeds as follows: Take out the Cycle −1920·59 and the corresponding value of L in degrees, increased by 7°, here 53°. Add the L of the period 5·60, here 214°. The sum is ⊙ = 267°. The same procedure should be adopted with the other solutions. In Table C with Arg. ⊙ the first column shows approximately the necessary interval of invisibility in days. Only solutions 1 and 2 are possible, because in the other solutions the necessary interval is greater than the observed interval of 3 days. Hence only −1971 or −1915 can be Ammizaduga 6. The computation is not quite correct, because the secular variation of Table C has been neglected. As an example of accurate computation I select the inferior conjunction of Ammizaduga 16 = −1905, where the recorded dates are e last Tammuz 5, m first Tammuz 20. Tables M, N, pp. [XV], [XVI], give for Tammuz 1 in this year July 24. But the new moon occurred July 21, 8·4h p, whence Tammuz 1 = July 23 civil. See Crescent Tables. The computation gives e last July 26 = Tammuz 5 (not Tammuz 4, because in the evening Tammuz 5 had already begun); m first Aug. 13 = Tammuz 22. e last is in agreement with observation, but m first was observed two days earlier, γ being 4·3°, while my tables give the morning where $\gamma = 5{\cdot}7°$. $\gamma = 4{\cdot}3°$ is an exceptionally successful observation. For an accurate computation of γ see *Planeten-Tafeln*, xxxiv. It should be noted that in Table A we must regard the secular variation of T, which is given for units of 1,500 years reckoned from −1500. Thus for the year 0 we should have with Arg. I = 34 the variation −5, and for the year +1930 about −11. Both these are expressed in units of 0·01 of T. After finding the time T

No.	*Year.*	*Period.*	⊙	*Int.*
1	−1971·0	5·60	283°	2d
2	1915·0	5·60	267	3
3	1851·0	5·60	249	6
4	1803·0	53·56	236	7
5	1795·0	5·60	232	9

of inferior conjunction enter Table C with Arg. ⊙ = 116·3°. The table gives about 16·3 days as the interval of invisibility. This table also is constructed for the year −1500. Find by interpolation with Arg. ⊙ the values of T for e last and m first and add algebraically to them the small variation found in correction T under the headings −3000, −1500, 0. Write the sums under the T of inferior conjunction. The result is: e last (Table N, p. [XIV]) July 27d 2h p or July 26 evening; m first Aug. 12d 10h p or Aug. 13 morning. Observe that in Table C the T of m first is not always positive. If ⊙ is between 300° and 350°, it is negative, as also is e last, so that e last and m first both fall before inferior conjunction.

Example 9.			I.		T.	L.
Cycle	−1920·59		219		147·51	45·9°
Period	15·19		75		1164·26	67·6
Year	−1905·40		294	Tab. A	2·81	2·8
Inf. conj., Aug. 6d 2h p Bb					1314·6	116·3 ⊙
					−10·0	
	e last	m first			+6·3	
Table C	−9·9	+6·3		e last	1304·6	= July 27
Correct.	−0·1	0·0		m first	1320·9	= Aug. 12
	−10·0	+6·3				

To illustrate the use of Table D, I select the inferior conjunction of +1934 Feb. 5, which is very interesting. With ⊙ = 316° I find from Table C that Venus is invisible at Babylon one day only, but at places in 38° terrestrial latitude she does not disappear. At latitude 43° she is both morning and evening star for one day, at 48° for two days, and at 53° for three days, the m first lying considerably before inferior conjunction. The greatest brilliance occurs on the evening of 1933, December 31, with stellar magnitude $m = -4{\cdot}4$ (*Planeten-Tafeln* give $m = -4{\cdot}44$), so that Venus on that day should be easily visible in the middle of the day to an observer who knows her approximate place in the sky.

Example 10.		I.	T.	L.	
Cycle	1920·50	199	180·18	93·9°	
Period	13·59	235	580·33	212·1	
Year	1934·09	34	6·90	10·0	
		Var.	−11	316·0 ⊙	
Inf. conj., Feb. 5, 7h a Gr			767·3		
				Brill.	Station.
Table D, Arg. I, gr. elong.			−72		
			+70	767	767
Gr. elong. east, ev. Nov. 25			695	−36	−21
„ „ west, mor. Apr. 16			837	+35	+19
Greatest brilliance, Dec. 31				ev. 731	746 ev.
„ „ March 12				mor. 802	786 mor.
Stationary points Jan. 15					
Stationary points Feb. 24					

MARS, p. [XII]. The cycles used in the Cycle Table are of 47 and 79 years, so as to keep the value of I in this table as close as possible to 0. The construction of Tables A and C was rendered extremely difficult by the great eccentricity of the planet's orbit and its proximity to the Earth at opposition. For these reasons and because of the length of the synodic period (779·94 days = $2\frac{1}{7}$ years) it can be understood that the Babylonians took little notice of the heliacal phenomena of this planet and that the dates given for these phenomena in their ephemerides can be affected by large errors. As Table C shows in the column headed 'Interval', Mars can be invisible from e last to m first about 210 days at Babylon, while in our northern latitudes this interval can exceed 300 days. Now the γ of Mars changes sometimes by only 0·05° daily, so that Table C can give only a good approximation for e last and m first at Babylon. For all three outer planets the conjunction must be computed with Period Table and Table A if e last and m first are required, while the opposition must be computed with the same tables if the stationary points (Table B) are required. One of the stationary points (a) lies before opposition, the other (b) after opposition. Between a and b the planet is retrograde. At conjunction the Sun has the same longitude as the planet. Hence λ = ⊙. At opposition λ = ⊙ ± 180°. To find in which sign of the zodiac e last or m first occurs apply to λ of conjunction the number of degrees shown in Table C. For the longitude of the stationary points, Table B gives the correction to be applied to longitude of opposition, positive for point a and negative for point b.

Example 11.		I.		T.	L.
Cycle	−459·45	4		543·4	90·4
Period	35·23	293		1181·0	84·2
Year	−424·22	297	Tab. A	8·4	4·9
Conjunction, Sept. 27, 7^h p				1732·8	179·5 ⊙, λ
Table C, Arg. ⊙				−66	−44
				+49	+37
Tammuz 25, e last				1667	136° = Leo
Araḫsamna 22, m first				1782	217° = Scorpius

Artaxerxes 40, −424, e last observed on Tammuz 22, m first on Araḫsamna 18. Computation gives Tammuz 25 and Araḫsamna 22. The latter date is received as follows: The Day Number is 1782 − 1461 = 321. Table M, p. [XV], gives Cycle −447 with Day Number 4, and Period 23.

321 minus Day Number of Cycle is 317, which gives in period-line 23, Araḫsamna 22.

Cambyses 7, −522, e last observed on Ayar 28; computation gives Sivan 4.

In the Period Table for opposition there is a column which gives the stellar magnitude *m* for the moment of opposition, here −1·5. Mars reaches *m* = −2·8 at the oppositions of 1924 and 2003 only. The last column gives a very rough value of the geocentric latitude β at opposition. *m* in the Period Table for conjunction is the stellar magnitude at e last and m first for Babylon.

Example 12. Mars opposition 1928 Dec. 21^d 2^h p Gr		I.	T.	L.
Cycle	1924·64	395	209·2	126·2°
Period	4·27	108	98·9	97·5
Year	1928·91	103	48·3	45·3
			356·4	269·0 ⊙
Table B, Arg. I			−39	89·0 λ
			+37	+2° β
Stationary point a, 1928 Nov. 12			317	−1·5 *m*
„ „ b, 1929 Jan. 27			393	
So also *Nautical Almanac.*				

JUPITER, p. [XIII]. Cycles of 83 and 12 years are used so as to keep the value of I in the Cycle Table close to 0. To avoid errors of one day the great long-period inequality is included in the Cycle Tables of Jupiter and Saturn. Since the synodic period is 398·88 days all phenomena occur about 34 days later each year than in the preceding year of the Julian calendar, or in the absence of an intercalary month 45 days later than in the preceding year of the Babylonian calendar. Thus, if in any year e last falls on Nisan 1, it will fall in the next year about Ayar 17. The interval of invisibility at conjunction between e last and m first is for Babylon 28 to 34 days. See Table C. The acronychal rising lies about three days before opposition. In the example of −386 the Babylonians give the acronychal rising correctly, but, as might be expected, their stationary points are very inaccurate. The stellar magnitude at the moment of opposition is *m* = −2·4. The geocentric longitude λ at opposition is 328·5°, that of stationary point a = 333·5° (Pisces), that of stationary point b = 323·5° (Aquarius). Here the Babylonian dates are converted roughly (error one day) by Table M, p. [XV]. For the accurate date compute the crescent.

Example 13. −386 opposition, stationary points.		I.	T.	L.
Cycle	−445·32	3	1337·5	152·4°
Period	58·97	389	1085·7	350·6
Year	−386·35	392	8·5	5·5
Opposition, Aug. 27, 5^h p Bb			2431·7	148·5 ⊙
Table B, stationary points			−59	328·5 λ
			+59	+5·0
				−5·0
Station a, June 29 = Sivan 30			2372	333·5° a
„ b, Oct. 25 = Tešrit 29			2490	323·5 b
Acron. rising = 2429 = Aug. 25, Ab 27.				

In the example of −424 the e last was observed on Kislev 7. The longitude λ of e last is about 257°, that of m first 263°, both in Sagittarius.

In the example of 1928 the *Nautical Almanac* gives the same dates. For modern times the heliacal phenomena also can be computed for Babylon, but the results, except in the case of Venus, will not be accurate, because for these phenomena the Tables are only correct from −2000 to the year 0.

Example 14. −424 conjunction, e last, m first.		I.	T.	L.
Cycle	−445·32	3	1337·5	152·4°
Period	21·30	318	473·2	106·6
Year	−424·02	321	0·9	0·6
Conjunction, Dec. 15^d 2^h p			1811·6	259·6 ⊙, λ
Table C			−14	−3
			+14	+3
e last, Dec. 1 = Kislev 8			1797	257°
m first, Dec. 30 = Tebet 7			1826	263°

Modern time, 1928 opposition.		I.	T.
Cycle	1904·79	12	282·5
Period	24·03	10	9·4
Year	1928·82	22	11·0
Opposition, Oct. 28^d 10^h p Gr			302·9
Stat. points, Aug. 30, Dec. 26.			

SATURN, p. [XIV]. Cycles of 59 and 58 years are used. Since the synodic period is 378·09 days all phenomena recur about 13 days later in the Julian and about 24 days later in the Babylonian calendar than in the previous year. We have few Babylonian observations of Saturn, but more than of Mars. Invisibility at conjunction lasts at Babylon from 31 to 45 days. See Table C. The stellar magnitude at opposition varies greatly.

Example 15. −134 e last, m first.		I.	T.	L.
Cycle	−178·12	1	1042·5	224·6°
Period	43·99	197	1458·9	358·3
Year	−134·13	198	10·9	8·2
Conjunction, Nov. 16^d 7^h a			2512·3	231·1 ⊙, λ
			−17	−2
			+15	+3
e last, Tešrit 29			2495	229° e last
m first, Kislev 3			2527	234° m first

For −134 the Babylonians give e last Araḫsamna 4, m first Kislev 4. They could see the planet 4 days longer in the evening than the tables imply. But the adopted value of γ = 10·0° agrees well with other observations.

Note. Where the greatest accuracy is required, compute the crescent and determine the Babylonian day as beginning at sunset. Then, except for e last, m first of Venus, where these tables are sufficient, make the computation for the heliacal phenomena of the planets with the help of the *Planeten-Tafeln*, xxxiv, where several examples are given. These tables can be used without any knowledge of astronomy.

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TABLES

CYCLE TABLE.

Day of Month		Fraction of Year: Positive Years	Fraction of Year: Negative Years
Jan.	1– 2	0·00	1·00
	3– 6	0·01	0·99
	7–10	0·02	0·98
	11–13	0·03	0·97
	14–17	0·04	0·96
	18–21	0·05	0·95
	22–24	0·06	0·94
	25–28	0·07	0·93
	29– 1	0·08	0·92
Febr.	2– 4	0·09	0·91
	5– 8	0·10	0·90
	9–11	0·11	0·89
	12–15	0·12	0·88
	16–19	0·13	0·87
	20–22	0·14	0·86
	23–26	0·15	0·85
	27– 2	0·16	0·84
March	3– 5	0·17	0·83
	6– 9	0·18	0·82
	10–13	0·19	0·81
	14–16	0·20	0·80
	17–20	0·21	0·79
	21–24	0·22	0·78
	25–27	0·23	0·77
	28–31	0·24	0·76
April	1– 4	0·25	0·75
	5– 7	0·26	0·74
	8–11	0·27	0·73
	12–15	0·28	0·72
	16–18	0·29	0·71
	19–22	0·30	0·70
	23–26	0·31	0·69
	27–29	0·32	0·68
	30– 3	0·33	0·67
May	4– 7	0·34	0·66
	8–10	0·35	0·65
	11–14	0·36	0·64
	15–17	0·37	0·63
	18–21	0·38	0·62
	22–25	0·39	0·61
	26–28	0·40	0·60
	29– 1	0·41	0·59
June	2– 5	0·42	0·58
	6– 8	0·43	0·57
	9–12	0·44	0·56
	13–16	0·45	0·55
	17–19	0·46	0·54
	20–23	0·47	0·53
	24–27	0·48	0·52
	28–30	0·49	0·51
July	1– 4	0·50	0·50
	5– 8	0·51	0·49
	9–11	0·52	0·48
	12–15	0·53	0·47
	16–19	0·54	0·46
	20–22	0·55	0·45
	23–26	0·56	0·44
	27–30	0·57	0·43
	31– 2	0·58	0·42
Aug.	3– 6	0·59	0·41
	7– 9	0·60	0·40
	10–13	0·61	0·39
	14–17	0·62	0·38
	18–20	0·63	0·37
	21–24	0·64	0·36
	25–28	0·65	0·35
	29–31	0·66	0·34
Sept.	1– 4	0·67	0·33
	5– 8	0·68	0·32
	9–11	0·69	0·31
	12–15	0·70	0·30
	16–19	0·71	0·29
	20–22	0·72	0·28
	23–26	0·73	0·27
	27–30	0·74	0·26
Oct.	1– 3	0·75	0·25
	4– 7	0·76	0·24
	8–11	0·77	0·23
	12–14	0·78	0·22
	15–18	0·79	0·21
	19–22	0·80	0·20
	23–25	0·81	0·19
	26–29	0·82	0·18
	30– 1	0·83	0·17
Nov.	2– 5	0·84	0·16
	6– 9	0·85	0·15
	10–12	0·86	0·14
	13–16	0·87	0·13
	17–20	0·88	0·12
	21–23	0·89	0·11
	24–27	0·90	0·10
	28– 1	0·91	0·09
Dec.	2– 4	0·92	0·08
	5– 8	0·93	0·07
	9–12	0·94	0·06
	13–15	0·95	0·05
	16–19	0·96	0·04
	20–23	0·97	0·03
	24–26	0·98	0·02
	27–30	0·99	0·01
	31	1·00	0·00

Babylon

Year	I	II	T	L	θ
−3507·50	440	679	549·730	73·28	286·5
−3478·55	113	623	894·687	53·48	126·4
−3449·61	785	567	1239·644	33·67	326·3
−3420·67	458	510	123·601	13·87	166·2
−3391·72	131	454	468·558	354·07	6·1
−3373·69	122	483	1209·883	4·88	354·8
−3344·74	795	427	93·839	345·08	194·7
−3315·80	468	370	438·796	325·28	34·6
−3286·85	140	314	783·753	305·46	234·5
−3257·91	813	258	1128·710	285·66	74·4
−3228·96	486	201	12·666	265·86	274·3
−3210·93	477	230	753·991	276·65	263·0
−3181·98	150	174	1098·948	256·86	102·9
−3153·04	823	118	1443·904	237·05	302·8
−3124·10	496	61	327·861	217·25	142·7
−3095·15	168	5	672·817	197·45	342·6
−3066·21	841	949	1017·774	177·65	182·4
−3048·18	832	978	298·098	188·45	171·2
−3019·23	505	921	643·055	168·65	11·1
−2990·29	178	865	988·011	148·85	210·9
−2961·35	850	809	1332·968	129·05	50·8
−2932·40	523	752	216·924	109·25	250·7
−2903·46	196	696	561·880	89·45	90·6
−2885·43	187	725	1303·205	100·24	79·3
−2856·49	860	669	187·161	80·44	279·2
−2827·54	533	612	532·117	60·64	119·1
−2798·60	206	556	877·073	40·84	319·0
−2769·65	878	500	1222·030	21·04	158·8
−2740·71	551	443	105·986	1·25	358·7
−2711·77	224	387	450·942	341·45	198·6
−2693·74	215	416	1192·266	352·24	187·4
−2664·79	888	360	76·222	332·44	27·3
−2635·85	561	303	421·178	312·64	227·1
−2606·90	234	247	766·134	292·84	67·0
−2577·96	907	191	1111·090	273·05	266·9
−2549·02	579	134	1456·046	253·25	106·7
−2520·07	252	78	340·002	233·45	306·6
−2491·13	925	22	684·958	213·65	146·5
−2462·18	598	965	1029·913	193·85	346·4
−2433·24	270	909	1374·869	174·05	186·2
−2404·30	943	853	258·825	154·25	26·1
−2375·35	616	796	603·780	134·46	226·0
−2346·41	289	740	948·736	114·66	65·9
−2317·46	962	683	1293·692	94·86	265·7
−2288·52	634	627	177·647	75·06	105·6
−2270·49	626	656	918·971	85·86	94·4
−2241·54	299	600	1263·927	66·06	294·2
−2212·60	972	544	147·882	46·26	134·1
−2183·66	645	487	492·838	26·46	334·0
−2154·71	318	431	837·793	6·67	173·9
−2125·77	990	374	1182·749	346·87	13·7
−2107·74	982	404	463·073	357·67	2·5
−2078·79	655	347	808·028	337·87	202·4
−2049·85	328	291	1152·983	318·08	42·2
−2020·90	1	235	36·939	298·28	242·1
−1991·96	673	178	381·894	278·48	82·0
−1963·02	346	122	726·849	258·69	281·8
−1934·07	19	65	1071·804	238·89	121·7
−1916·04	11	95	352·128	249·68	110·5
−1887·10	684	38	697·083	229·89	310·3
−1858·15	357	982	1042·039	210·09	150·2
−1829·21	30	926	1386·994	190·29	350·1
−1800·26	702	869	270·949	170·50	189·9
−1771·32	375	813	615·904	150·70	29·8
−1753·29	367	842	1357·227	161·50	18·5
−1724·34	40	786	241·182	141·71	218·4
−1695·40	713	729	586·137	121·91	58·3
−1666·46	386	673	931·092	102·11	258·1
−1637·51	59	617	1276·047	82·32	98·0
−1608·57	735	560	160·002	62·52	297·9
−1590·54	723	589	901·325	73·32	286·6
−1561·59	396	533	1246·280	53·53	126·5
−1532·65	69	477	130·235	33·73	326·3
−1503·70	742	420	475·189	13·93	166·2
−1474·76	415	364	820·144	354·14	6·1
−1445·82	88	308	1165·099	334·34	205·9
−1416·87	761	251	49·053	314·55	45·8
−1398·84	753	280	790·377	325·34	34·6
−1369·90	420	224	1135·331	305·55	234·4
−1340·95	99	168	19·286	285·75	74·3
−1312·01	772	111	364·240	265·96	274·1
−1283·06	445	55	709·195	246·16	114·0
−1254·12	118	999	1054·149	226·37	313·9
−1225·17	791	942	1399·103	206·57	153·7
−1207·14	782	972	679·427	217·37	142·5
−1178·20	455	915	1024·381	97·58	342·3
−1149·26	128	859	1369·335	177·78	182·2
−1120·31	801	802	253·290	157·99	22·1
−1091·37	474	746	598·244	138·19	221·9
−1062·42	147	690	943·198	118·40	61·8

Midnight

Year	I	II	T	L	θ
−1033·48	821	633	1288·152	98·61	261·6
−1015·45	812	663	568·475	109·41	250·4
− 986·50	485	606	913·429	89·61	90·2
− 957·56	158	550	1258·383	69·82	290·1
− 928·62	831	494	142·337	50·02	130·0
− 899·67	504	437	487·291	30·23	329·8
− 870·73	177	381	832·245	10·44	169·7
− 841·78	850	325	1177·199	350·64	9·6
− 823·75	842	354	457·522	1·44	358·3
− 794·81	515	297	802·476	341·65	198·1
− 765·86	188	241	1147·430	321·86	38·0
− 736·92	861	185	31·384	302·06	237·8
− 707·97	534	128	376·338	282·27	77·7
− 679·03	208	72	721·291	262·48	277·5
− 650·09	881	16	1066·245	242·69	117·4
− 632·06	873	45	346·568	253·49	106·1
− 603·11	546	988	691·522	233·70	306·0
− 574·17	219	932	1036·475	213·90	145·9
− 545·22	892	876	1381·428	194·11	345·7
− 516·28	565	819	265·382	174·32	185·6
− 487·33	238	763	610·335	154·52	25·4
− 458·39	911	707	955·289	134·73	225·3
− 440·36	903	736	235·612	145·53	214·0
− 411·42	576	679	580·565	125·74	53·9
− 382·47	249	623	925·519	105·95	253·7
− 353·53	922	567	1270·472	86·15	93·6
− 324·58	595	510	154·425	66·36	293·4
− 295·64	268	454	499·378	46·57	133·3
− 266·69	942	398	844·331	26·78	333·1
− 237·75	615	341	1189·284	6·99	173·0
− 219·72	607	371	469·607	17·79	161·7
− 190·77	280	314	814·560	358·00	1·6
− 161·83	953	258	1159·514	338·20	201·4
− 132·89	626	202	43·467	318·41	41·3
− 103·94	299	145	388·420	298·62	241·1
− 75·00	972	89	733·372	278·83	80·9
− 46·05	645	32	1078·325	259·04	280·8
− 17·11	318	976	1423·278	239·25	120·6
1·92	311	5	703·601	250·05	109·4
30·87	984	949	1048·553	230·26	309·2
59·81	657	893	1393·506	210·47	149·1
88·75	330	836	277·459	190·68	348·9
117·70	3	780	622·412	170·89	188·8
146·64	677	723	967·365	151·10	28·6
175·59	350	667	1312·317	131·31	228·5
204·53	23	611	196·270	111·52	68·3
233·48	696	554	541·222	91·73	268·2
251·51	688	584	1282·645	102·53	256·9
280·45	361	527	166·497	82·74	96·7
309·40	35	471	511·450	62·95	296·6
338·34	708	415	856·402	43·16	136·4
367·28	381	358	1201·355	23·37	336·3
396·23	54	302	85·307	3·58	176·1
425·17	728	246	430·259	343·79	15·9
454·12	401	189	775·212	324·00	215·8
473·15	393	218	55·534	334·80	204·5
501·09	66	162	400·486	315·01	44·4
530·04	739	106	745·438	295·22	244·2
558·98	413	49	1090·391	275·44	84·0
587·92	86	993	1435·343	255·65	283·9
616·87	759	937	319·295	235·86	123·7
645·81	432	880	664·247	216·07	323·6
674·76	106	824	1009·199	196·28	163·4
703·70	779	768	1354·151	176·49	3·2
732·65	452	711	238·103	156·70	203·1
750·68	444	741	979·425	167·50	191·8
779·62	118	684	1324·377	147·72	31·7
808·57	791	628	208·329	127·93	231·5
837·51	464	571	553·281	108·14	71·3
866·45	137	515	898·233	88·35	271·2
895·40	811	459	1243·184	68·56	111·0
924·34	484	402	127·136	48·78	310·8
953·29	157	346	472·088	28·99	150·7
982·23	831	290	817·039	9·20	350·5
1000·26	823	319	97·361	20·00	330·2
1029·21	496	263	442·313	0·22	179·1
1058·15	170	206	787·265	340·43	18·9
1087·10	843	150	1132·216	320·64	218·8
1116·04	516	94	16·168	300·85	58·6
1144·98	190	37	361·119	281·07	258·4
1173·93	863	981	706·070	261·28	98·3
1202·87	536	925	1051·022	241·49	298·1
1231·82	210	868	1395·973	221·70	137·9
1260·76	883	812	279·924	201·92	337·8
Greenwich Midnight					
1904·69	10	687	253·413	168·02	191·6
1933·63	683	631	598·363	148·23	31·4
1962·58	356	574	943·313	128·45	231·3
1991·52	30	518	1288·263	108·66	71·1

PERIOD TABLE FOR NEW MOON.

