

# NDIAN CHRONOLOGY

FOR CONSULTATION ONLY

(SOLAR, LUNAR AND PLANETARY).

# A PRACTICAL GUIDE

TO

THE INTERPRETATION AND VERIFICATION

Tithis, Nakshatras, Horoscopes and other Indian Time-records.

B.C. 1 to A.D. 2000.

BY

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TO

# The Hon'ble Mr. V. Krishnaswami Aiyar,

MEMBER OF THE EXECUTIVE COUNCIL

OF HIS EXCELLENCY THE GOVERNOR OF FORT ST. GEORGE,

# THIS WORK

Undertaken and carried out under his kind encouragement and advice,

IS

by permission respectfully dedicated.

## PREFACE.



THIS book, which was announced to the public under various names \*, is now issued under a title which restricts it to its original scope, namely, as a **Manual of Indian Chronology**, designed to present in one view and in a usable form all the material ordinarily required by investigators in that field of research.

The bulk of the tables, as well as of the letter-press, is devoted to a detailed exhibition of the *decursus* of Indian Chronology, solar, lunar and planetary, with eclipses, week-days, English calendar months and dates, *adhika* and *kshaya masas*, and mean places of the Sun and major planets, from *B.C.* 1 to A.D. 2000. The portion of the work, called Table X, will, it is hoped, supply a long-felt want among Epigraphists and Archæologists, official as well as non-official, in India, inasmuch as it will enable them to verify on the spot and *in less than a minute in any case*, the exact English equivalent of any Indian date occurring in any inscription as well as to test its genuineness. The instructions set opposite the Eye-Table at the end of the book are alone sufficient for any person, however previously unacquainted with the subject, to calculate quite accurately the ending moment of a *tithi* or *nakshatra*.

The work is intended, however, for the use of a much wider public than the scientific few who are interested in Indian chronological research. The same principles, whereby we are enabled to re-call into the light of history the inscriptions that are being unearthed at the rate of a thousand every year by the various Indian Epigraphical departments, continue to guide the religious observances and civil usages of millions of people in India at the present day, and no one interested in the social and religious life of this vast continent can fail to take at least some slight account of a system, so ancient and so thoroughly ingrained in the habits of the people. The Indian calendar is generally considered either too abstruse for popular, or too inaccurate for scientific, exposition, but neither of these objections is more than a fallacy. A good deal has been done in the past to put Indian chronology on its proper footing, namely, as the faithful handmaid of Indian history, and there is no reason why the torch so worthily carried in their day by the late Professor Kielhorn, the present Dr. Fleet and other workers in the field, should not be kept bright and burning in the hands of their successors, provided they are equipped with the necessary knowledge of data and principles.

Lastly, there is hardly any person, holding a position of consequence, public or private, in India, who is not occasionally confronted with the citation of an Indian date. To Magistrates, Judges, Lawyers, Missionaries, Business Men of every description, as well as to Historians, it is of interest to know the meaning of chronological terms in daily use among the people, although all may not, equally with the epigraphist and the archæologist, feel inclined to enter upon a regular study of Indian chronology. To those with scanty leisure, Tables XII and XVIII, forming a luni-solar and planetary Ephemeris for the 80 years A.D. 1840 to A.D. 1920, together with the simple instructions as to their use, contained in the Second and Fourth Parts of the book headed "Use of the Tables" and "Planetary Chronology" as well as in the Eye-Table, will be found no less handy than serviceable. The publications ordinarily known by the name of *Jantre* are unscientific, and few of them are up to date, whereas the ephemeris portion of the present work will enable any one to understand and decide, with reference to first principles, any question of current Indian chronology for seventy years past and some ten years to come. A table (XV) has also been inserted to link together the Indian and Muhammadan calendars.

\* "Tithes, Nakshatras and other Indian dates B.C. 1 to A.D. 2000" (Indian Review for May 1910) : "Indian Astronomy and Chronology with a Criticism on Indian Astrology" (Advt. page of the Journal of the South Indian Association, Madras), etc. The book necessarily contains a vast amount of figures and tables, but the perusal of no part of it will requisition a greater knowledge of mathematics than is implied in the four simple rules of Arithmetic. Decimals have been used freely in order to ensure accuracy, but not only have tables whereby the decimal parts of a day, degree, etc., can be converted into *ghatikas*, *palas*, hours, minutes and seconds, been freely inserted, but the more important tables for the calculation of anomalies and equations for *tithis* and *nakshatras* (Table IX) and the Nakshatra Table itself (Table XI) have been twice given, once in the form of decimals and again as days, *ghatikas* and *palas*.

It was originally intended to limit this compilation to solar and lunar chronology, but the frequent occurrence, in chronological records, in Indian literature as well as in daily Indian life, of allusions to the mean or actual places of planets, induced the writer to add a considerable number of tables on this interesting, though somewhat difficult, subject. The tables of anomalies and equations, used for planets, are based mainly on those of *Varilala Kuchinna*, as reproduced in Warren's *Kala Sankalita*. The computation of the geocentric longitudes of planets for the years A.D. 1840 to A.D. 1920, contained in Table XVIII, entailed an enormous number of detailed calculations, but the results will, it is hoped, be found sufficiently accurate for practical purposes. By "practical purposes " the author means solely the purposes of Indian chronology, and he wishes it to be distinctly understood that he does not believe in astrology any more than in the need for, or efficacy of, the fasts, festivals and donations mentioned in Chapter XVI, "Notes on tithis in relation to festivals", which find a place in this book, merely and solely because of the frequent references in inscriptions to Hindu fasts and feasts.

In conclusion, the author wishes to state that, while he has spared no pains to acquaint himself with the works of previous writers on the subject, he has endeavoured to work out details upon his own method which is explained in Part III----- Construction of Tables ". To one honoured name in the field of Indian astronomy and chronology, that of **Professor Hermann Jacobi**, he wishes, though an utter stranger, to express special indebtedness, since to him the author owes his first knowledge of the subject as well as numerous illustrations serving to test the correctness of his method.

Lastly, he must thank the *Premier Press*, of Messrs. Hee & Co., for the skill with which they have executed a work, which, though packed with figures, has been reproduced with a high degree of neatness consistently with economy. The author would have been glad to have inserted the proper diacritical marks throughout the text, but this would have entailed further delay in publishing a work, which, in the endeavour to make it accurate and reliable in more important respects, has already been kept too long in the press. Such marks have, therefore, been sparingly used, except in the Index, which gives the proper marks for every Sanskrit word occurring in the text, and to which reference should be made in case of doubt. The Index also explains the meaning of terms not occurring in the text, such as *Dakshinayana*, *Uttarayana*, *Aparapaksha*, etc.

MADRAS, 25th March 1911.

L.D.S.

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#### ADDENDA, Section 6 of Text and TABLE VI.



## Surya Siddhanta Constants for Centuries from 0 Kaliyuga to 3101 K.Y. (B.C