Year	I	II	T	L	θ	dT
0·00	0	0	0·000	0·00	0·0	+2
0·08	72	81	29·540	29·12	1·6	+1
0·16	143	152	59·070	58·22	3·1	+2
0·24	215	243	88·591	87·32	4·7	+2
0·32	287	323	118·113	116·42	6·3	+2
0·40	359	404	147·645	145·53	7·8	+1
0·49	430	485	177·185	174·64	9·4	+2
0·57	502	566	206·724	203·76	10·9	+2
0·65	574	647	236·253	232·86	12·5	+1
0·73	645	728	265·773	261·96	14·1	+2
0·81	717	808	295·296	291·06	15·6	+2
0·89	789	889	324·829	320·17	17·2	+2
0·97	861	970	354·370	349·28	18·8	+2
1·05	932	51	383·908	18·40	20·3	+2
1·13	4	132	413·435	47·50	21·9	+2
1·21	76	213	442·955	76·60	23·5	+2
1·29	147	294	472·479	105·70	25·0	+2
1·37	219	374	502·014	134·81	26·6	+2
1·46	291	455	531·555	163·93	28·1	+2
1·54	363	536	561·092	193·04	29·7	+1
1·62	434	617	590·617	222·14	31·3	+2
1·70	506	698	620·138	251·24	32·8	+1
1·78	578	779	649·663	280·34	34·4	+1
1·86	649	860	679·199	309·45	36·0	+1
1·94	721	940	708·740	338·57	37·5	+1
2·02	793	21	738·275	7·68	39·1	+2
2·10	865	102	767·800	36·78	40·7	+1
2·18	936	183	797·320	65·88	42·2	+1
2·26	8	264	826·840	94·98	43·8	+2
2·34	80	345	856·384	124·09	45·4	+1
2·43	151	425	885·923	153·21	46·9	+1
2·51	223	506	915·459	182·32	48·5	+1
2·59	295	587	944·982	211·42	50·0	+1
2·67	367	668	974·502	240·52	51·6	+2
2·75	438	749	1004·030	269·62	53·2	+2
2·83	510	830	1033·569	298·73	54·7	+1
2·91	582	911	1063·109	327·85	56·3	+2
2·99	653	991	1092·642	356·96	57·9	+1
3·07	725	72	1122·164	26·06	59·4	+2
3·15	797	153	1151·685	55·16	61·0	+1
3·23	868	234	1181·214	84·26	62·6	+2
3·31	940	315	1210·754	113·38	64·1	+1
3·40	12	396	1240·294	142·49	65·7	+1
3·48	84	476	1269·825	171·60	67·2	+1
3·56	155	557	1299·346	200·70	68·8	+2
3·64	227	638	1328·868	229·80	70·4	+1
3·72	299	719	1358·399	258·90	71·9	+1
3·80	370	800	1387·938	288·02	73·5	+2
3·88	442	881	1417·478	317·13	75·1	+1
3·96	514	962	1447·008	346·24	76·6	+1
4·04	586	42	15·528	15·34	78·2	+2
4·12	657	123	45·051	44·44	79·8	+1
4·20	729	204	74·583	73·54	81·3	+1
4·29	801	285	104·124	102·66	82·9	+1
4·37	872	366	133·662	131·77	84·4	+1
4·45	944	447	163·190	160·88	86·0	+2
4·53	16	528	192·711	189·98	87·6	+1
4·61	88	608	222·234	219·07	89·1	+1
4·69	159	689	251·768	248·18	90·7	+1
4·77	231	770	281·309	277·30	92·3	+1
4·85	303	851	310·840	306·42	93·8	+1
4·93	374	932	340·373	335·52	95·4	+1
5·01	446	13	369·893	4·61	97·0	+1
5·09	518	93	399·417	33·72	98·5	+1
5·17	590	174	428·952	62·83	100·1	+1
5·26	661	255	458·493	91·94	101·6	+1
5·34	733	336	488·030	121·06	103·2	+1
5·42	805	417	517·555	150·16	104·8	+1
5·50	876	498	547·075	179·25	106·3	+1
5·58	948	579	576·601	208·36	107·9	+1
5·66	20	659	606·137	237·47	109·5	+1
5·74	92	740	635·678	266·59	111·0	+1
5·82	163	821	665·213	295·70	112·6	+1
5·90	235	902	694·737	324·80	114·2	+1
5·98	307	983	724·258	353·89	115·7	+1

Year	I	II	T	L	θ	dT
6·06	378	64	753·785	23·00	117·3	+1
6·14	450	144	783·322	52·11	118·9	+1
6·23	522	225	812·863	81·23	120·4	+1
6·31	594	306	842·396	110·34	122·0	+1
6·39	665	387	871·920	139·44	123·5	+1
6·47	737	468	901·440	168·53	125·1	+1
6·55	809	549	930·968	197·63	126·7	+1
6·63	880	630	960·507	226·75	128·2	+1
6·71	952	710	990·048	255·87	129·8	+1
6·79	24	791	1019·580	284·98	131·4	+1
6·87	96	872	1049·102	314·07	132·9	+1
6·95	167	953	1078·623	343·17	134·5	+1
7·03	239	34	1108·153	12·28	136·1	+1
7·11	311	115	1137·692	41·39	137·6	+1
7·20	382	195	1167·232	70·51	139·2	+1
7·28	454	276	1196·763	99·62	140·7	+1
7·36	526	357	1226·284	128·71	142·3	+1
7·44	598	438	1255·806	157·81	143·9	+1
7·52	669	519	1285·337	186·92	145·4	+1
7·60	741	600	1314·877	216·04	147·0	+1
7·68	813	681	1344·416	245·15	148·6	+1
7·76	884	761	1373·945	274·26	150·1	+1
7·84	956	842	1403·466	303·35	151·7	+1
7·92	28	923	1432·989	332·45	153·3	0
8·00	100	4	1·521	1·56	154·8	+1
8·09	171	85	31·062	30·68	156·4	+1
8·17	243	166	60·600	59·79	157·9	+1
8·25	315	247	90·128	88·90	159·5	+1
8·33	386	327	119·648	117·99	161·1	+1
8·41	458	408	149·172	147·09	162·6	0
8·49	530	489	178·706	176·20	164·2	+1
8·57	602	570	208·247	205·32	165·8	+1
8·65	673	651	237·784	234·43	167·3	+1
8·73	745	732	267·310	263·53	168·9	+1
8·81	817	812	296·830	292·63	170·5	+1
8·89	888	893	326·355	321·73	172·0	+1
8·97	960	974	355·891	350·84	173·6	0
9·06	32	55	385·432	19·96	175·2	+1
9·14	104	136	414·968	49·07	176·7	0
9·22	175	217	444·493	78·17	178·3	0
9·30	247	298	474·013	107·27	179·8	0
9·38	319	378	503·539	136·37	181·4	+1
9·46	390	459	533·076	165·48	183·0	0
9·54	462	540	562·617	194·60	184·5	0
9·62	534	621	592·151	223·71	186·1	+1
9·70	605	702	621·675	252·81	187·7	0
9·78	677	783	651·195	281·91	189·2	+1
9·86	749	863	680·728	311·01	190·8	0
9·94	821	944	710·261	340·13	192·4	0
10·03	892	25	739·801	9·24	193·9	+1
10·11	964	106	769·334	38·35	195·5	+1
10·19	36	187	798·857	67·45	197·0	+1
10·27	107	268	828·378	96·55	198·6	0
10·35	179	349	857·907	125·65	200·2	0
10·43	251	429	887·446	154·77	201·7	0
10·51	323	510	916·986	183·89	203·3	0
10·59	394	591	946·518	212·99	204·9	0
10·67	466	672	976·039	242·09	206·4	0
10·75	538	753	1005·560	271·19	208·0	+1
10·83	609	834	1035·091	300·30	209·6	0
10·91	681	915	1064·631	329·41	211·1	0
11·00	753	995	1094·170	358·53	212·7	0
11·08	825	76	1123·700	27·63	214·2	+1
11·16	896	157	1153·221	56·73	215·8	+1
11·24	968	238	1182·743	85·83	217·4	0
11·32	40	319	1212·275	114·94	218·9	0
11·40	111	400	1241·816	144·05	220·5	0
11·48	183	480	1271·354	173·17	222·1	0
11·56	255	561	1300·883	202·27	223·6	0
11·64	327	642	1330·404	231·37	225·2	0
11·72	398	723	1359·926	260·47	226·8	0
11·80	470	804	1389·460	289·58	228·3	0
11·89	542	885	1419·001	318·70	229·9	0
11·97	613	966	1448·538	347·81	231·4	0
12·05	685	46	17·066	16·91	233·0	0

Year	I	II	T	L	θ	dT
12·13	757	127	46·586	46·01	234·6	0
12·21	829	208	76·110	75·11	236·1	0
12·29	900	289	105·645	104·22	237·7	0
12·37	972	370	135·186	133·34	239·3	0
12·45	44	451	164·722	162·45	240·8	0
12·53	115	531	194·248	191·55	242·4	0
12·61	187	612	223·768	220·65	244·0	0
12·69	259	693	253·293	249·75	245·5	0
12·77	331	774	282·829	278·86	247·1	0
12·86	402	855	312·371	307·98	248·7	0
12·94	474	936	341·906	337·09	250·2	0
13·02	546	17	371·430	6·19	251·8	0
13·10	617	97	400·950	35·29	253·3	0
13·18	689	178	430·477	64·39	254·9	0
13·26	761	259	460·014	93·50	256·5	0
13·34	833	340	489·555	122·62	258·0	0
13·42	904	421	519·089	151·73	259·6	0
13·50	976	502	548·612	180·83	261·2	0
13·58	48	583	578·133	209·93	262·7	0
13·66	119	663	607·661	239·03	264·3	0
13·74	191	744	637·199	268·14	265·9	0
13·83	263	825	666·740	297·26	267·4	0
13·91	335	906	696·272	326·37	269·0	0
13·99	406	987	725·795	355·47	270·5	0
14·07	478	68	755·315	24·57	272·1	0
14·15	550	148	784·845	53·67	273·7	0
14·23	621	229	814·384	82·79	275·2	0
14·31	693	310	843·924	111·90	276·8	0
14·39	765	391	873·455	141·01	278·4	0
14·47	837	472	902·977	170·11	279·9	0
14·55	908	553	932·498	199·21	281·5	0
14·63	980	634	962·029	228·31	283·1	0
14·71	52	714	991·569	257·43	284·6	0
14·80	123	795	1021·109	286·54	286·2	0
14·88	195	876	1050·638	315·65	287·7	0
14·96	267	957	1080·159	344·75	289·3	0
15·04	339	38	1109·681	13·85	290·9	0
15·12	410	119	1139·214	42·95	292·4	0
15·20	482	199	1168·754	72·07	294·0	0
15·28	554	280	1198·293	101·19	295·6	0
15·36	625	361	1227·821	130·29	297·1	0
15·44	697	442	1257·341	159·39	298·7	0
15·52	769	523	1286·884	188·49	300·3	0
15·60	841	604	1316·398	217·60	301·8	0
15·68	912	685	1345·939	246·71	303·4	0
15·77	984	765	1375·476	275·83	304·9	0
15·85	56	846	1405·003	304·93	306·5	0
15·93	127	927	1434·523	334·03	308·1	0
16·01	199	8	3·048	3·13	309·6	0
16·09	271	89	32·583	32·24	311·2	0
16·17	342	170	62·124	61·35	312·8	0
16·25	414	250	91·660	90·47	314·3	0
16·33	486	331	121·185	119·57	315·9	0
16·41	558	412	150·705	148·66	317·5	0
16·49	629	493	180·231	177·77	319·0	0
16·57	701	574	209·768	206·88	320·6	0
16·66	773	655	239·309	236·00	322·2	0
16·74	844	736	268·844	265·11	323·7	0
16·82	916	816	298·368	294·21	325·3	0
16·90	988	897	327·888	323·30	326·8	0
16·98	60	978	357·415	352·41	328·4	0
17·06	131	59	386·953	21·52	330·0	0
17·14	203	140	416·494	50·64	331·5	0
17·22	275	221	446·027	79·75	333·1	0
17·30	346	302	475·550	108·85	334·7	0
17·38	418	382	505·070	137·94	336·2	0
17·46	490	463	534·590	167·05	337·8	0
17·54	562	544	564·138	196·16	339·4	0
17·63	633	625	593·678	225·28	340·9	0
17·71	705	706	623·210	254·39	342·5	0
17·79	777	787	652·732	283·49	344·0	0
17·87	848	867	682·253	312·58	345·6	0
17·95	920	948	711·783	341·69	347·2	0
18·03	992	29	741·323	10·80	348·7	0
18·11	64	110	770·863	39·92	350·3	0

Year	I	II	T	L	θ	dT
18·19	135	191	800·393	69·03	351·9	0
18·27	207	272	829·914	98·12	353·4	0
18·35	279	353	859·436	127·22	355·0	0
18·43	350	433	888·967	156·33	356·6	0
18·51	422	514	918·506	185·45	358·1	0
18·60	494	595	948·047	214·56	359·7	−1
18·68	566	676	977·576	243·67	1·2	−1
18·76	637	757	1007·096	272·76	2·8	0
18·84	709	838	1036·619	301·86	4·4	0
18·92	781	918	1066·152	330·97	5·9	0
19·00	852	999	1095·693	0·09	7·5	0
19·08	924	80	1125·231	29·20	9·1	−1
19·16	996	161	1154·758	58·31	10·6	0
19·24	68	242	1184·278	87·40	12·2	0
19·32	139	323	1213·802	116·50	13·8	0
19·40	211	404	1243·337	145·61	15·3	−1
19·48	283	484	1272·878	174·73	16·9	−1
19·57	354	565	1302·415	203·84	18·4	−1
19·65	426	646	1331·941	232·93	20·0	−1
19·73	498	727	1361·461	262·04	21·6	−1
19·81	570	808	1390·986	291·14	23·1	−1
19·89	641	889	1420·521	320·25	24·7	0
19·97	713	970	1450·063	349·37	26·3	−1
20·05	785	50	18·598	18·48	27·8	0
20·13	856	131	48·123	47·58	29·4	−1
20·21	928	212	77·643	76·68	31·0	−1
20·29	0	293	107·169	105·78	32·5	0
20·37	72	374	136·706	134·90	34·1	0
20·46	143	455	166·247	164·01	35·7	0
20·54	215	535	195·782	193·12	37·2	−1
20·62	287	616	225·308	222·22	38·8	−1
20·70	358	697	254·825	251·32	40·3	0
20·78	430	778	284·353	280·42	41·9	−1
20·86	502	859	313·891	309·54	43·5	−1
20·94	574	940	343·432	338·65	45·0	−1
21·02	645	21	372·966	7·76	46·6	−1
21·10	717	101	402·487	36·86	48·2	−1
21·18	789	182	432·008	65·96	49·7	−1
21·26	860	263	461·537	95·06	51·3	−1
21·34	932	344	491·076	124·18	52·9	−1
21·43	4	425	520·617	153·30	54·4	−1
21·51	76	506	550·148	182·40	56·0	−1
21·59	147	586	579·670	211·50	57·5	−1
21·67	219	667	609·191	240·60	59·1	−1
21·75	291	748	638·722	269·71	60·7	−1
21·83	362	829	668·261	298·82	62·2	−1
21·91	434	910	697·801	327·94	63·8	−1
21·99	506	991	727·331	357·04	65·4	−1
22·07	577	72	756·852	26·14	66·9	−1
22·15	649	152	786·374	55·24	68·5	−1
22·23	721	233	815·906	84·35	70·1	−1
22·31	793	314	845·446	113·46	71·6	−1
22·40	864	395	874·985	142·58	73·2	−1
22·48	936	476	904·513	171·68	74·7	−1
22·56	8	557	934·034	200·78	76·3	−1
22·64	79	638	963·557	229·88	77·9	−1
22·72	151	718	993·091	258·99	79·4	−1
22·80	223	799	1022·632	288·11	81·0	−1
22·88	295	880	1052·169	317·22	82·6	−1
22·96	366	961	1081·696	346·32	84·1	−1
23·04	438	42	1111·216	15·42	85·7	−1
23·12	510	123	1140·740	44·52	87·3	−1
23·20	581	203	1170·275	73·63	88·8	−1
23·28	653	284	1199·816	102·75	90·4	−1
23·37	725	365	1229·353	131·86	91·9	−1
23·45	797	446	1258·878	160·96	93·5	−1
23·53	868	527	1288·398	190·06	95·1	−1
23·61	940	608	1317·924	219·16	96·6	−1
23·69	12	689	1347·460	248·27	98·2	−1
23·77	83	769	1377·001	277·39	99·8	−1
23·85	155	850	1406·536	306·50	101·3	−1
23·93	227	931	1436·061	335·60	102·9	−1
24·01	299	12	4·581	4·70	104·5	−1
24·09	370	93	34·107	33·80	106·0	−1
24·17	442	174	63·645	62·91	107·6	−1

Year	I	II	T	L	θ	dT
24·26	514	254	93·166	92·03	109·2	−1
24·34	585	335	122·720	121·14	110·7	−1
24·42	657	416	152·243	150·24	112·3	−1
24·50	729	497	181·763	179·34	113·8	−1
24·58	801	578	211·291	208·44	115·4	−1
24·66	872	659	240·830	237·55	117·0	−1
24·74	944	740	270·371	266·67	118·5	−2
24·82	16	820	299·903	295·78	120·1	−2
24·90	87	901	329·425	324·88	121·7	−1
24·98	159	982	358·946	353·98	123·2	−2
25·06	231	63	388·476	23·08	124·8	−2
25·14	303	144	418·015	52·20	126·4	−1
25·23	374	225	447·555	81·31	127·9	−1
25·31	446	305	477·086	110·42	129·5	−2
25·39	518	386	506·607	139·52	131·0	−1
25·47	589	467	536·129	168·62	132·6	−2
25·55	661	548	565·660	197·72	134·2	−2
25·63	733	629	595·200	226·84	135·7	−1
25·71	805	710	624·739	255·95	137·3	−1
25·79	876	791	654·269	285·06	138·9	−2
25·87	948	871	683·789	314·16	140·4	−1
25·95	20	952	713·312	343·26	142·0	−2
26·03	91	33	742·844	12·36	143·6	−1
26·11	163	114	772·385	41·48	145·1	−1
26·20	235	195	801·923	70·60	146·7	−1
26·28	307	276	831·451	99·70	148·2	−1
26·36	378	357	860·971	128·80	149·8	−1
26·44	450	437	890·495	157·90	151·4	−2
26·52	522	518	920·029	187·01	152·9	−2
26·60	593	599	949·570	216·12	154·5	−2
26·68	665	680	979·107	245·24	156·1	−2
26·76	737	761	1008·634	274·34	157·6	−2
26·84	809	842	1038·154	303·44	159·2	−2
26·92	880	922	1067·678	332·54	160·8	−1
27·00	952	3	1097·214	1·65	162·3	−2
27·08	24	84	1126·755	30·77	163·9	−2
27·17	95	165	1156·291	59·88	165·5	−2
27·25	167	246	1185·816	88·98	167·0	−2
27·33	239	327	1215·336	118·07	168·6	−2
27·41	311	408	1244·862	147·18	170·1	−2
27·49	382	488	1274·399	176·29	171·7	−2
27·57	454	569	1303·940	205·41	173·3	−2
27·65	526	650	1333·474	234·52	174·8	−1
27·73	597	731	1362·998	263·62	176·4	−2
27·81	669	812	1392·518	292·71	178·0	−1
27·89	741	893	1422·046	321·82	179·5	−2
27·97	813	973	1451·584	350·93	181·1	−2
28·06	884	54	20·124	20·05	182·7	−1
28·14	956	135	49·658	49·16	184·2	−2
28·22	28	216	79·180	78·26	185·8	−1
28·30	99	297	108·701	107·35	187·3	−2
28·38	171	378	138·230	136·46	188·9	−2
28·46	243	459	167·769	165·57	190·5	−2
28·54	314	539	197·309	194·69	192·0	−2
28·62	386	620	226·841	223·80	193·6	−2
28·70	458	701	256·363	252·90	195·2	−2
28·78	530	782	285·884	281·99	196·7	−2
28·86	601	863	315·414	311·10	198·3	−2

If the year and its fraction are in heavy type a solar eclipse visible at Babylon is possible.

NEW MOON. TABLE A.

VALUES OF T.

II

I	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700
0	425	423	421	419	418	416	415	414	413	413	413	413	413	414	415	416	418	419	421	423	425	427	429	431	432	434	435	436	437
10	402	400	398	396	394	393	391	390	390	389	389	389	390	390	391	392	394	395	397	399	401	403	405	407	409	410	411	412	413
20	378	376	374	372	371	369	368	367	366	366	365	366	366	367	367	368	370	372	373	375	377	379	381	383	385	386	388	389	390
30	355	353	351	349	347	346	345	344	343	343	342	342	343	343	344	345	347	348	350	352	354	356	358	359	361	363	364	365	366
40	332	330	328	326	325	323	322	321	320	319	319	319	319	320	321	322	323	325	327	328	330	332	334	336	338	339	341	342	343
50	309	307	305	304	302	300	299	298	297	297	296	296	297	297	298	299	300	302	304	305	307	309	311	313	314	316	317	319	320
60	287	285	283	281	280	278	277	276	275	274	274	274	274	275	276	277	278	279	281	283	284	286	288	290	292	293	295	296	297
70	265	263	261	260	258	256	255	254	253	252	252	252	252	253	254	255	256	257	259	260	262	264	266	268	269	271	272	273	274
80	243	242	240	238	237	235	234	233	232	231	231	231	231	231	232	233	234	236	237	239	240	242	244	246	247	249	250	251	252
90	222	221	219	217	216	214	213	212	211	210	210	210	210	210	211	212	213	214	216	218	219	221	223	224	226	227	229	230	231
100	202	201	199	197	196	194	193	192	191	190	190	190	190	190	191	192	193	194	195	197	199	200	202	204	205	207	208	209	210
110	183	181	180	178	177	175	174	173	172	171	171	170	171	171	172	172	173	174	176	177	179	180	182	184	185	187	188	189	190
120	164	162	161	159	158	156	155	154	153	153	152	152	152	152	153	154	155	156	157	158	160	161	163	164	166	167	169	170	171
130	146	145	143	142	140	139	138	137	136	135	135	134	134	135	135	136	137	138	139	140	142	143	145	146	147	149	150	151	152
140	129	128	126	125	124	122	121	120	119	119	118	118	118	118	118	119	120	121	122	123	125	126	127	129	130	131	132	133	134
150	113	112	110	109	108	107	106	105	104	103	103	102	102	102	103	103	104	105	106	107	108	110	111	112	113	115	116	117	118
160	98	97	96	94	93	92	91	90	89	89	88	88	88	88	88	89	89	90	91	92	93	94	96	97	98	99	100	101	102
170	84	83	82	81	80	79	77	77	76	75	75	75	74	74	75	75	76	76	77	78	79	80	81	83	84	85	86	87	88
180	71	71	70	68	67	67	66	65	64	63	63	62	62	62	62	63	63	64	65	66	66	67	68	70	71	72	72	73	74
190	60	59	58	57	56	56	55	54	53	52	52	52	51	51	52	52	52	53	53	54	55	56	57	58	59	60	60	61	62
200	50	49	48	48	47	46	45	44	44	43	43	42	42	42	42	42	43	43	43	44	45	46	46	47	48	49	50	50	51
210	41	41	40	39	38	38	37	36	36	35	35	34	34	34	34	34	34	34	35	35	36	37	37	38	39	40	40	41	42
220	34	33	33	32	31	31	30	29	29	28	28	27	27	27	27	27	27	27	28	28	29	29	30	30	31	32	32	33	34
230	28	27	27	27	26	25	25	24	24	23	23	23	23	22	22	22	22	22	22	22	23	23	24	24	25	25	26	26	27
240	24	23	23	23	22	22	21	21	20	20	19	19	19	18	18	18	18	18	18	18	19	19	19	19	20	20	21	21	22
250	21	21	20	20	20	19	19	19	18	18	17	17	17	16	16	16	16	16	16	16	16	16	16	16	17	17	17	18	18
260	19	19	19	19	19	19	18	18	18	17	17	17	16	16	16	15	15	15	15	15	15	15	15	15	15	15	16	16	16
270	20	20	20	20	20	20	19	19	19	18	18	18	17	17	17	16	16	16	15	15	15	15	15	15	15	15	15	15	16
280	22	22	22	22	22	22	22	22	22	21	21	21	20	20	19	19	18	18	18	17	17	17	17	16	16	16	16	17	17
290	25	26	26	26	26	27	27	26	26	26	26	25	25	24	24	23	23	22	22	21	21	20	20	20	20	20	20	20	20
300	31	31	32	32	32	33	33	32	32	32	32	32	31	31	30	29	29	28	27	27	26	26	25	25	25	25	24	24	24
310	37	38	39	39	40	40	40	40	40	40	40	39	39	38	38	37	36	36	35	34	33	33	32	32	31	31	31	30	30
320	46	47	48	48	49	49	50	50	50	50	49	49	48	48	47	46	46	45	44	43	42	41	41	40	40	39	39	39	39
330	56	57	58	59	59	60	60	61	61	61	60	60	60	59	58	57	56	55	54	53	52	52	51	50	50	49	48	48	48
340	68	69	70	71	72	72	73	73	74	73	73	73	72	72	71	70	69	68	67	66	65	64	63	62	61	60	60	60	60
350	82	83	84	85	86	87	87	88	88	88	88	87	87	86	85	84	83	82	81	80	78	77	76	75	74	73	73	72	72
360	97	98	99	100	101	102	103	103	104	104	103	103	103	102	101	100	99	97	96	95	94	92	91	90	89	88	87	87	87
370	113	115	116	117	118	119	120	120	121	121	121	120	120	119	118	117	116	114	113	112	110	109	107	106	105	104	103	103	103
380	131	133	134	135	136	137	138	139	139	140	139	139	139	138	137	136	134	133	131	130	128	127	125	124	123	122	121	120	120
390	150	152	154	155	156	157	158	159	159	160	160	159	159	158	157	156	154	153	151	150	148	146	145	143	142	141	140	139	139
400	171	173	174	176	177	178	179	180	181	181	181	181	180	179	178	177	175	174	172	170	169	167	165	164	162	161	161	160	159
410	193	194	196	198	199	201	202	202	203	203	203	203	202	201	200	199	198	196	194	192	191	189	187	185	184	183	182	181	180
420	216	218	219	221	223	224	225	226	227	227	227	227	226	225	224	223	221	219	218	216	214	212	210	208	207	205	204	204	203
430	239	241	243	245	247	248	249	250	251	251	251	251	250	249	248	247	246	244	242	240	238	236	234	232	231	229	228	227	227
440	264	266	268	270	272	273	274	275	276	276	277	276	276	275	274	272	271	269	267	265	263	261	259	257	255	254	253	252	251
450	290	292	294	296	298	299	300	301	302	302	302	302	302	301	300	298	297	295	293	291	289	286	284	283	281	279	278	277	276
460	316	318	320	322	324	326	327	328	329	329	329	329	329	328	326	325	323	321	319	317	315	313	311	309	307	306	304	303	303
470	343	345	347	349	351	352	354	355	356	356	356	356	356	355	353	352	350	348	346	344	342	340	338	336	334	332	331	330	329
480	370	372	374	376	378	380	381	382	383	384	384	384	383	382	381	379	378	376	374	372	370	367	365	363	361	360	358	357	356
490	397	399	402	404	406	407	409	410	411	411	411	411	411	410	409	407	405	403	401	399	397	395	393	391	389	387	386	385	384
500	425	427	429	431	433	435	436	438	438	439	439	439	438	438	436	435	433	431	429	427	425	423	421	418	416	415	413	412	411
I	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700

II

Unit of T $=0^{d}\cdot001$.

I	725	750	775	800	825	850	875	900	925	950	975	1000
0	437	438	437	437	436	435	434	432	431	429	427	425
10	414	414	414	413	413	412	410	409	407	405	404	402
20	390	390	390	390	389	388	387	385	384	382	380	378
30	366	367	367	366	366	365	364	362	360	359	357	355
40	343	343	343	343	342	341	340	339	337	336	334	332
50	320	320	320	320	319	319	318	316	315	313	311	309
60	297	298	297	297	297	296	295	294	292	290	289	287
70	275	275	275	275	275	274	273	272	270	268	267	265
80	253	253	253	253	253	252	251	250	248	247	245	243
90	231	232	232	232	231	231	230	229	227	226	224	222
100	211	211	211	211	211	210	209	208	207	206	204	202
110	191	191	191	191	191	190	189	188	187	186	184	183
120	171	172	172	172	171	171	170	169	168	167	165	164
130	153	153	153	153	153	152	152	151	150	149	148	146
140	135	135	136	136	135	135	134	134	133	132	130	129
150	118	119	119	119	119	119	118	117	116	115	114	113
160	103	103	103	104	103	103	103	102	101	100	99	98
170	88	89	89	89	89	89	88	88	87	86	85	84
180	75	75	75	76	76	75	75	75	74	73	72	71
190	62	63	63	63	64	64	63	63	62	62	61	60
200	52	52	53	53	53	53	53	52	52	51	51	50
210	42	43	43	43	43	43	43	43	43	42	42	41
220	34	34	35	35	35	35	35	35	35	35	34	34
230	27	28	28	28	29	29	29	29	29	28	28	28
240	22	23	23	23	24	24	24	24	24	24	24	24
250	19	19	19	20	20	20	21	21	21	21	21	21
260	16	17	17	18	18	18	19	19	19	19	19	19
270	16	16	17	17	18	18	18	19	19	19	19	20
280	17	17	18	18	19	19	20	20	21	21	21	22
290	20	20	21	21	22	22	23	23	23	24	25	25
300	25	25	25	26	26	27	28	28	29	30	30	31
310	31	31	31	32	32	33	34	35	35	36	37	37
320	39	39	39	40	40	41	42	43	44	44	45	46
330	48	49	49	49	50	51	52	53	53	54	55	56
340	60	60	60	61	61	62	63	64	65	66	67	68
350	72	72	73	73	74	75	76	77	78	79	81	82
360	87	87	87	88	88	89	90	91	93	94	95	97
370	102	103	103	103	104	105	106	108	109	110	112	113
380	120	120	120	121	122	123	124	125	127	128	130	131
390	139	139	139	140	140	141	143	144	146	147	149	150
400	159	159	159	160	160	161	163	164	166	167	169	171
410	180	180	180	181	182	183	184	186	187	189	191	193
420	203	202	203	203	204	205	207	208	210	212	214	216
430	226	226	226	227	228	229	230	232	234	235	237	239
440	251	251	251	251	252	253	255	257	258	260	262	264
450	276	276	276	277	278	279	280	282	284	286	288	290
460	302	302	302	303	304	305	306	308	310	312	314	316
470	329	329	329	329	330	331	333	334	336	338	341	343
480	356	356	356	356	357	358	360	362	363	365	368	370
490	383	383	383	384	385	386	387	389	391	393	395	397
500	411	411	411	411	412	413	415	416	418	421	423	425
I	725	750	775	800	825	850	875	900	925	950	975	1000

P.P.

	12	13	14	15
1	1	1	1	2
2	2	3	3	3
3	4	4	4	5
4	5	5	6	6
5	6	7	7	8
6	7	8	8	9
7	8	9	10	11
8	10	10	11	12
9	11	12	13	14

	16	17	18	19
1	2	2	2	2
2	3	3	4	4
3	5	5	5	6
4	6	7	7	8
5	8	9	9	10
6	10	10	11	11
7	11	12	13	13
8	13	14	14	15
9	14	15	16	17

	21	22	23	24
1	2	2	2	2
2	4	4	5	5
3	6	7	7	7
4	8	9	9	10
5	11	11	12	12
6	13	13	14	14
7	15	15	16	17
8	17	18	18	19
9	19	20	21	22

	25	26	27	28
1	3	3	3	3
2	5	5	5	6
3	8	8	8	8
4	10	10	11	11
5	13	13	14	14
6	15	16	16	17
7	18	18	19	20
8	20	21	22	22
9	23	23	24	25

NEW MOON. TABLE A.

VALUES OF L.

II

I	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
0	61	67	72	76	78	79	78	75	71	66	61	56	52	48	45	44	44	46	50	55	61
10	59	65	70	74	76	76	75	72	68	64	59	54	49	45	42	41	42	44	47	52	59
20	56	63	68	71	74	74	73	70	66	62	57	52	47	43	40	39	39	41	45	50	56
30	54	60	65	69	71	72	71	68	64	59	54	49	45	41	37	37	37	39	43	48	54
40	52	58	63	67	69	69	69	66	62	57	52	47	43	39	35	34	34	37	40	45	52
50	49	55	61	64	67	67	66	63	59	55	50	45	40	36	33	32	32	34	38	43	49
60	47	53	58	62	64	65	64	61	57	53	48	43	38	34	31	30	30	32	35	41	47
70	45	51	56	60	62	63	62	59	55	51	46	41	36	32	28	28	28	30	33	38	45
80	42	49	54	58	60	61	60	57	53	49	44	39	34	30	26	25	25	27	31	36	42
90	40	46	52	56	58	59	58	55	51	47	42	37	32	28	24	23	23	25	29	34	40
100	38	44	50	54	56	57	56	53	49	45	40	35	30	26	22	21	21	23	27	32	38
110	36	42	48	52	54	55	54	51	47	43	38	33	28	24	20	19	19	21	25	30	36
120	34	40	46	50	52	53	52	49	45	41	36	31	26	22	18	17	17	19	23	28	34
130	32	39	44	48	51	51	51	48	44	39	34	29	24	20	17	16	15	17	21	26	32
140	31	37	42	46	49	50	49	46	42	38	33	27	23	18	15	14	14	16	19	24	31
150	29	35	41	45	47	48	47	45	41	36	31	26	21	17	13	12	12	14	18	23	29
160	27	34	39	43	46	47	46	43	39	35	30	24	20	15	12	10	10	12	16	21	27
170	26	32	38	42	45	45	45	42	38	34	28	23	18	14	10	9	9	11	15	20	26
180	25	31	37	41	44	44	44	41	37	32	27	22	17	13	9	8	8	10	13	18	25
190	24	30	36	40	43	43	43	40	36	31	26	21	16	11	8	7	6	8	12	17	24
200	23	29	35	39	42	42	42	39	35	30	25	20	15	10	7	5	5	7	11	16	23
210	22	28	34	38	41	41	41	38	34	29	24	19	14	10	6	4	4	6	10	15	22
220	21	28	33	37	40	41	40	37	33	29	24	18	13	9	5	4	4	6	9	14	21
230	20	27	33	37	40	40	40	37	33	28	23	18	13	8	4	3	3	5	9	14	20
240	20	27	32	37	39	40	40	36	33	28	23	17	12	8	4	3	2	5	8	13	20
250	20	26	32	36	39	40	39	36	32	28	22	17	12	7	3	2	2	4	8	13	20
260	19	26	32	36	39	40	39	36	32	27	22	17	12	7	3	2	2	4	8	13	19
270	20	26	32	36	39	40	39	36	32	28	22	17	12	7	3	2	2	4	8	13	20
280	20	26	32	37	39	40	40	37	32	28	22	17	12	7	3	2	2	4	8	13	20
290	20	27	33	37	40	40	40	37	33	28	23	17	12	7	3	2	2	4	8	13	20
300	21	27	33	38	40	41	41	38	33	29	23	18	13	8	4	3	3	5	9	14	21
310	21	28	34	38	41	42	42	38	34	29	24	18	13	8	5	3	3	5	9	15	21
320	22	29	35	39	42	43	42	39	35	30	25	19	14	9	5	4	4	6	10	16	22
330	23	30	36	40	43	44	43	40	36	31	26	20	15	10	6	5	5	7	11	17	23
340	25	31	37	42	44	45	44	41	37	32	27	21	16	11	7	6	6	8	12	18	25
350	26	33	39	43	46	47	46	43	39	34	28	22	17	13	9	8	7	10	14	19	26
360	28	35	40	45	48	48	48	44	40	35	30	24	19	14	10	9	9	11	15	21	28
370	29	36	42	46	49	50	49	46	42	37	31	25	20	15	12	10	10	13	17	22	29
380	31	38	44	48	51	52	51	48	43	39	33	27	22	17	13	12	12	15	19	24	31
390	33	40	46	50	53	54	53	50	45	40	35	29	24	19	15	14	14	16	21	26	33
400	35	42	48	52	55	56	55	52	47	42	37	31	26	21	17	16	16	18	23	28	35
410	38	44	50	55	58	58	57	54	50	45	39	33	28	23	19	18	18	21	25	31	38
420	40	47	53	57	60	60	60	56	52	47	41	35	30	25	21	20	21	23	27	33	40
430	42	49	55	59	62	63	62	59	54	49	43	38	32	28	24	23	23	25	29	35	42
440	45	52	58	62	65	65	65	61	57	52	46	40	35	30	26	25	25	28	32	38	45
450	47	54	60	65	67	68	67	64	59	54	48	42	37	33	29	28	28	30	35	40	47
460	50	57	63	67	70	70	70	66	62	56	51	45	40	35	31	30	31	33	37	43	50
470	53	60	66	70	73	73	72	69	64	59	53	47	42	38	34	33	33	36	40	46	53
480	55	62	68	73	75	76	75	71	67	62	56	50	45	40	36	36	36	38	43	49	55
490	58	65	71	76	78	79	78	74	70	64	59	53	48	43	39	38	39	41	46	51	58
500	61	68	74	78	81	81	80	77	72	67	61	55	50	46	42	41	41	44	48	54	61
I	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000

II

Unit of L $=0^{\circ}\cdot01$

NEW MOON. TABLE A—Continued.

VALUES OF T.

I \ II	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700
500	425	427	429	431	433	435	436	438	438	439	439	439	438	438	436	435	433	431	429	427	425	423	421	418	416	415	413	412	411
510	453	455	457	459	461	462	464	465	466	466	467	466	466	465	464	463	461	459	457	455	453	450	448	446	444	443	441	440	439
520	480	482	484	486	488	490	491	492	493	494	494	494	493	493	492	490	489	487	485	482	480	478	476	474	472	470	469	468	467
530	507	509	511	513	515	517	518	520	521	521	521	521	521	520	519	517	516	514	512	510	508	506	503	501	499	498	496	495	494
540	534	536	538	540	542	543	545	546	547	547	548	548	547	546	545	544	543	541	539	537	535	532	530	528	527	525	523	522	521
550	560	562	564	566	568	570	571	572	573	574	574	574	573	573	572	571	569	567	565	563	561	559	557	555	553	551	550	549	548
560	585	587	589	591	593	595	596	597	598	599	599	599	599	598	597	596	594	593	591	589	587	585	583	581	579	577	576	575	574
570	610	612	614	616	618	619	621	622	623	623	624	624	623	623	622	621	619	618	616	614	612	610	608	606	604	603	601	600	599
580	634	636	638	640	642	643	644	645	646	647	647	647	647	646	645	644	643	641	640	638	636	634	632	630	629	627	626	625	624
590	657	659	661	662	664	666	667	668	669	669	670	670	669	669	668	667	666	664	663	661	659	657	656	654	652	651	649	648	647
600	679	681	682	684	686	687	688	689	690	691	691	691	691	690	690	689	687	686	685	683	681	679	678	676	674	673	672	671	670
610	699	701	703	704	706	707	708	709	710	711	711	711	711	710	710	709	708	706	705	704	702	700	699	697	696	694	693	692	691
620	719	720	722	723	725	726	727	728	729	730	730	730	730	729	729	728	727	726	724	723	721	720	718	717	715	714	713	712	711
630	737	738	739	741	742	744	745	745	746	747	747	747	747	747	746	746	745	744	742	741	740	738	737	735	734	733	732	731	730
640	753	754	756	757	758	759	760	761	762	763	764	764	764	763	762	762	761	760	759	758	756	755	754	752	751	750	749	748	747
650	768	769	771	772	773	774	775	776	777	777	778	778	778	778	777	776	776	775	774	773	772	770	769	768	767	766	765	764	763
660	782	783	784	785	786	787	788	789	789	790	790	790	790	790	790	789	789	788	787	786	785	784	783	782	781	780	779	778	778
670	793	794	795	796	797	798	799	800	800	801	801	802	802	802	801	801	800	800	799	798	797	796	795	794	794	793	792	791	790
680	804	804	805	806	807	808	809	809	810	811	811	811	811	811	811	811	810	810	809	809	808	807	806	805	804	804	803	802	801
690	812	813	814	815	815	816	817	817	818	818	818	819	819	819	819	819	819	818	818	817	816	816	815	814	814	813	812	811	811
700	819	820	820	821	822	822	823	823	824	824	825	825	825	825	826	825	825	825	825	824	824	823	822	822	821	821	820	819	819
710	825	825	826	826	826	827	827	828	829	829	829	830	830	830	830	830	830	830	830	829	829	829	828	828	827	827	826	825	825
720	828	829	829	829	830	830	830	831	831	832	832	833	833	833	833	833	833	833	833	833	833	832	832	832	831	831	830	830	830
730	830	830	831	831	831	831	832	832	833	833	833	834	834	835	835	835	835	835	835	835	835	835	835	834	834	834	833	833	832
740	831	831	831	831	831	831	831	832	832	832	833	833	834	834	834	835	835	835	835	835	835	835	835	835	835	835	834	834	834
750	829	829	829	829	829	829	830	830	830	830	831	831	832	832	833	833	833	833	834	834	834	834	834	834	834	834	834	834	833
760	826	826	826	826	826	826	826	826	827	827	828	828	828	829	829	829	830	830	831	831	831	832	832	832	832	832	832	831	831
770	822	822	821	821	821	821	821	821	821	822	822	822	823	823	824	824	825	825	826	826	827	827	828	828	828	828	828	828	828
780	816	816	815	815	815	815	814	815	815	815	815	816	816	817	818	818	819	820	820	821	821	822	822	823	823	823	823	823	823
790	809	808	808	807	807	807	806	807	807	807	807	807	808	808	809	810	810	811	812	813	814	814	815	815	816	816	816	816	816
800	800	799	799	798	798	797	797	797	797	797	797	798	798	799	799	800	801	802	803	804	804	805	806	806	807	807	808	808	808
810	790	789	788	788	787	787	787	786	786	787	787	787	788	789	790	791	791	792	793	794	795	796	797	797	798	798	799	799	798
820	778	777	777	776	775	775	774	774	774	774	775	775	776	777	777	778	779	780	781	782	783	784	785	786	787	787	788	788	787
830	766	765	764	763	762	762	761	761	761	761	762	762	763	764	765	766	767	768	770	771	772	773	773	774	775	775	776	776	776
840	752	751	750	749	748	747	747	746	746	747	747	747	748	749	750	751	752	753	754	756	757	758	759	760	761	761	762	762	762
850	737	736	735	734	733	732	731	731	731	731	731	732	732	733	734	735	736	738	739	740	742	743	744	745	746	747	747	748	748
860	721	720	718	717	716	716	715	714	714	714	715	715	716	717	718	719	720	721	723	724	726	727	728	729	730	731	731	732	732
870	704	703	701	700	699	698	697	697	697	697	698	698	699	700	701	702	704	705	706	707	709	710	711	712	713	714	715	715	716
880	686	685	683	682	681	680	679	679	678	678	678	679	679	680	681	683	684	686	687	689	690	692	693	694	695	696	697	698	698
890	667	666	664	663	662	661	660	659	659	659	659	659	660	661	662	663	665	666	668	669	671	673	674	675	676	677	678	679	679
900	648	646	644	643	642	641	640	639	639	639	639	639	640	641	642	643	645	646	648	650	651	653	655	656	657	658	659	660	660
910	627	626	624	623	621	620	619	619	618	618	618	619	619	620	621	623	624	626	627	629	631	632	634	636	637	638	639	639	640
920	606	605	603	602	600	599	598	597	597	597	597	597	598	599	600	601	603	604	606	608	609	611	613	614	616	617	618	619	619
930	585	583	581	580	578	577	576	575	575	575	575	575	576	577	578	579	581	582	584	586	588	589	591	593	594	595	596	597	598
940	563	561	559	558	556	555	554	553	553	552	552	553	553	554	555	557	558	560	562	564	566	567	569	571	572	573	574	575	576
950	541	539	537	535	534	533	532	531	530	530	530	530	531	532	533	534	535	537	539	541	543	545	546	548	550	551	552	553	553
960	518	516	514	513	511	510	509	508	507	507	507	507	507	508	509	511	512	514	516	518	520	522	523	525	527	528	529	530	531
970	495	493	491	489	488	486	485	484	484	483	483	484	484	485	486	487	489	490	492	494	496	498	500	502	503	505	506	507	507
980	472	470	468	466	465	463	462	461	460	460	460	460	460	461	462	464	465	467	469	471	473	475	477	478	480	481	482	483	484
990	449	447	445	443	441	440	438	437	437	436	436	436	437	438	439	440	441	443	445	447	449	451	453	455	456	458	459	460	461
1000	425	423	421	419	418	416	415	414	413	413	413	413	413	414	415	416	418	419	421	423	425	427	429	431	432	434	435	436	437
I	0	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700

I \ II	725	750	775	800	825	850	875	900	925	950	975	1000
500	411	411	411	411	412	413	415	416	418	421	423	425
510	439	438	439	439	440	441	442	444	446	448	450	453
520	466	466	466	467	468	469	470	472	474	476	478	480
530	494	494	494	494	495	496	497	499	501	503	505	507
540	521	521	521	522	522	523	524	526	528	530	532	534
550	548	547	547	548	548	549	551	552	554	556	558	560
560	573	573	573	574	574	575	577	578	580	581	583	585
570	599	598	599	599	600	601	602	603	605	606	608	610
580	623	623	623	623	624	625	626	627	629	630	632	634
590	647	646	646	647	647	648	649	650	652	654	655	657
600	669	669	669	669	670	670	671	673	674	675	677	679
610	691	690	690	690	691	691	692	694	695	696	698	699
620	711	710	710	711	711	711	712	713	714	716	717	719
630	729	729	729	729	729	730	731	732	733	734	735	737
640	747	746	746	746	746	747	748	749	750	751	752	753
650	762	762	762	762	762	763	763	764	765	766	767	768
660	777	776	776	776	776	777	777	778	779	780	781	782
670	790	789	789	789	789	789	790	790	791	792	793	793
680	801	800	800	800	800	800	801	801	802	802	803	804
690	810	810	810	809	809	810	810	810	811	811	812	812
700	818	818	817	817	817	817	817	818	818	818	819	819
710	824	824	824	824	824	823	823	824	824	824	824	825
720	829	829	828	828	828	828	828	828	828	828	828	828
730	832	832	831	831	831	831	830	830	830	830	830	830
740	833	833	832	832	832	831	831	831	831	831	831	831
750	833	833	832	832	831	831	831	830	830	830	829	829
760	831	831	830	830	829	829	828	828	827	827	827	826
770	827	827	827	826	826	825	824	824	823	823	822	822
780	822	822	822	821	820	820	819	819	818	817	817	816
790	816	815	815	814	814	813	812	812	811	810	809	809
800	808	807	807	806	806	805	804	803	802	801	801	800
810	798	798	797	797	796	795	795	794	793	792	791	790
820	787	787	787	786	785	784	783	782	781	780	779	778
830	775	775	775	774	773	772	771	770	769	768	767	766
840	762	762	762	761	760	759	758	757	755	754	753	752
850	748	747	747	746	745	744	743	742	741	740	738	737
860	732	732	731	731	730	729	728	726	725	724	722	721
870	716	715	715	714	713	712	711	710	708	707	705	704
880	698	698	697	697	696	695	694	692	691	689	688	686
890	680	679	679	678	677	676	675	674	672	670	669	667
900	660	660	660	659	658	657	656	654	653	651	649	648
910	640	640	640	639	638	637	636	634	633	631	629	627
920	619	619	619	618	617	616	615	613	612	610	608	606
930	598	598	598	597	596	595	594	592	590	589	587	585
940	576	576	576	575	574	573	572	570	569	567	565	563
950	554	554	554	553	552	551	550	548	546	545	543	541
960	531	531	531	530	529	528	527	525	524	522	520	518
970	508	508	508	507	506	505	504	502	501	499	497	495
980	485	485	484	484	483	482	481	479	478	476	474	472
990	461	461	461	460	460	459	457	456	454	452	450	449
1000	437	438	437	437	436	435	434	432	431	429	427	425
I	725	750	775	800	825	850	875	900	925	950	975	1000

Unit of T = $0^{d}\cdot001$.

P.P.

	12	13	14	15
1	1	1	1	2
2	2	3	3	3
3	4	4	4	5
4	5	5	6	6
5	6	7	7	8
6	7	8	8	9
7	8	9	10	11
8	10	10	11	12
9	11	12	13	14

	16	17	18	19
1	2	2	2	2
2	3	3	4	4
3	5	5	5	6
4	6	7	7	8
5	8	9	9	10
6	10	10	11	11
7	11	12	13	13
8	13	14	14	15
9	14	15	16	17

	21	22	23	24
1	2	2	2	2
2	4	4	5	5
3	6	7	7	7
4	8	9	9	10
5	11	11	12	12
6	13	13	14	14
7	15	15	16	17
8	17	18	18	19
9	19	20	21	22

	25	26	27	28
1	3	3	3	3
2	5	5	5	6
3	8	8	8	8
4	10	10	11	11
5	13	13	14	14
6	15	16	16	17
7	18	18	19	20
8	20	21	22	22
9	23	23	24	25

VALUES OF L.

I \ II	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
500	61	68	74	78	81	81	80	77	72	67	61	55	50	46	42	41	41	44	48	54	61
510	64	71	77	81	84	84	83	79	75	70	64	58	53	48	45	44	44	47	51	57	64
520	67	74	80	84	86	87	86	82	77	72	66	61	55	51	47	46	47	50	54	60	67
530	69	76	82	87	89	89	88	85	80	75	69	63	58	54	50	49	50	52	57	62	69
540	72	79	85	89	92	92	91	87	83	77	72	66	61	56	53	52	52	55	59	65	72
550	75	82	88	92	94	95	94	90	85	80	74	68	63	59	55	55	55	58	62	68	75
560	78	85	90	94	97	97	96	92	88	82	77	71	66	61	58	57	58	60	65	71	78
570	80	87	93	97	99	100	99	95	90	85	79	73	68	64	60	60	60	63	67	73	80
580	82	89	95	99	102	102	101	97	92	87	81	76	70	66	63	62	62	65	70	75	82
590	85	92	97	102	104	104	103	99	94	89	84	78	73	68	65	64	65	68	72	78	85
600	87	94	100	104	106	106	105	101	96	91	86	80	75	71	67	66	67	70	74	80	87
610	89	96	102	106	108	108	107	103	98	93	88	82	77	73	69	69	69	72	76	82	89
620	91	98	104	108	110	110	109	105	100	95	89	84	79	75	71	71	71	74	78	84	91
630	93	100	106	110	112	112	111	107	102	97	91	86	81	76	73	72	73	76	80	86	93
640	95	102	107	111	113	113	112	108	104	99	93	87	82	78	75	74	75	78	82	88	95
650	96	103	109	113	115	115	114	110	105	100	94	89	84	80	76	76	76	79	83	89	96
660	98	104	110	114	116	116	115	111	106	101	95	90	85	81	78	77	78	81	85	91	98
670	99	106	111	115	117	117	116	112	107	102	97	91	86	82	79	78	79	82	86	92	99
680	100	107	112	116	118	118	117	113	108	103	98	92	87	83	80	79	80	83	87	93	100
690	101	108	113	117	119	119	118	114	109	104	98	93	88	84	81	80	81	84	88	94	101
700	102	108	114	118	120	120	118	114	110	105	99	94	89	85	82	81	82	85	89	95	102
710	102	109	114	118	120	120	119	115	110	105	100	94	89	85	82	82	82	85	90	95	102
720	103	109	115	118	120	120	119	115	111	105	100	95	90	86	83	82	83	86	90	96	103
730	103	109	115	119	121	120	119	115	111	106	100	95	90	86	83	82	83	86	90	96	103
740	103	109	115	118	120	120	119	115	111	106	100	95	90	86	83	83	83	86	90	96	103
750	103	109	115	118	120	120	119	115	110	106	100	95	90	86	83	83	83	86	90	96	103
760	102	109	114	118	120	120	119	115	110	105	100	94	90	86	82	82	83	86	90	96	102
770	102	108	114	117	119	119	118	114	110	105	99	94	90	86	82	82	83	86	90	95	102
780	101	108	113	117	119	119	118	114	109	104	99	93	89	85	82	81	82	85	89	95	101
790	101	107	112	116	118	118	117	113	108	103	98	93	88	84	81	81	82	84	88	94	101
800	100	106	111	115	117	117	116	112	107	102	97	92	88	84	80	80	81	83	88	93	100
810	99	105	110	114	116	116	115	111	106	101	96	91	87	83	80	79	80	82	87	92	99
820	98	104	109	113	115	115	113	110	105	100	95	90	86	82	79	78	79	81	86	91	98
830	96	103	108	111	113	113	112	108	104	99	94	89	84	80	77	77	78	80	84	90	96
840	95	101	106	110	112	112	111	107	103	98	93	88	83	79	76	76	76	79	83	88	95
850	93	100	105	108	110	110	109	106	101	96	91	86	82	78	75	74	75	77	82	87	93
860	92	98	103	107	109	109	108	104	100	95	90	85	80	76	73	73	73	76	80	85	92
870	90	96	101	105	107	107	106	102	98	93	88	83	79	75	72	71	72	74	78	84	90
880	88	94	100	103	105	105	104	100	96	91	86	81	77	73	70	69	70	72	76	82	88
890	86	92	98	101	103	103	102	99	94	90	85	80	75	71	68	68	68	71	75	80	86
900	84	90	96	99	101	101	100	97	92	88	83	78	73	69	66	66	66	69	73	78	84
910	82	88	93	97	99	99	98	95	90	86	81	76	71	67	64	64	64	67	70	76	82
920	80	86	91	95	97	97	96	93	88	84	79	74	69	65	62	62	62	65	68	74	80
930	78	84	89	93	95	95	94	90	86	82	77	72	67	63	60	60	60	62	66	72	78
940	75	82	87	90	92	93	92	88	84	80	75	69	65	61	58	57	58	60	64	69	75
950	73	79	84	88	90	90	89	86	82	77	72	67	63	59	56	55	56	58	62	67	73
960	71	77	82	86	88	88	87	84	80	75	70	65	61	57	54	53	53	56	59	65	71
970	68	75	80	83	85	86	85	81	77	73	68	63	59	55	51	51	51	53	57	62	68
980	66	72	77	81	83	83	83	79	75	71	66	61	56	52	49	48	49	51	55	60	66
990	64	70	75	79	81	81	80	77	73	68	63	58	54	50	47	46	46	48	52	57	64
1000	61	67	72	76	78	79	78	75	71	66	61	56	52	48	45	44	44	46	50	55	61
I	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000

Unit of L = $0^{\circ}\cdot01$.

NEW MOON. TABLE B.

	T Year														L Year												
II	−4000	−3600	−3200	−2800	−2400	−2000	−1600	−1200	−800	−400	0	400	800	2000	−4000	−3500	−3000	−2500	−2000	−1500	−1000	−500	0	500	1000	2000	II
															+°	+°	+°	+°	+°	+°	+°	+°	+°	+°	+°	+°	
0	199	198	198	198	198	197	197	197	196	196	196	196	195	195	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0
10	211	211	211	210	210	209	209	209	208	208	207	207	207	206	0·14	0·14	0·14	0·14	0·13	0·13	0·13	0·13	0·13	0·13	0·13	0·12	10
20	224	223	223	222	222	221	221	221	220	220	219	219	218	217	0·27	0·27	0·27	0·27	0·27	0·27	0·26	0·26	0·26	0·26	0·26	0·25	20
30	237	236	235	235	234	233	233	232	232	231	231	230	230	228	0·41	0·41	0·40	0·40	0·40	0·39	0·39	0·39	0·38	0·38	0·38	0·37	30
40	249	248	247	247	246	245	245	244	243	243	242	241	241	239	0·54	0·54	0·54	0·53	0·53	0·53	0·52	0·52	0·51	0·51	0·50	0·49	40
50	261	260	259	258	258	257	256	255	255	254	253	252	251	249	0·68	0·67	0·67	0·66	0·65	0·65	0·64	0·64	0·63	0·62	0·62	0·61	50
60	273	272	271	270	269	268	268	267	266	265	264	263	262	260	0·80	0·80	0·79	0·79	0·78	0·77	0·77	0·76	0·75	0·74	0·74	0·72	60
70	284	283	282	281	280	279	278	278	277	276	275	274	273	270	0·93	0·93	0·92	0·91	0·91	0·90	0·89	0·88	0·87	0·86	0·85	0·83	70
80	295	294	293	292	291	290	289	288	287	286	285	284	283	280	1·05	1·05	1·04	1·03	1·02	1·01	1·00	0·99	0·98	0·97	0·96	0·94	80
90	306	305	304	303	302	300	299	298	297	296	295	294	292	289	1·17	1·17	1·16	1·15	1·13	1·12	1·11	1·10	1·09	1·08	1·07	1·05	90
100	316	315	314	313	312	310	309	308	307	306	304	303	301	298	1·29	1·28	1·27	1·26	1·25	1·24	1·22	1·21	1·20	1·19	1·18	1·15	100
110	326	325	324	322	321	320	319	317	316	315	313	312	310	307	1·40	1·39	1·38	1·37	1·35	1·34	1·32	1·31	1·30	1·29	1·28	1·25	110
120	335	334	333	331	330	329	327	326	325	323	322	320	319	315	1·50	1·49	1·47	1·46	1·45	1·43	1·42	1·41	1·39	1·37	1·36	1·34	120
130	344	343	341	340	339	337	336	334	333	332	330	328	327	323	1·60	1·58	1·57	1·56	1·54	1·53	1·51	1·50	1·48	1·46	1·45	1·42	130
140	352	351	349	348	346	345	344	342	341	339	338	336	334	330	1·69	1·67	1·66	1·64	1·62	1·61	1·59	1·58	1·56	1·54	1·53	1·50	140
150	359	358	356	355	354	352	351	349	348	346	344	343	341	337	1·77	1·76	1·74	1·73	1·71	1·69	1·67	1·66	1·64	1·62	1·61	1·57	150
160	366	365	363	362	360	359	357	356	354	352	351	349	348	343	1·84	1·83	1·81	1·80	1·78	1·76	1·74	1·73	1·71	1·69	1·68	1·64	160
170	372	371	369	368	366	365	363	361	360	358	357	355	354	348	1·91	1·90	1·88	1·86	1·84	1·82	1·81	1·79	1·77	1·75	1·74	1·70	170
180	377	376	374	373	371	370	368	366	365	363	361	359	358	353	1·97	1·95	1·94	1·92	1·90	1·88	1·87	1·85	1·83	1·81	1·79	1·75	180
190	382	381	379	377	376	374	373	371	369	367	365	364	362	357	2·02	2·00	1·98	1·97	1·95	1·93	1·91	1·89	1·87	1·85	1·83	1·80	190
200	386	385	383	381	380	378	376	375	373	371	369	367	365	360	2·06	2·04	2·02	2·01	1·99	1·97	1·95	1·93	1·91	1·89	1·87	1·84	200
210	389	388	386	384	383	381	379	378	376	374	372	370	368	363	2·10	2·08	2·06	2·05	2·03	2·01	1·99	1·97	1·95	1·93	1·91	1·87	210
220	392	390	388	387	385	383	381	380	378	376	374	372	370	365	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·93	1·89	220
230	394	392	390	389	387	385	383	382	380	378	376	374	372	367	2·15	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·91	230
240	395	393	391	389	388	386	384	382	380	379	377	375	373	368	2·16	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·92	240
250	395	393	391	389	388	386	384	382	380	379	377	375	373	368	2·16	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·92	250
260	394	392	390	389	387	385	383	382	380	378	376	374	372	367	2·15	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·91	260
270	392	391	389	387	385	384	382	380	378	377	375	373	371	366	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·94	1·90	270
280	390	389	387	385	383	382	380	378	376	374	373	371	369	364	2·11	2·09	2·07	2·05	2·03	2·01	2·00	1·97	1·95	1·93	1·91	1·88	280
290	387	386	384	382	380	379	377	375	373	372	370	368	366	361	2·08	2·06	2·04	2·03	2·01	1·99	1·97	1·95	1·93	1·91	1·89	1·85	290
300	384	382	380	378	377	375	373	372	370	368	366	365	363	358	2·04	2·02	2·00	1·98	1·97	1·95	1·93	1·91	1·89	1·87	1·85	1·82	300
310	380	378	376	374	373	371	369	368	366	364	362	361	359	354	1·98	1·97	1·95	1·93	1·91	1·89	1·88	1·86	1·84	1·82	1·81	1·77	310
320	375	373	371	369	368	366	364	363	361	359	358	356	354	349	1·93	1·92	1·90	1·88	1·86	1·84	1·82	1·81	1·79	1·77	1·76	1·72	320
330	368	367	365	363	362	360	359	357	356	354	352	351	349	344	1·87	1·85	1·83	1·82	1·80	1·78	1·76	1·75	1·73	1·71	1·70	1·67	330
340	362	360	359	357	356	354	353	351	350	348	346	345	343	339	1·79	1·78	1·76	1·75	1·73	1·72	1·70	1·69	1·67	1·65	1·64	1·60	340
350	355	353	352	350	349	347	346	344	343	341	340	338	337	333	1·72	1·71	1·69	1·68	1·66	1·65	1·63	1·62	1·60	1·58	1·57	1·54	350
360	347	346	344	343	342	340	339	337	336	334	333	331	330	326	1·64	1·63	1·61	1·60	1·58	1·57	1·55	1·54	1·52	1·50	1·49	1·46	360
370	339	338	336	335	334	332	331	330	328	327	325	324	322	319	1·54	1·53	1·52	1·51	1·49	1·48	1·47	1·45	1·44	1·43	1·41	1·38	370
380	330	329	328	326	325	324	323	321	320	319	317	316	314	311	1·44	1·43	1·42	1·41	1·40	1·39	1·38	1·36	1·35	1·34	1·32	1·30	380
390	321	320	319	317	316	315	314	313	311	310	309	308	306	303	1·34	1·33	1·32	1·31	1·30	1·29	1·28	1·26	1·25	1·24	1·23	1·21	390
400	311	310	309	308	307	306	305	304	302	301	300	299	297	294	1·24	1·23	1·22	1·21	1·20	1·19	1·18	1·17	1·16	1·15	1·13	1·11	400
410	301	300	299	298	297	296	295	294	293	292	291	290	288	285	1·13	1·12	1·11	1·10	1·09	1·08	1·07	1·06	1·05	1·04	1·03	1·01	410
420	291	290	289	288	287	286	285	284	283	282	281	280	279	276	1·02	1·01	1·00	0·99	0·98	0·97	0·96	0·95	0·94	0·93	0·92	0·91	420
430	280	279	278	277	277	276	275	274	273	272	271	270	269	267	0·90	0·89	0·88	0·88	0·87	0·86	0·85	0·85	0·84	0·83	0·82	0·80	430
440	269	268	267	266	266	265	264	263	263	262	261	260	259	257	0·78	0·77	0·76	0·76	0·75	0·74	0·73	0·73	0·72	0·72	0·71	0·69	440
450	257	257	256	255	255	254	253	253	252	251	250	250	249	247	0·66	0·65	0·64	0·64	0·63	0·63	0·62	0·62	0·61	0·60	0·60	0·58	450
460	246	246	245	244	244	243	242	241	241	240	240	239	239	237	0·53	0·52	0·52	0·51	0·51	0·50	0·50	0·50	0·49	0·49	0·48	0·47	460
470	234	234	233	233	232	232	231	231	230	230	229	228	228	226	0·40	0·39	0·39	0·38	0·38	0·37	0·37	0·37	0·36	0·36	0·36	0·35	470
480	222	222	222	221	221	220	220	219	219	218	218	217	217	216	0·27	0·26	0·26	0·26	0·26	0·25	0·25	0·25	0·25	0·25	0·24	0·24	480
490	210	210	210	210	209	209	208	208	208	207	207	207	206	205	0·13	0·13	0·13	0·13	0·13	0·12	0·12	0·12	0·12	0·12	0·12	0·12	490
															−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	
500	198	198	198	198	198	197	197	197	196	196	196	195	195	195	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	500
510	186	186	186	186	186	186	186	185	185	185	185	185	185	184	0·13	0·13	0·13	0·13	0·13	0·12	0·12	0·12	0·12	0·12	0·12	0·12	510
520	174	174	174	174	174	174	174	174	174	174	174	174	174	174	0·27	0·26	0·26	0·26	0·26	0·25	0·25	0·25	0·25	0·25	0·24	0·24	520
530	163	163	163	163	163	163	163	163	163	163	163	163	163	163	0·40	0·39	0·39	0·38	0·38	0·37	0·37	0·37	0·36	0·36	0·36	0·35	530
540	151	151	151	151	151	151	152	152	152	152	152	152	152	153	0·53	0·52	0·52	0·51	0·51	0·50	0·50	0·50	0·49	0·49	0·48	0·47	540
550	140	140	140	140	140	140	141	141	141	141	141	141	141	143	0·66	0·65	0·64	0·64	0·63	0·63	0·62	0·62	0·61	0·60	0·60	0·58	550
560	128	129	129	129	129	129	130	130	130	130	130	131	131	133	0·78	0·77	0·76	0·76	0·75	0·74	0·73	0·73	0·72	0·72	0·71	0·69	560
570	117	118	118	118	119	119	119	120	120	120	121	121	121	123	0·90	0·89	0·88	0·88	0·87	0·86	0·85	0·85	0·84	0·83	0·82	0·80	570
580	106	107	107	108	108	108	109	109	110	110	110	111	111	113	1·02	1·01	1·00	0·99	0·98	0·97	0·96	0·95	0·94	0·93	0·92	0·91	580
590	96	97	97	98	98	98	99	99	100	100	101	101	102	104	1·13	1·12	1·11	1·10	1·09	1·08	1·07	1·06	1·05	1·04	1·03	1·01	590
600	86	87	87	88	88	89	89	90	90	91	92	92	93	95	1·24	1·23	1·22	1·21	1·20	1·19	1·18	1·17	1·16	1·15	1·13	1·11	600
610	76	77	78	78	79	79	80	81	81	82	83	83	84	87	1·34	1·33	1·32	1·31	1·30	1·29	1·28	1·26	1·25	1·24	1·23	1·21	610
620	67	68	69	69	70	71	71	72	73	74	74	75	76	79	1·44	1·43	1·42	1·41	1·40	1·39	1·38	1·36	1·35	1·34	1·32	1·30	620
630	59	59	60	61	61	62	63	64	65	65	66	67	68	71	1·54	1·53	1·52	1·51	1·49	1·48	1·47	1·45	1·44	1·43	1·41	1·38	630
640	50	51	52	53	53	54	55	56	57	58	59	60	61	64	1·64	1·63	1·61	1·60	1·58	1·57	1·55	1·54	1·52	1·50	1·49	1·46	640
650	42	43	44	45	46	47	48	49	50	51	52	53	54	57	1·72	1·71	1·69	1·68	1·66	1·65	1·63	1·62	1·60	1·58	1·57	1·54	650
660	35	36	37	38	39	40	41	42	43	44	45	46	47	51	1·79	1·78	1·76	1·75	1·73	1·72	1·70	1·69	1·67	1·65	1·64	1·60	660
670	29	30	31	32	33	34	35	36	37	38	39	40	41	45	1·87	1·85	1·83	1·82	1·80	1·78	1·76	1·75	1·73	1·71	1·70	1·67	670
680	24	25	26	27	28	29	30	31	32	33	34	35	36	40	1·93	1·92	1·90	1·88	1·86	1·84	1·82	1·81	1·79	1·77	1·76	1·72	680
690	19	20	21	22	23	24	25	26	27	28	29	30	31	35	1·98	1·97	1·95	1·93	1·91	1·89	1·88	1·86	1·84	1·82	1·81	1·77	690
700	14	15	16	17	18	19	20	22	23	24	25	26	27	31	2·04	2·02	2·00	1·98	1·97	1·95	1·93	1·91	1·89	1·87	1·85	1·82	700
710	10	11	12	13	15	16	17	18	19	20	22	23	24	28	2·08	2·06	2·04	2·03	2·01	1·99	1·97	1·95	1·93	1·91	1·89	1·85	710
720	7	8	9	11	12	13	14	15	16	18	19	20	21	26	2·11	2·09	2·07	2·05	2·03	2·01	2·00	1·97	1·95	1·93	1·91	1·88	720
730	5	6	7	9	10	11	12	13	14	16	17	18	19	24	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·94	1·90	730
740	4	5	6	7	8	9	10	12	13	14	16	17	18	22	2·15	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·91	740
750	3	4	5	6	7	9	10	11	12	14	15	16	18	22	2·16	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·92	750

Unit of T = 0ᵈ·001.

NEW MOON. TABLE B.

	T Year														L Year												
II	−4000	−3600	−3200	−2800	−2400	−2000	−1600	−1200	−800	−400	0	400	800	2000	−4000	−3500	−3000	−2500	−2000	−1500	−1000	−500	0	500	1000	2000	II
															−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	−°	
750	3	4	5	6	7	9	10	11	12	14	15	16	18	22	2·16	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·92	750
760	3	4	5	6	7	9	10	11	12	14	15	16	18	22	2·16	2·14	2·12	2·10	2·08	2·06	2·04	2·02	2·00	1·98	1·96	1·92	760
770	3	5	6	7	8	9	11	12	13	15	16	17	19	23	2·15	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·91	770
780	5	6	8	9	10	11	12	13	15	16	17	19	20	24	2·13	2·11	2·09	2·07	2·05	2·03	2·01	1·99	1·97	1·95	1·93	1·89	780
790	8	9	10	11	12	13	15	16	17	18	19	21	22	26	2·10	2·08	2·06	2·05	2·03	2·01	1·99	1·97	1·95	1·93	1·91	1·87	790
800	11	12	13	14	15	16	18	19	20	21	22	24	25	29	2·06	2·04	2·02	2·01	1·99	1·97	1·95	1·93	1·91	1·89	1·87	1·84	800
810	15	16	17	18	19	20	21	23	24	25	26	27	29	33	2·02	2·00	1·98	1·97	1·95	1·93	1·91	1·89	1·87	1·85	1·83	1·80	810
820	20	21	22	23	24	25	26	27	28	29	30	32	33	37	1·97	1·95	1·94	1·92	1·90	1·88	1·87	1·85	1·83	1·81	1·79	1·75	820
830	25	26	27	28	29	30	31	32	33	34	35	37	38	41	1·91	1·90	1·88	1·86	1·84	1·82	1·81	1·79	1·77	1·75	1·74	1·70	830
840	31	32	33	34	35	36	37	38	39	40	41	42	43	47	1·84	1·83	1·81	1·80	1·78	1·76	1·74	1·73	1·71	1·69	1·68	1·64	840
850	38	39	40	40	41	42	43	44	45	46	47	48	49	53	1·77	1·76	1·74	1·73	1·71	1·69	1·67	1·66	1·64	1·62	1·61	1·57	850
860	45	46	47	48	49	49	50	51	52	53	54	55	56	59	1·69	1·67	1·66	1·64	1·62	1·61	1·59	1·58	1·56	1·54	1·53	1·50	860
870	53	54	55	56	56	57	58	59	60	61	62	62	63	66	1·60	1·58	1·57	1·56	1·54	1·53	1·51	1·50	1·48	1·46	1·45	1·42	870
880	62	63	64	64	65	66	66	67	68	69	70	70	71	74	1·50	1·49	1·47	1·46	1·45	1·43	1·42	1·41	1·39	1·37	1·36	1·34	880
890	71	72	73	73	74	75	75	76	77	78	78	79	80	82	1·40	1·39	1·38	1·37	1·35	1·34	1·32	1·31	1·30	1·29	1·28	1·25	890
900	80	81	82	83	83	84	85	85	86	87	87	88	89	91	1·29	1·28	1·27	1·26	1·25	1·24	1·22	1·21	1·20	1·19	1·18	1·15	900
910	91	91	92	93	93	94	95	95	96	96	97	97	98	100	1·17	1·17	1·16	1·15	1·13	1·12	1·11	1·10	1·09	1·08	1·07	1·05	910
920	102	102	103	103	104	104	105	105	106	106	107	107	108	110	1·05	1·05	1·04	1·03	1·02	1·01	1·00	0·99	0·98	0·97	0·96	0·94	920
930	113	114	114	114	115	115	115	116	116	117	117	117	118	120	0·93	0·92	0·92	0·91	0·91	0·90	0·89	0·88	0·87	0·86	0·85	0·83	930
940	125	125	125	126	126	126	126	127	127	127	128	128	128	130	0·80	0·80	0·79	0·79	0·78	0·77	0·77	0·76	0·75	0·74	0·74	0·72	940
950	137	137	137	137	137	138	138	138	138	138	139	139	139	140	0·68	0·67	0·67	0·66	0·65	0·65	0·64	0·64	0·63	0·62	0·62	0·61	950
960	149	149	149	149	149	149	149	149	149	149	150	150	150	151	0·54	0·54	0·54	0·53	0·53	0·53	0·52	0·52	0·51	0·51	0·50	0·49	960
970	161	161	161	161	161	161	161	161	161	161	161	161	161	162	0·41	0·41	0·40	0·40	0·40	0·39	0·39	0·39	0·38	0·38	0·38	0·37	970
980	174	173	173	173	173	173	173	173	173	173	173	172	172	173	0·27	0·27	0·27	0·27	0·27	0·27	0·26	0·26	0·26	0·26	0·26	0·25	980
990	187	186	186	186	185	185	185	185	185	184	184	184	184	184	0·14	0·14	0·14	0·14	0·13	0·13	0·13	0·13	0·13	0·13	0·13	0·12	990
1000	199	198	198	198	198	197	197	197	196	196	196	196	195	195	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	0·00	1000

Unit of T = 0ᵈ·001.

TABLE C.

Conversion of the days of T into Julian months and days.

Jan. 0	Feb. 0	Mar. 0	Apr. 0	May 0	June 0	July 0	Aug. 0	Sept. 0	Oct. 0	Nov. 0	Dec. 0
0	31	60	91	121	152	182	213	244	274	305	335
366	397	425	456	486	517	547	578	609	639	670	700
731	762	790	821	851	882	912	943	974	1004	1035	1065
1096	1127	1155	1186	1216	1247	1277	1308	1339	1369	1400	1430
1461	1492	1521	1552	1582	1613	1643	1674	1705	1735	1766	1796
1827	1858	1886	1917	1947	1978	2008	2039	2070	2100	2131	2161
2192	2223	2251	2282	2312	2343	2373	2404	2435	2465	2496	2526
2557	2588	2616	2647	2677	2708	2738	2769	2800	2830	2861	2891
2922											

TABLE D.

Conversion of decimals of T into hours and minutes.

Morning.	Afternoon.	0 h	0 m	1 m	2 m	3 m	4 m	5 m	6 m	7 m	8 m	9 m
0·00	0·50	0	0	1	3	4	6	7	9	10	12	13
0·01	0·51		14	16	17	19	20	22	23	24	26	27
0·02	0·52		29	30	32	33	35	36	37	39	40	42
0·03	0·53		43	45	46	48	49	50	52	53	55	56
0·04	0·54		58	59								
		1			0	2	3	5	6	8	9	11
0·05	0·55		12	13	15	16	18	19	21	22	23	25
0·06	0·56		26	28	29	31	32	34	35	36	38	39
0·07	0·57		41	42	44	45	47	48	49	51	52	54
0·08	0·58		55	57	58							
		2				0	1	2	4	5	7	8
0·09	0·59		10	11	12	14	15	17	18	20	21	23
0·10	0·60		24	25	27	28	30	31	33	34	36	37
0·11	0·61		38	40	41	43	44	46	47	48	50	51
0·12	0·62		53	54	56	57	59					
		3						0	1	3	4	6
0·13	0·63		7	9	10	12	13	14	16	17	19	20
0·14	0·64		22	23	24	26	27	29	30	32	33	35
0·15	0·65		36	37	39	40	42	43	45	46	48	49
0·16	0·66		50	52	53	55	56	58	59			
		4								0	2	3
0·17	0·67		5	6	8	9	11	12	13	15	16	18
0·18	0·68		19	21	22	24	25	26	28	29	31	32
0·19	0·69		34	35	36	38	39	41	42	44	45	47
0·20	0·70		48	49	51	52	54	55	57	58		
		5									0	1
0·21	0·71		2	4	5	7	8	10	11	12	14	15
0·22	0·72		17	18	20	21	23	24	25	27	28	30
0·23	0·73		31	33	34	36	37	38	40	41	43	44
0·24	0·74		46	47	48	50	51	53	54	56	57	59
0·25	0·75	6	0	1	3	4	6	7	9	10	12	13
0·26	0·76		14	16	17	19	20	22	23	24	26	27
0·27	0·77		29	30	32	33	35	36	37	39	40	42
0·28	0·78		43	45	46	48	49	50	52	53	55	56
0·29	0·79		58	59								
		7			0	2	3	5	6	8	9	11
0·30	0·80		12	13	15	16	18	19	21	22	24	25
0·31	0·81		26	28	29	31	32	34	35	36	38	39
0·32	0·82		41	42	44	45	47	48	49	51	52	54
0·33	0·83		55	57	58							
		8				0	1	2	4	5	7	8
0·34	0·84		10	11	12	14	15	17	18	20	21	23
0·35	0·85		24	25	27	28	30	31	33	34	36	37
0·36	0·86		38	40	41	43	44	46	47	48	50	51
0·37	0·87		53	54	56	57	59					
		9						0	1	3	4	6
0·38	0·88		7	9	10	12	13	14	16	17	19	20
0·39	0·89		22	23	24	26	27	29	30	32	33	35
0·40	0·90		36	37	39	40	42	43	45	46	48	49
0·41	0·91		50	52	53	55	56	58	59			
		10								0	2	3
0·42	0·92		5	6	8	9	11	12	13	15	16	18
0·43	0·93		19	21	22	24	25	26	28	29	31	32
0·44	0·94		34	35	36	38	39	41	42	44	45	47
0·45	0·95		48	49	51	52	54	55	57	58		
		11									0	1
0·46	0·96		2	4	5	7	8	10	11	12	14	15
0·47	0·97		17	18	20	21	23	24	25	27	28	30
0·48	0·98		31	33	34	36	37	38	40	41	43	44
0·49	0·99		46	47	48	50	51	53	54	56	57	59

TABLE E.

Correction to the Babylonian time of new moon.

	h.	m.
Greenwich	−2	58
Rome	−2	8
Athens	−1	23
Constantinople	−1	2
Alexandria	−	58
Memphis	−	53
Assuan	−	47
Jerusalem	−	37
Boghazkeui	−	39
Mecca	−	18
Nineveh	−	5
Sippara	−	3
Seleucia, Borsippa		0
Kish	+	1
Nippur	+	3
Erech	+	4
Ur, Isin, Ellasar	+	6
Lagash	+	7
Lanka (Ceylon)	+2	25
Loyang (China)	+4	33

TABLE F.

Latitude β of the moon at the moment of new moon.

u	u	β	u	u
°	°	+°	°	°
180	0	$0{\cdot}00_{44}$	360	180
175	5	$0{\cdot}44_{44}$	355	185
170	10	$0{\cdot}88_{42}$	350	190
165	15	$1{\cdot}30_{41}$	345	195
160	20	$1{\cdot}71_{40}$	340	200
155	25	$2{\cdot}11_{38}$	335	205
150	30	$2{\cdot}49_{37}$	330	210
145	35	$2{\cdot}86_{35}$	325	215
140	40	$3{\cdot}21_{33}$	320	220
135	45	$3{\cdot}54_{29}$	315	225
130	50	$3{\cdot}83_{26}$	310	230
125	55	$4{\cdot}09_{23}$	305	235
120	60	$4{\cdot}32_{21}$	300	240
115	65	$4{\cdot}53_{17}$	295	245
110	70	$4{\cdot}70_{13}$	290	250
105	75	$4{\cdot}83_{10}$	285	255
100	80	$4{\cdot}93_{5}$	280	260
95	85	$4{\cdot}98_{2}$	275	265
90	90	5·00	270	270
		−		

If the Argument u is on the right hand the lower sign of β is to be used.

TABLE G. Transition from New Moon to Crescent at Babylon.

Hours which must elapse from New Moon to 6 p.m. on day of appearance of Crescent.

☉	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°	250°	☉
0	19·4	19·4	19·5	19·6	19·7	19·8	19·9	20·1	20·2	20·4	20·6	20·7	20·9	21·0	21·0	21·1	21·2	21·2	0
10	19·3	19·3	19·4	19·5	19·6	19·8	19·9	20·1	20·2	20·4	20·6	20·8	20·9	21·0	21·1	21·1	21·2	21·2	10
20	19·1	19·2	19·3	19·4	19·5	19·7	19·9	20·1	20·3	20·5	20·7	20·9	21·0	21·1	21·2	21·2	21·3	21·3	20
30	18·9	19·0	19·1	19·3	19·5	19·7	19·9	20·2	20·4	20·7	20·9	21·1	21·2	21·3	21·4	21·4	21·5	21·5	30
40	18·7	18·8	18·9	19·1	19·4	19·7	20·0	20·3	20·6	20·9	21·2	21·4	21·5	21·6	21·7	21·7	21·8	21·8	40
50	18·4	18·5	18·7	19·0	19·3	19·6	20·0	20·4	20·8	21·2	21·6	21·8	22·0	22·1	22·2	22·3	22·4	22·4	50
60	18·3	18·4	18·6	18·9	19·2	19·6	20·1	20·7	21·2	21·7	22·2	22·5	22·7	22·9	23·0	23·1	23·2	23·2	60
70	18·2	18·3	18·6	18·9	19·3	19·8	20·3	21·0	21·7	22·3	22·8	23·2	23·5	23·8	24·0	24·1	24·2	24·2	70
80	18·3	18·5	18·7	19·0	19·4	19·9	20·6	21·4	22·2	22·9	23·6	24·1	24·4	24·7	25·0	25·2	25·3	25·4	80
90	18·4	18·6	18·9	19·2	19·6	20·2	21·0	21·9	22·8	23·7	24·5	25·1	25·5	25·8	26·1	26·4	26·6	26·7	90
100	18·6	18·8	19·1	19·5	19·9	20·6	21·5	22·5	23·5	24·6	25·5	26·1	26·6	27·0	27·4	27·7	27·9	28·1	100
110	18·9	19·1	19·4	19·8	20·3	21·1	22·0	23·2	24·3	25·4	26·4	27·1	27·7	28·2	28·7	29·0	29·2	29·4	110
120	19·4	19·6	19·9	20·3	20·9	21·7	22·7	23·9	25·0	26·2	27·3	28·1	28·8	29·4	29·9	30·2	30·5	30·7	120
130	19·9	20·1	20·4	20·9	21·5	22·4	23·5	24·7	25·8	27·0	28·2	29·1	29·8	30·5	31·0	31·4	31·7	31·9	130
140	20·4	20·6	21·0	21·5	22·1	23·1	24·2	25·4	26·7	27·9	29·1	30·1	30·9	31·6	32·1	32·5	32·9	33·1	140
150	20·9	21·1	21·5	22·0	22·7	23·8	24·9	26·2	27·5	28·8	30·0	31·1	32·0	32·7	33·3	33·7	34·1	34·2	150
160	21·5	21·7	22·1	22·6	23·4	24·5	25·7	27·0	28·3	29·7	31·0	32·1	33·1	33·8	34·4	34·9	35·3	35·4	160
170	22·1	22·3	22·7	23·3	24·1	25·2	26·4	27·7	29·0	30·5	31·9	33·0	34·0	34·7	35·3	35·8	36·2	36·4	170
180	22·6	22·8	23·2	23·8	24·6	25·7	26·9	28·2	29·5	31·0	32·4	33·5	34·5	35·2	35·8	36·4	36·8	37·0	180
190	22·6	22·8	23·2	23·8	24·6	25·6	26·8	28·1	29·5	30·9	32·3	33·4	34·4	35·1	35·7	36·3	36·7	36·9	190
200	22·6	22·8	23·2	23·7	24·5	25·5	26·6	28·0	29·4	30·8	32·2	33·3	34·2	35·0	35·6	36·2	36·6	36·7	200
210	22·5	22·6	23·0	23·5	24·3	25·3	26·4	27·8	29·2	30·6	32·0	33·0	33·9	34·7	35·3	35·9	36·2	36·3	210
220	22·3	22·4	22·8	23·3	24·0	25·0	26·1	27·4	28·7	30·1	31·5	32·5	33·3	34·0	34·5	35·1	35·4	35·5	220
230	22·0	22·2	22·5	23·0	23·7	24·6	25·7	26·9	28·0	29·3	30·6	31·6	32·4	33·0	33·5	33·9	34·2	34·4	230
240	21·6	21·8	22·1	22·6	23·3	24·1	25·1	26·2	27·2	28·4	29·5	30·4	31·1	31·7	32·2	32·5	32·8	33·0	240
250	21·1	21·3	21·6	22·1	22·7	23·5	24·4	25·4	26·3	27·3	28·3	29·1	29·8	30·3	30·8	31·1	31·4	31·6	250
260	20·6	20·8	21·1	21·6	22·2	22·9	23·7	24·6	25·4	26·2	27·1	27·8	28·4	28·9	29·4	29·7	30·0	30·2	260
270	20·2	20·3	20·6	21·1	21·7	22·3	23·1	23·8	24·5	25·2	26·0	26·6	27·1	27·6	28·0	28·3	28·5	28·7	270
280	19·9	20·0	20·3	20·6	21·1	21·7	22·4	23·1	23·7	24·3	25·0	25·5	26·0	26·4	26·7	27·0	27·2	27·3	280
290	19·6	19·7	19·9	20·2	20·6	21·1	21·7	22·3	22·9	23·5	24·1	24·6	25·0	25·3	25·5	25·7	25·9	26·0	290
300	19·4	19·5	19·7	19·9	20·2	20·7	21·2	21·7	22·3	22·8	23·3	23·7	24·1	24·4	24·5	24·6	24·8	24·8	300
310	19·3	19·4	19·5	19·7	19·9	20·3	20·8	21·3	21·8	22·3	22·7	23·0	23·3	23·5	23·7	23·8	23·9	23·9	310
320	19·4	19·5	19·6	19·7	19·9	20·1	20·5	20·9	21·3	21·8	22·2	22·4	22·6	22·8	23·0	23·1	23·2	23·2	320
330	19·6	19·6	19·6	19·7	19·8	20·0	20·4	20·7	21·0	21·3	21·7	21·8	22·0	22·2	22·4	22·5	22·6	22·6	330
340	19·6	19·6	19·6	19·7	19·8	20·0	20·3	20·5	20·7	20·9	21·2	21·4	21·6	21·7	21·8	21·9	22·0	22·0	340
350	19·5	19·5	19·6	19·6	19·8	19·9	20·1	20·3	20·4	20·6	20·8	20·9	21·1	21·2	21·3	21·4	21·5	21·5	350
360	19·4	19·4	19·5	19·6	19·7	19·8	19·9	20·1	20·2	20·4	20·6	20·7	20·9	21·0	21·0	21·1	21·2	21·2	360
☉	70	60	50	40	30	20	10	0	350	340	330	320	310	300	290	280	270	260	☉

TABLE H.

Correction in hours.

I	☉=0°/360° 90°	180°	270°	☉=60°/300° 90°	180°	270°	☉=120°/240° 90°	180°	270°	☉=180° 90°	180°	270°	I
975	−2·2	−2·5	−2·5	−2·2	−2·6	−2·9	−2·3	−3·2	−3·8	−2·4	−3·5	−4·4	975
0	−2·2	−2·5	−2·5	−2·2	−2·6	−2·8	−2·3	−3·1	−3·7	−2·4	−3·4	−4·3	950
25	−2·1	−2·4	−2·4	−2·1	−2·5	−2·6	−2·2	−2·9	−3·5	−2·3	−3·2	−4·1	925
50	−1·9	−2·2	−2·2	−1·9	−2·3	−2·4	−2·1	−2·7	−3·3	−2·2	−2·9	−3·8	900
75	−1·7	−2·0	−2·0	−1·7	−2·1	−2·2	−1·9	−2·5	−3·0	−2·0	−2·6	−3·3	875
100	−1·5	−1·7	−1·7	−1·5	−1·8	−1·9	−1·6	−2·2	−2·6	−1·7	−2·3	−2·8	850
125	−1·2	−1·4	−1·4	−1·2	−1·5	−1·6	−1·3	−1·8	−2·2	−1·4	−1·9	−2·3	825
150	−0·9	−1·1	−1·1	−0·9	−1·2	−1·2	−1·0	−1·4	−1·7	−1·1	−1·5	−1·8	800
175	−0·6	−0·7	−0·7	−0·6	−0·8	−0·8	−0·7	−0·9	−1·2	−0·7	−1·0	−1·3	775
200	−0·3	−0·4	−0·4	−0·3	−0·4	−0·4	−0·4	−0·5	−0·6	−0·4	−0·5	−0·7	750
225	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	725
250	+0·4	+0·4	+0·5	+0·4	+0·5	+0·5	+0·4	+0·5	+0·6	+0·5	+0·6	+0·7	700
275	+0·8	+0·8	+0·9	+0·8	+0·9	+1·0	+0·8	+1·0	+1·2	+0·9	+1·2	+1·4	675
300	+1·2	+1·2	+1·3	+1·2	+1·3	+1·4	+1·2	+1·5	+1·7	+1·3	+1·7	+2·0	650
325	+1·5	+1·6	+1·7	+1·5	+1·7	+1·8	+1·6	+1·9	+2·2	+1·7	+2·2	+2·6	625
350	+1·8	+1·9	+2·0	+1·8	+2·1	+2·1	+1·9	+2·3	+2·7	+2·1	+2·6	+3·1	600
375	+2·1	+2·2	+2·3	+2·1	+2·4	+2·4	+2·2	+2·7	+3·2	+2·4	+3·0	+3·6	575
400	+2·3	+2·4	+2·5	+2·3	+2·6	+2·7	+2·4	+3·0	+3·6	+2·6	+3·4	+4·0	550
425	+2·5	+2·6	+2·7	+2·5	+2·8	+3·0	+2·6	+3·3	+4·0	+2·8	+3·7	+4·4	525
450	+2·7	+2·8	+2·9	+2·7	+3·0	+3·2	+2·8	+3·5	+4·2	+3·0	+3·9	+4·7	500
475	+2·8	+2·9	+3·0	+2·8	+3·1	+3·3	+2·9	+3·6	+4·3	+3·1	+4·0	+4·8	475
I	90	360	270	90	360	270	90	360	270	90	360	270	I

MERCURY.

CYCLE TABLE.

Year	I	T	L
		d	°
−2099·31	150	607·8	138·1
−2086·31	153	975·8	140·9
−2073·30	156	1343·7	143·7
−2060·29	159	250·7	146·5
−2047·29	161	618·7	149·3
−2034·28	164	986·7	152·1
−2021·27	167	1354·7	154·9
−2008·27	170	261·6	157·6
−1995·26	173	629·6	160·4
−1982·25	176	997·6	163·2
−1969·24	179	1365·6	166·0
−1956·24	182	272·6	168·8
−1943·23	184	640·5	171·6
−1930·22	187	1008·5	174·4
−1917·21	190	1376·5	177·1
−1904·21	193	283·5	179·9
−1891·20	196	651·5	182·7
−1878·19	199	1019·4	185·5
−1865·18	202	1387·4	188·3
−1852·18	205	294·4	191·1
−1839·17	207	662·4	193·8
−1826·16	210	1030·4	196·6
−1813·15	213	1398·3	199·4
−1800·15	216	305·3	202·2
−1787·14	219	673·3	205·0
−1774·13	222	1041·3	207·8
−1761·12	225	1409·3	210·6
−1748·12	228	316·2	213·4
−1735·11	230	684·2	216·1
−1722·10	233	1052·2	218·9
−1709·09	236	1420·2	221·7
−1696·09	239	327·2	224·5
−1683·08	242	695·1	227·3
−1670·07	245	1063·1	230·1
−1657·06	248	1431·1	232·9
−1644·06	251	338·1	235·6
−1631·05	253	706·1	238·4
−1618·04	256	1074·0	241·2
−1605·03	259	1442·0	244·0
−1592·03	262	349·0	246·8
−1579·02	265	717·0	249·6
−1566·01	268	1085·0	252·4
−1553·00	271	1452·9	255·1
−1539·99	274	359·9	257·9
−1526·99	276	727·9	260·7
−1513·98	279	1095·9	263·5
−1500·97	282	2·8	266·3
−1487·96	285	370·8	269·1
−1474·96	288	738·8	271·9
−1461·95	291	1106·8	274·6
−1448·94	294	13·8	277·4
−1435·93	296	381·8	280·2
−1422·93	299	749·8	283·0
−1409·92	302	1117·8	285·8
−1396·91	305	24·8	288·6
−1383·90	308	392·8	291·3
−1370·90	311	760·7	294·1
−1357·89	314	1128·7	296·9
−1344·88	317	35·7	299·7
−1331·88	319	403·7	302·5
−1318·87	322	771·6	305·3
−1305·86	325	1139·6	308·0
−1292·85	328	46·6	310·8
−1279·85	331	414·6	313·6
−1266·84	334	782·6	316·4
−1253·83	337	1150·5	319·2
−1240·82	340	57·5	322·0
−1227·82	342	425·5	324·7
−1214·81	345	793·5	327·5
−1201·80	348	1161·5	330·3
−1188·79	351	68·4	333·1
−1175·79	354	436·4	335·9
−1162·78	357	804·4	338·7
−1149·77	360	1172·4	341·4
−1136·76	363	79·4	344·2
−1123·76	365	447·3	347·0
−1110·75	368	815·3	349·8
−1097·74	371	1183·3	352·6
−1084·73	374	90·3	355·4
−1071·73	377	458·2	358·2
−1058·72	380	826·2	1·0
−1045·71	383	1194·2	3·7
−1032·70	386	101·2	6·5
−1019·70	388	469·2	9·3
−1006·69	391	837·1	12·1

Year	I	T	L
		d	°
− 993·68	394	1205·1	14·9
− 980·67	397	112·1	17·7
− 967·67	0	480·1	20·5
− 954·66	3	848·1	23·3
− 941·65	6	1216·0	26·0
− 928·64	9	123·0	28·8
− 915·64	11	491·0	31·6
− 902·63	14	859·0	34·4
− 889·62	17	1227·0	37·2
− 876·61	20	133·9	40·0
− 863·61	23	501·9	42·7
− 850·60	26	869·9	45·5
− 837·59	29	1237·9	48·3
− 824·58	31	144·8	51·1
− 811·58	34	512·8	53·9
− 798·57	37	880·8	56·7
− 785·56	40	1248·8	59·4
− 772·55	43	155·8	62·2
− 759·55	46	523·7	65·0
− 746·54	49	891·7	67·8
− 733·53	52	1259·7	70·6
− 720·52	54	166·7	73·4
− 707·52	57	534·7	76·2
− 694·51	60	902·6	79·0
− 681·50	63	1270·6	81·8
− 668·49	66	177·6	84·6
− 655·49	69	545·6	87·4
− 642·48	72	913·5	90·2
− 629·47	74	1281·5	92·9
− 616·46	77	188·5	95·7
− 603·46	80	556·5	98·5
− 590·45	83	924·5	101·3
− 577·44	86	1292·4	104·1
− 564·43	89	199·4	106·9
− 551·43	92	567·4	109·6
− 538·42	95	935·4	112·4
− 525·41	97	1303·4	115·2
− 512·41	100	210·3	118·0
− 499·40	103	578·3	120·7
− 486·39	106	946·3	123·5
− 473·38	109	1314·3	126·3
− 460·38	112	221·2	129·1
− 447·37	115	589·2	131·8
− 434·36	118	957·2	134·6
− 421·35	120	1325·2	137·4
− 408·35	123	232·2	140·2
− 395·34	126	600·1	143·0
− 382·33	129	968·1	145·8
− 369·32	132	1336·1	148·6
− 356·32	135	243·1	151·4
− 343·31	138	611·0	154·1
− 330·30	141	979·0	156·9
− 317·29	143	1347·0	159·7
− 304·29	146	254·0	162·5
− 291·28	149	622·0	165·3
− 278·27	152	989·9	168·1
− 265·26	155	1357·9	170·9
− 252·26	158	264·9	173·6
− 239·25	161	632·9	176·4
− 226·24	164	1000·9	179·2
− 213·23	166	1368·8	182·0
− 200·23	169	275·8	184·8
− 187·22	172	643·8	187·6
− 174·21	175	1011·8	190·4
− 161·20	178	1379·8	193·2
− 148·20	181	286·8	195·9
− 135·19	184	654·7	198·7
− 122·18	187	1022·7	201·5
− 109·17	189	1390·7	204·3
− 96·16	192	297·7	207·1
− 83·16	195	665·7	209·9
− 70·15	198	1033·6	212·7
− 57·14	201	1401·6	215·5
− 44·13	204	308·6	218·2
− 31·13	207	676·6	221·0
− 18·12	210	1044·6	223·8
− 5·11	212	1412·6	226·6
1924·20	307	65·9	341·2
1937·21	309	433·8	344·0
1950·22	312	801·8	346·8
1963·23	315	1169·8	349·6
1976·24	318	10·8	352·4

PERIOD TABLE.

Conjunction

Superior Year	I	T	L	Inferior Year	I	T	L
		d	°			d	°
0·00	0	0·0	0·0	0·16	263	57·9	57·1
0·32	127	115·9	114·2	0·48	390	173·8	171·3
0·63	254	231·8	228·4	0·79	117	289·7	285·5
0·95	381	347·6	342·6	1·11	244	405·6	39·7
1·27	108	463·5	96·9	1·43	371	521·4	154·0
1·59	235	579·4	211·1	1·75	98	637·3	268·2
1·90	361	695·3	325·3	2·06	225	753·2	22·4
2·22	88	811·1	79·5	2·38	352	869·1	136·6
2·54	215	927·0	193·7	2·70	79	985·0	250·8
2·86	342	1042·9	307·9	3·01	206	1100·8	5·0
3·17	69	1158·8	62·1	3·33	332	1216·7	119·2
3·49	196	1274·7	176·4	3·65	59	1332·6	233·5
3·81	323	1390·5	290·6	3·97	186	1448·5	347·7
4·12	50	45·4	44·8	4·28	313	103·3	101·9
4·44	177	161·3	159·0	4·60	40	219·2	216·1
4·76	304	277·2	273·2	4·92	167	335·1	330·3
5·08	30	393·0	27·4	5·24	294	451·0	84·5
5·39	157	508·9	141·6	5·55	21	566·9	198·7
5·71	284	624·8	255·9	5·87	148	682·7	313·0
6·03	11	740·7	10·1	6·19	275	798·6	67·2
6·35	138	856·6	124·3	6·50	1	914·5	181·4
6·66	265	972·4	238·5	6·82	128	1030·4	295·6
6·98	392	1088·3	352·7	7·14	255	1146·2	49·8
7·30	119	1204·2	106·9	7·46	382	1262·1	164·0
7·62	246	1320·1	221·1	7·77	109	1378·0	278·2
7·93	373	1435·9	335·4	8·09	236	32·9	32·5
8·25	99	90·8	89·6	8·41	363	148·8	146·7
8·57	226	206·7	203·8	8·73	90	264·6	260·9
8·88	353	322·6	318·0	9·04	217	380·5	15·1
9·20	80	438·5	72·2	9·36	344	496·4	129·3
9·52	207	554·3	186·4	9·68	70	612·3	243·5
9·84	334	670·2	300·6	9·99	197	728·1	357·7
10·15	61	786·1	54·9	10·31	324	844·0	112·0
10·47	188	902·0	169·1	10·63	51	959·9	226·2
10·79	315	1017·8	283·3	10·95	178	1075·8	340·4
11·11	42	1133·7	37·5	11·26	305	1191·7	94·6
11·42	168	1249·6	151·7	11·58	32	1307·5	208·8
11·74	295	1365·5	265·9	11·90	159	1423·4	323·0
12·06	22	20·3	20·1	12·22	286	78·3	77·2
12·37	149	136·2	134·4	12·53	13	194·2	191·5
12·69	276	252·1	248·6	12·85	139	310·0	305·7

TABLE A.

Arg. I	Superior Conjunction T	L	Inferior Conjunction T	L
	d	°	d	°
0	9·1	11·9	8·7	9·9
10	8·1	10·6	7·8	9·3
20	7·2	9·3	6·9	8·8
30	6·2	8·0	6·1	8·3
40	5·3	6·8	5·3	7·8
50	4·4	5·7	4·6	7·4
60	3·6	4·6	4·0	7·0
70	2·9	3·7	3·5	6·7
80	2·3	2·9	3·0	6·4
90	1·7	2·1	2·5	6·2
100	1·2	1·5	2·2	6·1
110	0·8	1·0	2·0	6·1
120	0·7	0·8	1·9	6·1
130	0·8	0·9	2·1	6·2
140	1·1	1·2	2·5	6·5
150	1·7	1·9	3·1	7·0
160	2·6	3·0	4·0	7·7
170	3·8	4·4	5·1	8·6
180	5·3	6·1	6·3	9·7
190	7·0	8·0	7·7	10·8
200	8·7	10·0	9·3	11·9
210	10·4	12·0	10·8	13·0
220	12·1	14·0	12·1	14·0
230	13·6	15·8	13·3	14·9
240	14·9	17·4	14·4	15·6
250	15·9	18·7	15·2	16·0
260	16·6	19·7	15·7	16·3
270	17·0	20·5	16·0	16·4
280	17·1	21·0	16·1	16·3
290	17·1	21·0	16·1	16·1
300	16·9	20·8	15·9	15·8
310	16·5	20·4	15·4	15·3
320	15·9	19·9	14·9	14·8
330	15·3	19·2	14·3	14·2
340	14·5	18·4	13·6	13·6
350	13·7	17·5	12·9	13·0
360	12·9	16·6	12·2	12·5
370	12·0	15·5	11·4	11·9
380	11·0	14·3	10·5	11·3
390	10·1	13·1	9·6	10·6
400	9·1	11·9	8·7	9·9

TABLE B.

Superior Conj.

☉	T m last	T e first
°	d	d
0	−21	+ 8
10	−21	+ 8
20	−22	+ 8
30	−22	+ 8
40	−22	+ 8
50	−21	+ 9
60	−20	+10
70	−19	+11
80	−17	+13
90	−15	+16
100	−13	+20
110	−12	+25
120	−11	+30
130	−11	+36
140	−11	+40
150	−12	+42
160	−13	+42
170	−14	+39
180	−15	+36
190	−16	+34
200	−16	+32
210	−17	+29
220	−17	+27
230	−17	+24
240	−17	+21
250	−17	+19
260	−17	+17
270	−17	+16
280	−17	+14
290	−17	+13
300	−17	+12
310	−17	+11
320	−18	+10
330	−19	+ 9
340	−20	+ 9
350	−20	+ 8
360	−21	+ 8

TABLE C.

Inferior Conjunction.

☉	T e last	T m first	☉	T e last	T m first
°	d	d	°	d	d
0	− 7	+31	180	−16	+ 6
10	− 7	+33	190	−16	+ 6
20	− 7	+33	200	−15	+ 6
30	− 7	+33	210	−14	+ 6
40	− 8	+33	220	−13	+ 6
50	− 8	+32	230	−11	+ 6
60	− 8	+27	240	− 9	+ 6
70	− 9	+21	250	− 8	+ 6
80	−10	+16	260	− 7	+ 6
90	−11	+13	270	− 7	+ 6
100	−11	+11	280	− 6	+ 7
110	−12	+10	290	− 6	+ 8
120	−13	+ 9	300	− 6	+ 9
130	−14	+ 8	310	− 6	+11
140	−15	+ 8	320	− 7	+13
150	−16	+ 7	330	− 7	+16
160	−16	+ 7	340	− 7	+21
170	−16	+ 7	350	− 7	+26
180	−16	+ 6	360	− 7	+31

TABLE D.

Inferior Conjunction.

I	gr. elong. T ev.	T mor.	station T ev.	T mor.
	− d	+ d	− d	+ d
0	19	20	10	10
20	18	21	10	11
40	17	23	9	11
60	16	25	9	11
80	16	26	10	12
100	16	27	10	12
120	17	27	10	12
140	18	28	10	12
160	20	27	10	12
180	22	26	11	12
200	24	25	11	12
220	26	22	13	11
240	27	20	14	10
260	28	18	15	9
280	28	17	14	9
300	27	16	14	9
320	26	16	13	8
340	25	16	12	9
360	23	17	11	9
380	21	18	10	9
400	19	20	10	10

VENUS.

CYCLE TABLE.

Year	I	T	L
		d	°
2999·70	184	470·18	356·3
2935·75	162	451·06	337·9
2879·80	143	434·33	321·7
2815·85	122	415·21	303·4
2759·90	103	398·48	287·3
2695·95	81	379·36	268·9
2640·00	62	362·63	252·8
2576·05	40	343·50	234·4
2520·10	21	326·78	218·3
2456·15	0	307·65	199·9
2400·20	381	290·92	183·9
2336·25	359	271·80	165·5
2280·30	340	255·07	149·4
2216·35	319	235·95	131·0
2160·39	300	219·22	114·9
2096·44	278	200·09	96·5
2040·49	259	183·37	80·4
1976·54	237	164·24	62·0
1920·59	219	147·51	45·9
1856·64	197	128·39	27·5
1800·69	178	111·65	11·4
1736·74	156	92·53	353·0
1680·79	137	75·80	336·9
1616·84	116	56·67	318·5
1560·88	97	39·94	302·5
1496·93	75	20·81	284·1
1440·98	56	4·08	267·9
1377·03	35	1445·95	249·5
1321·08	16	1429·21	233·4
1257·13	394	1410·09	215·0
1201·18	375	1393·36	199·0
1137·23	354	1374·22	180·6
1081·27	335	1357·49	164·5
1017·32	313	1338·37	146·1
961·37	294	1321·63	130·0
897·42	272	1302·50	111·6
841·47	253	1285·77	95·5
777·52	232	1266·64	77·1
721·57	213	1249·92	61·0
657·62	191	1230·79	42·6
601·67	172	1214·05	26·5
537·72	151	1194·92	8·1
481·77	132	1178·17	352·0
417·82	110	1159·04	333·6
361·87	91	1142·29	317·6
297·92	70	1123·15	299·2
241·96	51	1106·41	283·1
178·01	29	1087·27	264·7
122·06	10	1070·53	248·6
58·11	388	1051·39	230·2
1920·50	199	180·18	93·9

PERIOD TABLE.

Conjunction

Year	Superior I	Superior T	Superior L	Year	Inferior I	Inferior T	Inferior L
		d	°			d	°
0·00	0	0·0	0·0	0·80	320	291·96	287·8
1·60	239	583·9	215·5	2·40	159	875·88	143·3
3·20	79	1167·8	71·1	4·00	399	1459·80	358·9
4·80	318	290·8	286·6	5·60	238	582·73	214·4
6·39	158	874·7	142·2	7·19	78	1166·65	69·9
7·99	397	1458·6	357·7	8·79	317	289·57	285·5
9·59	237	581·5	213·2	10·39	156	873·49	141·0
11·19	76	1165·5	68·8	11·99	396	1457·41	356·6
12·79	316	288·4	284·3	13·59	235	580·33	212·1
14·39	155	872·3	139·9	15·19	75	1164·26	67·6
15·99	395	1456·2	355·4	16·79	314	287·18	283·2
17·59	234	579·1	210·9	18·39	154	871·10	138·7
19·18	74	1163·1	66·5	19·98	393	1455·02	354·3
20·78	313	286·0	282·0	21·58	233	577·94	209·8
22·38	152	869·9	137·6	23·18	72	1161·87	65·3
23·98	392	1453·8	353·1	24·78	312	284·79	280·9
25·58	231	576·7	208·6	26·38	151	868·71	136·4
27·18	71	1160·7	64·2	27·98	391	1452·63	352·0
28·78	310	283·6	279·7	29·58	230	575·55	207·5
30·38	150	867·5	135·3	31·18	69	1159·47	63·0
31·97	389	1451·4	350·8	32·77	309	282·40	278·6
33·57	229	574·4	206·3	34·37	148	866·32	134·1
35·17	68	1158·3	61·9	35·97	388	1450·24	349·7
36·77	308	281·2	277·4	37·57	227	573·16	205·2
38·37	147	865·1	133·0	39·17	67	1157·08	60·7
39·97	387	1449·0	348·5	40·77	306	280·00	276·3
41·57	226	572·0	204·0	42·37	146	863·93	131·8
43·16	65	1155·9	59·6	43·96	385	1447·85	347·4
44·76	305	278·8	275·1	45·56	225	570·77	202·9
46·36	144	862·7	130·7	47·16	64	1154·69	58·4
47·96	384	1446·7	346·2	48·76	304	277·61	274·0
49·56	223	569·6	201·7	50·36	143	861·54	129·5
51·16	63	1153·5	57·3	51·96	382	1445·46	345·1
52·76	302	276·4	272·8	53·56	222	568·38	200·6
54·36	142	860·3	128·4	55·16	61	1152·30	56·1
55·95	381	1444·3	343·9	56·75	301	275·22	271·7
57·55	221	567·2	199·4	58·35	140	859·14	127·2
59·15	60	1151·1	55·0	59·95	380	1443·07	342·8
60·75	299	274·0	270·5	61·55	219	565·99	198·3
62·35	139	857·9	126·1	63·15	59	1149·91	53·8

TABLE A.

For −1500

I	Sup. T	Sup. L	Inf. T	Conj. var.	Conj. L	I	Sup. T	Sup. L	Inf. T	Conj. var.	Conj. L
	d	°	d D		°		d	°	d D		°
0	4·0	6·0	5·95$_{17}$	−8	8·0	200	5·8	7·8	4·09$_{15}$	+9	6·1
5	4·4	6·6	6·12$_{16}$	−8	8·3	205	5·5	7·3	3·94$_{14}$	+8	5·8
10	4·8	7·1	6·28$_{15}$	−7	8·6	210	5·2	6·9	3·80$_{14}$	+8	5·5
15	5·2	7·7	6·43$_{15}$	−7	8·9	215	4·9	6·4	3·66$_{14}$	+7	5·2
20	5·6	8·2	6·58$_{13}$	−6	9·2	220	4·5	5·9	3·52$_{12}$	+7	5·0
25	6·0	8·8	6·71$_{11}$	−6	9·5	225	4·2	5·4	3·40$_{12}$	+6	4·7
30	6·4	9·3	6·82$_{10}$	−6	9·8	230	3·9	5·0	3·28$_{11}$	+6	4·4
35	6·8	9·9	6·92$_{9}$	−5	10·0	235	3·6	4·6	3·17$_{9}$	+5	4·2
40	7·2	10·4	7·01$_{8}$	−5	10·3	240	3·2	4·1	3·08$_{9}$	+4	4·0
45	7·5	10·8	7·09$_{6}$	−4	10·5	245	2·9	3·7	2·99$_{8}$	+4	3·8
50	7·8	11·2	7·15$_{5}$	−3	10·6	250	2·6	3·3	2·91$_{7}$	+3	3·6
55	8·2	11·7	7·20$_{4}$	−3	10·8	255	2·3	2·9	2·84$_{5}$	+3	3·4
60	8·5	12·1	7·24$_{2}$	−2	10·9	260	2·1	2·5	2·79$_{3}$	+2	3·2
65	8·7	12·5	7·26$_{1}$	−1	11·0	265	1·8	2·1	2·76$_{2}$	+2	3·1
70	9·0	12·8	7·27$_{1}$	0	11·1	270	1·5	1·8	2·74$_{1}$	+1	3·0
75	9·2	13·1	7·26$_{2}$	0	11·2	275	1·3	1·5	2·73$_{0}$	0	2·9
80	9·4	13·3	7·24$_{4}$	0	11·2	280	1·1	1·2	2·73$_{1}$	0	2·8
85	9·5	13·4	7·20$_{5}$	0	11·2	285	0·9	1·0	2·74$_{3}$	0	2·8
90	9·6	13·6	7·15$_{6}$	0	11·2	290	0·7	0·8	2·77$_{5}$	0	2·8
95	9·7	13·7	7·09$_{8}$	+1	11·1	295	0·6	0·6	2·82$_{6}$	−1	2·8
100	9·8	13·8	7·01$_{9}$	+2	11·0	300	0·5	0·5	2·88$_{7}$	−2	2·9
105	9·8	13·8	6·92$_{10}$	+3	10·9	305	0·4	0·4	2·95$_{9}$	−3	2·9
110	9·8	13·7	6·82$_{11}$	+4	10·8	310	0·3	0·3	3·04$_{10}$	−4	3·0
115	9·7	13·6	6·71$_{11}$	+5	10·7	315	0·3	0·4	3·14$_{11}$	−5	3·1
120	9·7	13·5	6·60$_{13}$	+6	10·5	320	0·2	0·4	3·25$_{12}$	−5	3·3
125	9·6	13·4	6·47$_{13}$	+6	10·3	325	0·3	0·4	3·37$_{13}$	−6	3·5
130	9·4	13·2	6·34$_{14}$	+7	10·1	330	0·3	0·5	3·50$_{15}$	−7	3·7
135	9·3	12·9	6·20$_{15}$	+7	9·9	335	0·4	0·7	3·65$_{15}$	−7	3·9
140	9·1	12·7	6·05$_{15}$	+8	9·7	340	0·5	0·9	3·80$_{17}$	−7	4·1
145	8·9	12·4	5·90$_{16}$	+8	9·4	345	0·7	1·1	3·97$_{17}$	−8	4·4
150	8·7	12·1	5·74$_{16}$	+8	9·2	350	0·8	1·4	4·14$_{18}$	−8	4·7
155	8·5	11·7	5·58$_{17}$	+9	8·9	355	1·0	1·7	4·32$_{18}$	−8	5·0
160	8·2	11·3	5·41$_{17}$	+9	8·6	360	1·3	2·1	4·50$_{18}$	−9	5·3
165	8·0	11·0	5·24$_{17}$	+9	8·3	365	1·5	2·5	4·68$_{19}$	−9	5·6
170	7·7	10·6	5·07$_{17}$	+10	8·0	370	1·8	2·9	4·87$_{19}$	−9	5·9
175	7·4	10·2	4·90$_{16}$	+10	7·7	375	2·1	3·4	5·06$_{19}$	−9	6·2
180	7·1	9·7	4·74$_{17}$	+10	7·4	380	2·5	3·9	5·25$_{18}$	−9	6·6
185	6·8	9·3	4·57$_{16}$	+10	7·1	385	2·8	4·4	5·43$_{18}$	−9	6·9
190	6·5	8·8	4·41$_{16}$	+9	6·7	390	3·2	4·9	5·61$_{17}$	−9	7·3
195	6·2	8·3	4·25$_{16}$	+9	6·4	395	3·6	5·5	5·78$_{17}$	−9	7·6
200	5·8	7·8	4·09	+9	6·1	400	4·0	6·0	5·95	−8	8·0

TABLE B.

Superior Conjunction.

☉	Interval	m last T −	e first T +	☉	Interval	m last T −	e first T +
°	d	d	d	°	d	d	d
0	66	42	24	180	60	22	38
10	68	44	24	190	59	22	37
20	69	45	24	200	58	22	36
30	70	46	24	210	58	23	35
40	72	48	24	220	57	23	34
50	73	48	25	230	56	23	33
60	74	48	26	240	55	23	32
70	75	48	27	250	55	24	31
80	75	47	28	260	54	25	29
90	74	44	30	270	54	26	28
100	70	38	32	280	54	27	27
110	66	32	34	290	54	28	26
120	63	28	35	300	56	30	26
130	63	26	37	310	57	32	25
140	62	24	38	320	58	33	25
150	61	23	38	330	59	35	24
160	61	23	38	340	61	38	23
170	60	22	38	350	64	40	24
180	60	22	38	360	66	42	24

m = −3·3

TABLE C.

Inferior Conjunction.

☉	Interval	−1500 e last T	−1500 m first T	☉	Interval	−1500 e last T	−1500 m first T
°	d	d	d	°	d	d	d
0	3·7	− 2·9	+0·8	180	17·6	−13·7	+3·9
10	5·2	− 3·0	+2·2	190	16·7	−12·7	+4·0
20	6·8	− 3·1	+3·7	200	15·4	−11·4	+4·0
30	8·4	− 3·2	+5·2	210	13·6	− 9·6	+4·0
40	9·8	− 3·3	+6·5	220	11·3	− 7·5	+3·8
50	11·1	− 3·5	+7·6	230	9·1	− 5·6	+3·5
60	12·2	− 3·9	+8·3	240	7·1	− 4·1	+3·0
70	13·1	− 4·5	+8·6	250	5·6	− 3·0	+2·6
80	13·7	− 5·4	+8·3	260	4·3	− 2·2	+2·1
90	14·2	− 6·5	+7·7	270	3·2	− 1·6	+1·6
100	14·8	− 7·7	+7·1	280	2·4	− 1·4	+1·0
110	15·7	− 9·1	+6·6	290	2·0	− 1·5	+0·5
120	16·6	−10·4	+6·2	300	1·7	− 1·7	0·0
130	17·2	−11·5	+5·7	310	1·5	− 1·9	−0·4
140	17·7	−12·5	+5·2	320	1·4	− 2·1	−0·7
150	18·2	−13·4	+4·8	330	1·5	− 2·3	−0·8
160	18·3	−13·9	+4·4	340	1·9	− 2·6	−0·7
170	18·1	−14·0	+4·1	350	2·6	− 2·8	−0·2
180	17·6	−13·7	+3·9	360	3·7	− 2·9	+0·8

m = −3·2

Correction T

☉	e last −3000	e last −1500	e last 0	m first −3000	m first −1500	m first 0
°	d	d	d	d	d	d
0	−0·4	0·0	+0·2	+1·4	0·0	−1·3
20	−0·4	0·0	+0·2	+1·9	0·0	−1·8
40	−0·5	0·0	+0·3	+1·9	0·0	−2·0
60	−0·9	0·0	+0·5	+1·2	0·0	−1·8
80	−1·1	0·0	+0·6	+0·7	0·0	−1·0
100	−0·9	0·0	+0·8	+0·1	0·0	−0·2
120	−0·3	0·0	+0·8	0·0	0·0	+0·1
140	0·0	0·0	+0·4	−0·1	0·0	+0·1
160	+0·5	0·0	−0·1	−0·2	0·0	+0·1
180	+1·2	0·0	−0·7	−0·2	0·0	+0·2
200	+1·9	0·0	−1·6	−0·5	0·0	+0·1
220	+1·9	0·0	−2·2	−0·6	0·0	+0·1
240	+1·5	0·0	−1·7	−0·6	0·0	0·0
260	+0·9	0·0	−0·9	−0·7	0·0	0·0
280	+0·4	0·0	−0·4	−0·6	0·0	0·0
300	+0·2	0·0	−0·1	−0·4	0·0	0·0
320	0·0	0·0	0·0	0·0	0·0	−0·1
340	−0·2	0·0	0·0	+0·7	0·0	−0·6
360	−0·4	0·0	+0·2	+1·4	0·0	−1·3

TABLE D.

Inferior Conjunction.

Gr. elong ev.	Gr. elong mor.	Greatest Brilliance ev. T	Greatest Brilliance ev. m	Greatest Brilliance mor. T	Greatest Brilliance mor. m	Station ev. T	Station mor. T
−	+	−		+		−	+
°	°	d		d		d	d
72	71	36	−4·4	35	−4·4	20	20
72	70	36	−4·4	35	−4·4	20	19
72	70	36	−4·3	36	−4·2	22	20
72	70	37	−4·3	36	−4·2	21	20
70	71	37	−4·2	37	−4·2	22	22
70	72	36	−4·2	37	−4·3	23	19
70	72	36	−4·2	37	−4·3	23	19
70	71	35	−4·3	36	−4·4	21	20
72	71	36	−4·4	35	−4·4	20	20

MARS.

CYCLE TABLE.

Year	I	T	L
		d	°
−2148·50	0	155·5	55·9
−2069·50	2	1254·2	59·4
−2022·52	393	880·8	51·6
−1943·52	395	518·5	55·0
−1864·51	397	156·1	58·4
−1785·50	399	1254·8	61·9
−1706·49	2	892·4	65·3
−1627·49	4	530·1	68·8
−1580·51	394	156·8	61·1
−1501·50	396	1255·4	64·6
−1422·49	399	893·1	68·0
−1343·48	1	530·7	71·5
−1264·48	3	168·3	74·9
−1185·47	5	1267·0	78·4
−1138·49	396	893·6	70·6
−1059·48	398	531·2	74·0
− 980·47	0	168·9	77·5
− 901·46	2	1267·5	80·9
− 822·46	5	905·2	84·4
− 775·48	395	531·8	76·7
− 696·47	397	169·4	80·1
− 617·46	399	1268·1	83·6
− 538·46	2	905·7	87·0
− 459·45	4	543·4	90·4
− 412·47	394	170·0	82·6
− 333·46	397	1268·7	86·1
− 254·45	399	906·3	89·5
− 175·45	1	544·0	93·0
− 96·44	3	181·6	96·4
− 49·46	394	1269·2	88·7

Greenwich.

Year	I	T	L
1924·64	395	209·2	126·2
2003·65	397	1307·8	129·7

PERIOD TABLE.

Opposition Year	I	T	L	m	β	Conjunction Year	I	T	L	m
		d	°		°			d	°	
0·00	0	0·0	0·0	−2·8	−7	1·07	227	390·0	24·4	+1·9
2·14	54	779·9	48·7	−2·2	−3	3·20	281	1169·9	73·1	+1·8
4·27	108	98·9	97·5	−1·5	+2	5·34	335	488·8	121·9	+1·6
6·41	162	878·8	146·2	−1·2	+4	7·47	389	1268·8	170·6	+1·4
8·54	216	197·7	195·0	−1·2	+5	9·61	44	587·7	219·3	+1·4
10·68	271	977·7	243·7	−1·4	+4	11·74	98	1367·6	268·1	+1·7
12·81	325	296·6	292·5	−2·0	+1	13·88	152	686·6	316·8	+1·8
14·95	379	1076·6	341·2	−2·6	−5	16·01	206	5·5	5·6	+1·9
17·08	33	395·5	29·9	−2·4	−5	18·15	260	785·5	54·3	+1·8
19·22	87	1175·4	78·7	−1·8	0	20·28	314	104·4	103·0	+1·8
21·35	141	494·4	127·4	−1·3	+3	22·42	368	884·3	151·8	+1·5
23·49	195	1274·3	176·2	−1·1	+5	24·55	22	203·3	200·5	+1·5
25·62	249	593·2	224·9	−1·3	+4	26·69	77	983·2	249·3	+1·6
27·76	304	1373·2	273·6	−1·7	+3	28·82	131	302·1	298·0	+1·8
29·89	358	692·1	322·4	−2·4	−3	30·96	185	1082·1	346·8	+1·9
32·03	12	11·0	11·1	−2·6	−6	33·10	239	401·0	35·5	+1·9
34·17	66	791·0	59·9	−2·0	−2	35·23	293	1181·0	84·2	+1·7
36·30	120	109·9	108·6	−1·4	+2	37·37	347	499·9	133·0	+1·5
38·44	174	889·9	157·4	−1·1	+4	39·50	1	1279·8	181·7	+1·5
40·57	228	208·8	206·1	−1·2	+5	41·64	55	598·8	230·5	+1·5
42·71	282	988·7	254·8	−1·4	+4	43·77	109	1378·7	279·2	+1·7
49·84	337	307·7	303·6	−2·1	0	45·91	164	697·6	328·0	+1·9
46·98	391	1087·6	352·3	−2·7	−6	48·04	218	16·6	16·7	+1·9
49·11	45	406·5	41·1	−2·3	−4	50·18	272	796·5	65·4	+1·8
51·25	99	1186·5	89·8	−1·6	+1	52·31	326	115·4	114·2	+1·6
53·38	153	505·4	138·6	−1·2	+4	54·45	380	895·4	162·9	+1·4
55·52	207	1285·3	187·3	−1·1	+5	56·58	34	214·3	211·7	+1·4
57·65	261	604·3	236·0	−1·3	+4	58·72	88	994·3	260·4	+1·7
59·79	315	1384·2	284·8	−1·8	+2	60·85	142	313·2	309·1	+1·8
61·92	369	703·2	333·5	−2·5	−4	62·99	197	1093·1	357·9	+1·9
64·06	24	22·1	22·3	−2·5	−6	65·12	251	412·1	46·6	+1·8
66·19	78	802·0	71·0	−1·9	−1	67·26	305	1192·0	95·4	+1·7
68·33	132	121·0	119·7	−1·4	+3	69·40	359	510·9	144·1	+1·4
70·47	186	900·9	168·5	−1·1	+4	71·53	13	1290·9	192·9	+1·5
72·60	240	219·8	217·2	−1·2	+4	73·67	67	609·8	241·6	+1·6
74·74	294	999·8	266·0	−1·7	+3	75·80	121	1389·7	290·3	+1·8
76·87	348	318·7	314·7	−2·2	−1	77·94	175	708·7	339·1	+1·9

TABLE B.

Opposition.
Stationary points.

Arg. I	T a	T b	λ
	d	d	° ±
0	−30	+32	5
20	−32	+32	6
40	−36	+33	7
60	−37	+34	8
80	−38	+36	9
100	−39	+37	9
120	−39	+38	10
140	−39	+39	10
160	−39	+41	10
180	−39	+42	10
200	−39	+42	10
220	−39	+43	10
240	−38	+43	10
260	−38	+43	9
280	−37	+42	9
300	−36	+40	8
320	−35	+39	7
340	−33	+37	6
360	−31	+33	6
380	−28	+32	5
400	−30	+32	5

TABLE A.

Arg. I	Opposition T	Opposition L	Conjunction T	Conjunction L	Arg. I	Opposition T	Opposition L	Conjunction T	Conjunction L
	d D	° D	d D	° D		d D	° D	d D	° D
0	30·3$_{29}$	26·6$_{27}$	22·0$_{22}$	21·5$_{22}$	200	23·3$_{15}$	22·8$_{14}$	28·8$_{12}$	25·3$_{13}$
5	33·2$_{28}$	29·3$_{26}$	24·2$_{22}$	23·7$_{23}$	205	21·8$_{14}$	21·4$_{14}$	27·6$_{12}$	24·0$_{13}$
10	36·0$_{26}$	31·9$_{25}$	26·4$_{22}$	26·0$_{23}$	210	20·4$_{15}$	20·0$_{14}$	26·4$_{12}$	22·7$_{12}$
15	38·6$_{24}$	34·4$_{23}$	28·6$_{21}$	28·3$_{22}$	215	18·9$_{14}$	18·6$_{13}$	25·2$_{12}$	21·5$_{12}$
20	41·0$_{22}$	36·7$_{22}$	30·7$_{20}$	30·5$_{20}$	220	17·5$_{14}$	17·3$_{13}$	24·0$_{12}$	20·3$_{12}$
25	43·2$_{20}$	38·9$_{20}$	32·7$_{19}$	32·5$_{19}$	225	16·1$_{14}$	16·0$_{13}$	22·8$_{12}$	19·1$_{12}$
30	45·2$_{17}$	40·9$_{17}$	34·6$_{18}$	34·4$_{18}$	230	14·7$_{14}$	14·7$_{13}$	21·6$_{12}$	17·9$_{12}$
35	46·9$_{14}$	42·6$_{14}$	36·4$_{16}$	36·2$_{16}$	235	13·3$_{13}$	13·4$_{13}$	20·4$_{11}$	16·7$_{12}$
40	48·3$_{11}$	44·0$_{12}$	38·0$_{15}$	37·8$_{15}$	240	12·0$_{13}$	12·1$_{12}$	19·3$_{11}$	15·5$_{11}$
45	49·4$_{8}$	45·2$_{9}$	39·5$_{14}$	39·3$_{13}$	245	10·7$_{13}$	10·9$_{12}$	18·2$_{11}$	14·4$_{11}$
50	50·2$_{6}$	46·1$_{7}$	40·9$_{13}$	40·6$_{12}$	250	9·4$_{12}$	9·7$_{12}$	17·1$_{11}$	13·3$_{11}$
55	50·8$_{4}$	46·8$_{5}$	42·2$_{12}$	41·8$_{10}$	255	8·2$_{11}$	8·5$_{11}$	16·0$_{11}$	12·2$_{10}$
60	51·2$_{1}$	47·3$_{2}$	43·4$_{9}$	42·8$_{8}$	260	7·1$_{11}$	7·4$_{10}$	14·9$_{10}$	11·2$_{10}$
65	51·3$_{0}$	47·5$_{1}$	44·3$_{6}$	43·6$_{6}$	265	6·0$_{10}$	6·4$_{9}$	13·9$_{10}$	10·2$_{10}$
70	51·3$_{1}$	47·6$_{0}$	44·9$_{5}$	44·2$_{5}$	270	5·0$_{9}$	5·5$_{9}$	12·9$_{10}$	9·2$_{9}$
75	51·2$_{1}$	47·6$_{1}$	45·4$_{4}$	44·7$_{2}$	275	4·1$_{8}$	4·6$_{9}$	11·9$_{9}$	8·3$_{9}$
80	51·1$_{3}$	47·5$_{3}$	45·8$_{3}$	44·9$_{1}$	280	3·3$_{7}$	3·7$_{8}$	11·0$_{8}$	7·4$_{8}$
85	50·8$_{5}$	47·2$_{4}$	46·1$_{1}$	45·0$_{0}$	285	2·6$_{7}$	2·9$_{8}$	10·2$_{8}$	6·6$_{8}$
90	50·3$_{7}$	46·8$_{5}$	46·2$_{0}$	45·0$_{2}$	290	1·9$_{6}$	2·1$_{6}$	9·4$_{7}$	5·8$_{7}$
95	49·6$_{8}$	46·3$_{6}$	46·2$_{1}$	44·8$_{2}$	295	1·3$_{5}$	1·5$_{5}$	8·7$_{7}$	5·1$_{6}$
100	48·8$_{8}$	45·7$_{7}$	46·1$_{2}$	44·6$_{4}$	300	0·8$_{4}$	1·0$_{4}$	8·0$_{6}$	4·5$_{5}$
105	48·0$_{9}$	45·0$_{7}$	45·9$_{3}$	44·2$_{5}$	305	0·4$_{3}$	0·6$_{4}$	7·4$_{5}$	4·0$_{4}$
110	47·1$_{10}$	44·3$_{8}$	45·6$_{4}$	43·7$_{6}$	310	0·1$_{0}$	0·2$_{2}$	6·9$_{4}$	3·6$_{3}$
115	46·1$_{10}$	43·5$_{8}$	45·2$_{5}$	43·1$_{6}$	315	0·1$_{1}$	0·0$_{0}$	6·5$_{3}$	3·3$_{2}$
120	45·1$_{11}$	42·7$_{9}$	44·7$_{7}$	42·5$_{7}$	320	0·2$_{2}$	0·0$_{1}$	6·2$_{1}$	3·1$_{0}$
125	44·0$_{12}$	41·8$_{10}$	44·0$_{7}$	41·8$_{8}$	325	0·4$_{5}$	0·1$_{3}$	6·1$_{0}$	3·1$_{1}$
130	42·8$_{13}$	40·8$_{11}$	43·3$_{8}$	41·0$_{8}$	330	0·9$_{7}$	0·4$_{5}$	6·1$_{2}$	3·2$_{2}$
135	41·5$_{13}$	39·7$_{11}$	42·5$_{8}$	40·2$_{9}$	335	1·6$_{9}$	0·9$_{8}$	6·3$_{2}$	3·4$_{4}$
140	40·2$_{12}$	38·6$_{12}$	41·7$_{8}$	39·3$_{9}$	340	2·5$_{12}$	1·7$_{10}$	6·5$_{4}$	3·8$_{6}$
145	39·0$_{13}$	37·4$_{13}$	40·9$_{9}$	38·4$_{10}$	345	3·7$_{14}$	2·7$_{12}$	6·9$_{5}$	4·4$_{7}$
150	37·7$_{13}$	36·1$_{12}$	40·0$_{9}$	37·4$_{11}$	350	5·1$_{16}$	3·9$_{14}$	7·4$_{7}$	5·1$_{9}$
155	36·4$_{14}$	34·9$_{12}$	39·1$_{10}$	36·3$_{12}$	355	6·7$_{19}$	5·3$_{17}$	8·1$_{9}$	6·0$_{10}$
160	35·0$_{14}$	33·7$_{12}$	38·1$_{11}$	35·1$_{12}$	360	8·6$_{21}$	7·0$_{19}$	9·0$_{10}$	7·0$_{12}$
165	33·6$_{15}$	32·5$_{13}$	37·0$_{11}$	33·9$_{12}$	365	10·7$_{24}$	8·9$_{21}$	10·0$_{12}$	8·2$_{14}$
170	32·1$_{14}$	31·2$_{14}$	35·9$_{11}$	32·7$_{12}$	370	13·1$_{26}$	11·0$_{23}$	11·2$_{13}$	9·6$_{16}$
175	30·7$_{15}$	29·8$_{14}$	34·8$_{12}$	31·5$_{13}$	375	15·7$_{28}$	13·3$_{25}$	12·5$_{15}$	11·2$_{17}$
180	29·2$_{14}$	28·4$_{14}$	33·6$_{12}$	30·2$_{12}$	380	18·5$_{29}$	15·8$_{26}$	14·0$_{17}$	12·9$_{20}$
185	27·8$_{15}$	27·0$_{14}$	32·4$_{12}$	29·0$_{12}$	385	21·4$_{30}$	18·4$_{27}$	15·7$_{20}$	14·9$_{21}$
190	26·3$_{15}$	25·6$_{14}$	31·2$_{12}$	27·8$_{12}$	390	24·4$_{30}$	21·1$_{28}$	17·7$_{21}$	17·0$_{22}$
195	24·8$_{15}$	24·2$_{14}$	30·0$_{12}$	26·6$_{13}$	395	27·4$_{29}$	23·9$_{27}$	19·8$_{22}$	19·2$_{23}$
200	23·3	22·8	28·8	25·3	400	30·3	26·6	22·0	21·5

TABLE C.

Conjunction.

☉ Arg.	Interval	T e last −	T m first +	λ−☉ e last −	λ−☉ m first +
°	d	d	d	°	°
0	141	59	82	44	55
10	133	56	77	41	51
20	126	53	73	39	47
30	119	51	68	37	44
40	113	50	63	34	42
50	108	48	60	32	39
60	104	47	57	31	36
70	99	46	53	29	34
80	96	46	50	29	32
90	94	46	48	30	31
100	93	47	46	30	29
110	93	48	45	30	28
120	95	50	45	31	28
130	97	52	45	33	29
140	100	55	45	35	30
150	104	59	45	38	31
160	107	61	46	40	33
170	110	63	47	42	35
180	115	66	49	44	37
190	122	69	53	47	40
200	131	72	59	51	45
210	143	75	68	54	50
220	157	78	79	57	60
230	177	82	95	60	74
240	198	87	111	64	86
250	206	91	115	68	90
260	209	94	115	71	89
270	209	95	114	73	88
280	210	96	114	74	88
290	207	95	112	74	87
300	201	93	108	72	82
310	191	87	104	67	78
320	179	79	100	61	75
330	169	73	96	55	71
340	159	67	92	51	65
350	150	63	87	48	60
360	141	59	82	44	55

Jupiter.

CYCLE TABLE.

Year	I	T	L
		d	°
−2153·35	10	1329·7	132·6
−2070·35	9	964·4	132·9
−1987·35	8	598·8	133·1
−1904·35	6	232·9	133·1
−1821·35	5	1327·9	132·9
−1738·35	3	961·7	132·7
−1655·35	2	595·6	132·4
−1572·35	0	229·6	132·3
−1560·34	5	234·3	137·0
−1477·34	4	1329·5	137·1
−1394·35	3	963·9	137·3
−1311·35	2	598·4	137·6
−1228·35	0	232·8	137·9
−1216·34	6	237·7	142·7
−1133·34	4	1333·1	143·0
−1050·34	3	967·4	143·1
− 967·34	2	601·5	143·1
− 884·34	0	235·6	143·1
− 872·33	5	240·2	147·7
− 789·33	4	1335·1	147·5
− 706·33	2	969·0	147·4
− 623·33	1	603·0	147·3
− 611·32	6	607·8	152·1
− 528·32	4	242·1	152·2
− 445·32	3	1337·5	152·4
− 362·32	2	972·0	152·7
− 279·33	1	606·4	153·0
− 196·33	0	240·8	153·2
− 113·33	398	1336·0	153·3
− 30·33	397	970·1	153·3
1904·79	12	282·5	197·6

TABLE A.

Arg. I	Opposition T	Opposition L	Conjunction T	Conjunction L
	d	°	d	°
0	9·2	6·2	4·8	5·8
10	10·1	7·1	5·8	6·8
20	10·9	8·0	6·8	7·7
30	11·5	8·8	7·8	8·5
40	12·1	9·5	8·8	9·3
50	12·5	10·1	9·8	9·9
60	12·7	10·7	10·7	10·5
70	12·8	11·1	11·4	10·9
80	12·7	11·3	12·1	11·2
90	12·5	11·5	12·6	11·4
100	12·2	11·5	13·0	11·5
110	11·7	11·3	13·2	11·4
120	11·2	11·0	13·3	11·2
130	10·5	10·6	13·2	10·9
140	9·8	10·1	12·9	10·5
150	9·0	9·5	12·6	9·9
160	8·1	8·9	12·1	9·2
170	7·3	8·2	11·5	8·4
180	6·4	7·4	10·8	7·7
190	5·6	6·6	10·0	7·0
200	4·8	5·8	9·2	6·2
210	4·0	5·0	8·4	5·4
220	3·3	4·2	7·5	4·6
230	2·7	3·5	6·6	3·9
240	2·1	2·8	5·7	3·2
250	1·6	2·1	4·8	2·6
260	1·3	1·6	4·0	2·0
270	1·1	1·2	3·2	1·4
280	1·1	0·9	2·5	1·0
290	1·2	0·7	1·9	0·7
300	1·4	0·6	1·5	0·6
310	1·8	0·6	1·1	0·5
320	2·3	0·7	0·9	0·6
330	2·9	1·0	0·9	0·9
340	3·7	1·5	1·0	1·3
350	4·5	2·1	1·3	1·9
360	5·4	2·8	1·7	2·5
370	6·4	3·6	2·3	3·3
380	7·3	4·4	3·0	4·1
390	8·3	5·3	3·9	4·9
400	9·2	6·2	4·8	5·8

PERIOD TABLE.

Opposition Year	I	T	L	m	Conjunction Year	I	T	L
		d	°	—			d	°
0·00	0	0·0	0·0	2·5	0·55	18	199·4	196·6
1·09	37	398·9	33·2	2·4	1·64	55	598·3	229·7
2·18	74	797·8	66·3	2·3	2·73	92	997·2	262·9
3·28	110	1196·7	99·5	2·2	3·82	129	1396·1	296·1
4·37	147	134·5	132·6	2·1	4·91	166	334·0	329·2
5·46	184	533·4	165·8	2·1	6·01	203	732·9	2·4
6·55	221	932·3	199·0	2·1	7·10	239	1131·7	35·5
7·64	258	1331·2	232·1	2·1	8·19	276	69·6	68·7
8·74	295	269·1	265·3	2·2	9·28	313	468·5	101·9
9·83	331	668·0	298·4	2·3	10·37	350	867·4	135·0
10·92	368	1066·8	331·6	2·4	11·47	387	1266·3	168·2
12·01	5	4·7	4·7	2·5	12·56	23	204·2	201·3
13·11	42	403·6	37·9	2·4	13·65	60	603·1	234·5
14·20	79	802·5	71·1	2·3	14·74	97	1001·9	267·6
15·29	116	1201·4	104·2	2·2	15·84	134	1400·8	300·8
16·38	152	139·3	137·4	2·1	16·93	171	338·7	334·0
17·47	189	538·1	170·5	2·1	18·02	208	737·6	7·1
18·56	226	937·0	203·7	2·1	19·11	244	1136·5	40·3
19·66	263	1335·9	236·9	2·1	20·20	281	74·4	73·4
20·75	300	273·8	270·0	2·2	21·30	318	473·2	106·6
21·84	336	672·7	303·2	2·3	22·39	355	872·1	139·8
22·93	373	1071·6	336·3	2·4	23·48	392	1271·0	172·9
24·03	10	9·4	9·5	2·4	24·57	29	208·9	206·1
25·12	47	408·3	42·7	2·4	25·66	65	607·8	239·2
26·21	84	807·2	75·8	2·3	26·76	102	1006·7	272·4
27·30	121	1206·1	109·0	2·2	27·85	139	1405·5	305·6
28·39	157	144·0	142·1	2·1	28·94	176	343·4	338·7
29·48	194	542·9	175·3	2·0	30·03	213	742·3	11·9
30·58	231	941·8	208·5	2·1	31·12	249	1141·2	45·0
31·67	268	1340·6	241·6	2·1	32·22	286	79·1	78·2
32·76	305	278·5	274·8	2·2	33·31	323	478·0	111·4
33·86	342	677·4	307·9	2·3	34·40	360	876·8	144·5
34·95	378	1076·3	341·1	2·4	35·49	397	1275·7	177·7
36·04	15	14·2	14·2	2·4	36·58	34	213·6	210·8
37·13	52	413·1	47·4	2·4	37·68	70	612·5	244·0
38·22	89	811·9	80·6	2·3	38·77	107	1011·4	277·1
39·32	126	1210·8	113·7	2·2	39·86	144	1410·3	310·3
40·41	163	148·7	146·9	2·1	40·95	181	348·2	343·5
41·50	199	547·6	180·0	2·0	42·05	218	747·0	16·6
42·59	236	946·5	213·2	2·1	43·14	255	1145·9	49·8
43·68	273	1345·4	246·4	2·2	44·23	291	83·8	82·9
44·78	310	283·2	279·5	2·3	45·32	328	482·7	116·1
45·87	347	682·1	312·7	2·4	46·41	365	881·6	149·3
46·96	383	1081·0	345·8	2·4	47·51	2	1280·5	182·4
48·05	20	18·9	19·0	2·4	48·60	39	218·3	215·6
49·14	57	417·8	52·2	2·3	49·69	76	617·2	248·7
50·24	94	816·7	85·3	2·2	50·78	112	1016·1	281·9
51·33	131	1215·6	118·5	2·1	51·87	149	1415·0	315·1
52·42	168	153·4	151·6	2·1	52·97	186	352·9	348·2
53·51	204	552·3	184·8	2·0	54·06	223	751·8	21·4
54·60	241	951·2	218·0	2·1	55·15	260	1150·6	54·5
55·70	278	1350·1	251·1	2·2	56·24	296	88·5	87·7
56·79	315	288·0	284·3	2·3	57·33	333	487·4	120·8
57·88	352	686·9	317·4	2·4	58·43	370	886·3	154·0
58·97	389	1085·7	350·6	2·4	59·52	7	1285·2	187·2
60·06	25	23·6	23·7	2·4	60·61	44	223·1	220·3
61·16	62	422·5	56·9	2·3	61·70	81	622·0	253·5
62·25	99	821·4	90·1	2·2	62·80	117	1020·8	286·6
63·34	136	1220·3	123·2	2·1	63·89	154	1419·7	319·8
64·43	173	158·2	156·4	2·1	64·98	191	357·6	353·0
65·53	209	557·0	189·5	2·1	66·07	228	756·5	26·1
66·62	246	955·9	222·7	2·1	67·16	265	1155·4	59·3
67·71	283	1354·8	255·9	2·2	68·26	302	93·3	92·4
68·80	320	292·7	289·0	2·3	69·35	338	492·1	125·6
69·89	357	691·6	322·2	2·4	70·44	375	891·0	158·8
70·99	394	1090·5	355·3	2·5	71·53	12	1289·9	191·9
72·08	30	28·4	28·5	2·4	72·62	49	227·8	225·1
73·17	67	427·2	61·7	2·3	73·72	86	626·7	258·2
74·26	104	826·1	94·8	2·2	74·81	122	1025·6	291·4
75·35	141	1225·0	128·0	2·1	75·90	159	1424·4	324·6
76·45	178	162·9	161·1	2·1	76·99	196	362·3	357·7
77·54	215	561·8	194·3	2·1	78·08	233	761·2	30·9
78·63	251	960·7	227·4	2·1	79·18	270	1160·1	64·0
79·72	288	1359·5	260·6	2·2	80·27	307	98·0	97·2
80·81	325	297·4	293·8	2·3	81·36	343	496·9	130·3
81·91	362	696·3	326·9	2·4	82·45	380	895·8	163·5

TABLE B.

Opposition.

Stationary points.

I	T a	T b
	d	d
0	−59	+59
50	−59	+59
100	−60	+60
150	−60	+62
200	−60	+63
250	−61	+62
300	−61	+61
350	−60	+59
400	−59	+59
λ	+5°·0	−5°·0

TABLE C.

Conjunction.

⊙	Interval	T − e last	T + m first	− λ-e last	+ ⊙ m first
°	d	d	d	°	°
0	34	10	24	3	6
10	34	10	24	3	5
20	33	10	23	3	5
30	33	11	22	2	5
40	32	11	21	2	5
50	31	12	19	2	5
60	30	12	18	3	4
70	28	12	16	3	4
80	28	13	15	3	4
90	28	14	14	3	4
100	28	14	14	3	3
110	28	15	13	3	3
120	28	15	13	3	3
130	29	16	13	3	3
140	28	16	12	4	3
150	28	16	12	4	3
160	28	16	12	4	3
170	28	16	12	4	3
180	28	16	12	4	2
190	28	16	12	4	3
200	28	16	12	4	3
210	28	16	12	4	3
220	28	16	12	4	3
230	28	16	12	4	3
240	28	15	13	4	3
250	28	15	13	4	3
260	28	14	14	3	3
270	29	13	16	3	4
280	30	13	17	3	4
290	31	12	19	3	4
300	32	12	20	3	5
310	33	11	22	3	5
320	33	10	23	3	5
330	34	10	24	3	5
340	34	10	24	3	6
350	34	10	24	3	6
360	34	10	24	3	6

Saturn.

CYCLE TABLE.

Year	I	T	L
		d	°
−2123·19	0	653·2	186·8
−2064·19	1	289·3	188·6
−2005·18	2	1386·6	190·5
−1946·18	3	1023·0	192·5
−1887·17	5	659·6	194·7
−1828·17	6	296·2	197·0
−1770·20	395	1015·8	186·7
−1711·19	397	652·4	188·9
−1652·19	398	289·0	191·1
−1593·18	399	1386·4	193·2
−1534·18	0	1022·7	195·1
−1475·18	0	658·7	196·9
−1416·17	0	294·7	198·5
−1357·17	0	1391·6	200·1
−1298·16	0	1027·5	201·7
−1239·16	0	663·4	203·2
−1180·16	0	299·4	204·9
−1121·15	1	1396·4	206·6
−1062·15	2	1032·7	208·5
−1003·15	3	669·1	210·5
− 944·14	5	305·5	212·6
− 886·17	393	1025·0	202·1
− 827·17	394	661·6	204·4
− 768·16	396	298·2	206·6
− 709·16	398	1395·8	208·8
− 650·15	399	1032·2	210·9
− 591·15	399	668·5	212·9
− 532·15	399	304·6	214·7
− 473·14	0	1401·6	216·4
− 414·14	0	1037·6	218·0
− 355·13	0	673·6	219·6
− 296·13	0	309·5	221·2
− 237·13	0	1406·4	222·9
− 178·12	1	1042·5	224·6
− 119·12	2	678·7	226·4
− 60·12	3	315·0	228·4
1914·97	398	1076·6	261·3
1973·97	399	1454·6	263·3

PERIOD TABLE.

Opposition Year	I	T	L	m	Conjunction Year	I	T	L
		d	°				d	°
0·00	0	0·0	0·0	−0·5	0·52	7	189·0	186·3
1·04	14	378·1	12·7	−0·4	1·55	21	567·1	199·0
2·07	28	756·2	25·3	−0·3	2·59	35	945·2	211·7
3·11	42	1134·3	38·0	−0·2	3·62	49	1323·3	224·3
4·14	56	51·4	50·7	+0·1	4·66	63	240·4	237·0
5·18	70	429·5	63·3	+0·4	5·69	77	618·5	249·7
6·21	84	807·6	76·0	+0·7	6·73	91	996·6	262·3
7·25	98	1185·6	88·7	+0·9	7·76	105	1374·7	275·0
8·28	112	102·7	101·3	+0·8	8·80	119	291·8	287·7
9·32	126	480·8	114·0	+0·6	9·83	133	669·9	300·3
10·35	141	858·9	126·6	+0·5	10·87	148	1048·0	313·0
11·39	155	1237·0	139·3	+0·3	11·90	162	1426·1	325·6
12·42	169	154·1	152·0	+0·2	12·94	176	343·2	338·3
13·46	183	532·2	164·6	+0·2	13·97	190	721·2	351·0
14·49	197	910·3	177·3	+0·2	15·01	204	1099·3	3·6
15·53	211	1288·4	190·0	+0·2	16·04	218	16·4	16·3
16·56	225	205·5	202·6	+0·2	17·08	232	394·5	29·0
17·60	239	583·6	215·3	+0·3	18·11	246	772·6	41·6
18·63	253	961·7	228·0	+0·4	19·15	260	1150·7	54·3
19·67	267	1339·7	240·6	+0·5	20·18	274	67·8	67·0
20·70	281	256·8	253·3	+0·7	21·22	288	445·9	79·6
21·74	295	634·9	266·0	+0·9	22·25	302	824·0	92·3
22·77	309	1013·0	278·6	+0·7	23·29	316	1202·1	105·0
23·81	323	1391·1	291·3	+0·4	24·32	330	119·2	117·6
24·84	337	308·2	304·0	+0·1	25·36	344	497·3	130·3
25·88	351	686·3	316·6	−0·1	26·39	358	875·3	143·0
26·91	365	1064·4	329·3	−0·3	27·43	372	1253·4	155·6
27·95	379	1442·5	342·0	−0·4	28·46	386	170·5	168·3
28·98	393	359·6	354·6	−0·5	29·50	0	548·6	181·0
30·02	7	737·7	7·3	−0·5	30·54	14	926·7	193·6
31·05	22	1115·8	19·9	−0·4	31·57	29	1304·8	206·3
32·09	36	32·9	32·6	−0·2	32·61	43	221·9	219·0
33·12	50	410·9	45·3	0·0	33·64	57	600·0	231·6
34·16	64	789·0	57·9	+0·3	34·68	71	978·1	244·3
35·20	78	1167·1	70·6	+0·5	35·71	85	1356·2	256·9
36·23	92	84·2	83·3	+0·8	36·75	99	273·3	269·6
37·27	106	462·3	95·9	+0·8	37·78	113	651·4	282·3
38·30	120	840·4	108·6	+0·7	38·82	127	1029·5	294·9
39·34	134	1218·5	121·3	+0·5	39·85	141	1407·5	307·6
40·37	148	135·6	133·9	+0·4	40·89	155	324·6	320·3
41·41	162	513·7	146·6	+0·2	41·92	169	702·7	332·9
42·44	176	891·8	159·3	+0·1	42·96	183	1080·8	345·6
43·48	190	1269·9	171·9	+0·1	43·99	197	1458·9	358·3
44·51	204	187·0	184·6	+0·1	45·03	211	376·0	10·9
45·55	218	565·0	197·3	+0·1	46·06	225	754·1	23·6
46·58	232	943·1	209·9	+0·2	47·10	239	1132·2	36·3
47·62	246	1321·2	222·6	+0·3	48·13	253	49·3	48·9
48·65	260	238·3	235·3	+0·5	49·17	267	427·4	61·6
49·69	274	616·4	247·9	+0·6	50·20	281	805·5	74·3
50·72	288	994·5	260·6	+0·8	51·24	295	1183·6	86·9
51·76	303	1372·6	273·2	+0·9	52·28	310	100·6	99·6
52·79	317	289·7	285·9	+0·6	53·31	324	478·7	112·2
53·83	331	667·8	298·6	+0·3	54·35	338	856·8	124·9
54·86	345	1045·9	311·2	0·0	55·38	352	1234·9	137·6
55·90	359	1424·0	323·9	−0·2	56·42	366	152·0	150·2
56·93	373	341·1	336·6	−0·3	57·45	380	530·1	162·9
57·97	387	719·2	349·2	−0·4	58·49	394	908·2	175·6

TABLE B.

Opposition.

Stationary points.

I	T a	T b
	− d	+ d
0	67	67
40	66	68
80	66	69
120	67	71
160	69	72
200	70	71
240	71	70
280	70	69
320	69	68
360	68	67
400	67	67
λ	+3°·5	−3°·5

TABLE C.

Conjunction.

⊙	T e last	T m first
°	d	d
0	−12	+31
10	−12	+31
20	−13	+30
30	−13	+28
40	−13	+27
50	−14	+25
60	−14	+24
70	−15	+23
80	−15	+21
90	−16	+20
100	−16	+19
110	−17	+17
120	−17	+16
130	−17	+16
140	−17	+16
150	−18	+15
160	−18	+15
170	−18	+15
180	−17	+15
190	−17	+14
200	−17	+14
210	−17	+14
220	−17	+15
230	−17	+15
240	−16	+16
250	−15	+16
260	−15	+17
270	−14	+19
280	−14	+21
290	−14	+23
300	−13	+25
310	−13	+28
320	−13	+30
330	−13	+31
340	−13	+32
350	−12	+32
360	−12	+31
λ	−2°	+3°

TABLE A.

Arg. I	Opposition T	Opposition L	Conjunction T	Conjunction L
	d	°	d	°
0	10·6	8·0	9·4	8·0
10	11·6	9·3	11·1	9·3
20	12·5	10·5	12·7	10·5
30	13·3	11·7	14·3	11·7
40	14·0	12·7	15·7	12·7
50	14·6	13·6	17·0	13·7
60	15·1	14·3	18·1	14·5
70	15·4	14·9	18·9	15·1
80	15·6	15·3	19·5	15·5
90	15·7	15·6	19·8	15·8
100	15·6	15·6	19·9	15·8
110	15·5	15·4	19·7	15·6
120	15·1	15·1	19·4	15·2
130	14·6	14·5	18·8	14·7
140	14·1	13·9	17·9	14·0
150	13·4	13·1	17·0	13·2
160	12·7	12·2	15·9	12·3
170	11·9	11·2	14·7	11·2
180	11·1	10·2	13·3	10·1
190	10·2	9·1	12·0	9·1
200	9·4	8·0	10·6	8·0

Arg. I	Opposition T	Opposition L	Conjunction T	Conjunction L
	d	°	d	°
200	9·4	8·0	10·6	8·0
210	8·6	6·9	9·2	6·9
220	7·8	5·8	7·8	5·8
230	7·0	4·8	6·4	4·8
240	6·3	3·8	5·1	3·9
250	5·6	2·8	4·0	3·0
260	5·1	2·0	2·9	2·1
270	4·7	1·4	2·0	1·4
280	4·4	0·9	1·2	0·9
290	4·2	0·5	0·6	0·5
300	4·2	0·4	0·2	0·3
310	4·3	0·4	0·1	0·2
320	4·5	0·6	0·3	0·4
330	4·9	1·0	0·7	0·8
340	5·5	1·6	1·3	1·4
350	6·1	2·4	2·2	2·2
360	6·9	3·3	3·3	3·1
370	7·8	4·4	4·6	4·2
380	8·7	5·6	6·1	5·4
390	9·6	6·8	7·7	6·7
400	10.6	8·0	9·4	8·0

TABLE N.

To convert the days of T into Julian months and days.

	Jan. 0	Feb. 0	Mar. 0	April 0	May 0	June 0	July 0	Aug. 0	Sept. 0	Oct. 0	Nov. 0	Dec. 0
0	0	31	60	91	121	152	182	213	244	274	305	335
1	366	397	425	456	486	517	547	578	609	639	670	700
2	731	762	790	821	851	882	912	943	974	1004	1035	1065
3	1096	1127	1155	1186	1216	1247	1277	1308	1339	1369	1400	1430
4	1461	1492	1521	1552	1582	1613	1643	1674	1705	1735	1766	1796
5	1827	1858	1886	1917	1947	1978	2008	2039	2070	2100	2131	2161
6	2192	2223	2251	2282	2312	2343	2373	2404	2435	2465	2496	2526
7	2557	2588	2616	2647	2677	2708	2738	2769	2800	2830	2861	2891
8	2922	2953										

Babylonian Calendar.

Table M.

Cycle	Year
3447	22
3379	20
3303	20
3227	19
3151	19
3083	17
3007	17
2931	17
2863	15
2787	15
2711	15
2643	13
2567	13
2491	13
2415	12
2347	11
2271	10
2203	9
2127	8
2067	5
1991	5
1967	9
1919	18
1875	12
1807	10
1731	10
1655	10
1579	9
1503	9
1427	9
1359	7
1283	7
1207	7
1139	5
1063	5
995	3
927	1
851	1
775	1
699	1
623	0
547	0
471	0
447	4
371*	4
295*	4
219*	4
143*	4
67*	3

Period	I Nis. 0	II Ayar 0	III Siv. 0	IV Tam. 0	V Ab 0	VI Ulul 0	VII Teš. 0	VIII Arah. 0	IX Kisl. 0	X Teb. 0	XI Šab. 0	XII Adar 0	Adar b 0
0	467	497	526	556	585	615	645	674	703	733	762	792	
1	821	851	880	910	940	969	999	1028	1058	1087	1117	1146	
2	1176	1205	1235	1265	1294	1324	1353	1383	1412	1442	10	40	69*
3	99	128	158	187	217	247	276	306	335	365	394	424	
4	453	483	512	542	571	601	631	660	689	719	748	778	807
5	837	866	896	926	955	985	1014	1044	1073	1103	1132	1162	
6	1191	1221	1250	1280	1310	1339	1369	1398	1428	1457	26	55	
7	85	114	144	173	203	232	262	292	321	351	380	409	439
8	469	498	528	557	587	617	646	676	705	734	764	793	
9	823	853	882	912	941	971	1001	1030	1059	1089	1118	1148	
10	1177	1207	1236	1266	1296	1325	1355	1384	1414	1443	12	41	71
11	100	130	159	189	219	248	278	307	337	366	396	425	
12	454	484	514	543	573	602	632	661	691	721	750	780	809
13	838	868	898	927	957	986	1016	1045	1075	1105	1134	1163	
14	1193	1222	1252	1282	1311	1341	1370	1400	1429	1459	27	57	
15	86	116	145	175	205	234	264	293	323	352	382	411	440
16	470	500	529	559	588	618	648	677	707	736	765	795	
17	824	854	884	913	943	972	1002	1032	1061	1091	1120	1149	
18	1179	1208	1238	1268	1297	1327	1356	1386	1415	1445	13	43	72
19	102	131	161	190	220	250	279	309	338	368	397	427	
20	456	486	515	545	574	604	634	663	693	722	751	781	
21	810	840	870	899	929	958	988	1017	1047	1077	1106	1135	1165*
22	1194	1224	1254	1283	1313	1342	1372	1401	1431	1460	29	58	
23	88	117	147	177	206	236	265	295	324	354	383	413	442
24	472	501	531	560	590	620	649	679	708	738	767	796	
25	826	856	885	915	944	974	1004	1033	1063	1092	1121	1151	
26	1180	1210	1239	1269	1299	1328	1358	1387	1417	1446	15	44	74
27	103	133	163	192	222	251	281	310	340	369	398	428	
28	458	487	517	546	576	606	635	665	694	724	753	782	
29	812	842	871	901	930	960	990	1019	1049	1078	1107	1137	1166
30	1196	1225	1255	1285	1314	1344	1373	1403	1432	1	30	60	
31	89	119	149	178	208	237	267	296	326	355	385	414	444
32	473	503	532	562	591	621	651	680	710	739	769	798	
33	828	857	887	916	946	976	1005	1035	1064	1094	1123	1152	
34	1182	1212	1241	1271	1300	1330	1359	1389	1418	1448	16	46	75
35	105	134	164	194	223	253	282	312	341	371	400	430	
36	459	489	518	548	578	607	637	666	696	725	755	784	
37	814	843	873	902	932	962	991	1021	1050	1080	1109	1139	1168
38	1198	1227	1257	1286	1316	1345	1375	1405	1434	3	32	61	
39	91	120	150	180	209	239	268	298	327	357	386	416	
40	445	475	504	534	564	593	623	652	682	711	741	770	800*
41	829	859	888	918	947	977	1007	1036	1066	1095	1124	1154	
42	1183	1213	1243	1272	1302	1331	1361	1390	1420	1449	18	47	77
43	106	136	165	195	225	254	284	313	343	372	402	431	
44	461	490	520	550	579	609	638	668	697	727	756	785	
45	815	845	874	904	933	963	993	1022	1052	1081	1110	1140	1169
46	1199	1228	1258	1288	1317	1347	1376	1406	1435	4	33	63	
47	92	122	151	181	211	240	270	299	329	358	388	417	
48	447	476	506	535	565	595	624	654	683	713	742	772	801
49	831	860	890	919	949	979	1008	1038	1067	1097	1126	1156	
50	1185	1215	1244	1274	1303	1333	1362	1392	1421	1451	19	49	78
51	108	137	167	197	226	256	285	315	344	374	403	433	
52	462	492	521	551	581	610	640	669	699	728	758	787	
53	817	846	876	905	935	965	994	1024	1053	1083	1112	1141	1171
54	1201	1230	1260	1289	1319	1349	1378	1408	1437	5	35	64	
55	94	123	153	183	212	242	271	301	330	360	389	419	
56	448	478	507	537	567	596	626	655	685	714	744	773	803
57	832	862	891	921	951	980	1010	1039	1069	1098	1127	1157	
58	1187	1216	1246	1275	1305	1335	1364	1394	1423	1452	21	50	
59	80	109	139	169	198	228	257	287	316	346	375	405	434*
60	464	493	523	552	582	612	641	671	700	730	759	789	
61	818	848	877	907	937	966	996	1025	1055	1084	1113	1143	1173
62	1202	1232	1261	1291	1320	1350	1380	1409	1439	7	36	66	
63	95	125	154	184	214	243	273	302	332	361	391	420	
64	450	479	509	538	568	598	627	657	686	716	745	775	804
65	834	863	893	922	952	982	1011	1041	1070	1100	1129	1159	
66	1188	1218	1247	1277	1306	1336	1366	1395	1424	1454	22	52	
67	81	111	140	170	200	229	259	288	318	347	377	406	436
68	465	495	524	554	584	613	643	672	702	731	761	790	
69	820	849	879	908	938	968	997	1027	1056	1086	1115	1145	1174
70	1204	1233	1263	1292	1322	1352	1381	1411	1440	8	38	67	
71	97	127	156	186	215	245	274	304	333	363	392	422	
72	451	481	510	540	570	599	629	658	688	717	747	776	806
73	835	865	894	924	953	983	1013	1042	1072	1101	1131	1160	
74	1190	1219	1249	1278	1308	1338	1367	1397	1426	1455	24	53	
75	83	112	142	172	201	231	260	290	319	349	378	408	437
							Ul. b 0	Teš. 0	Arah. 0	Kisl. 0	Teb. 0	Šab. 0	Adar 0

In this table the Julian and Babylonian days are civil, reckoned from midnight.

TABLE N.

	Jan. 0	Feb. 0	Mch. 0	Apr. 0	May 0	June 0	July 0	Aug. 0	Sept. 0	Oct. 0	Nov. 0	Dec. 0
1	0	31	60	91	121	152	182	213	244	274	305	335
2	366	397	425	456	486	517	547	578	609	639	670	700
3	731	762	790	**821**	**851**	**882**	**912**	**943**	**974**	**1004**	**1035**	**1065**
4	**1096**	**1127**	**1155**	1186	1216	1247	1277	1308	1339	1369	1400	1430
5	1461											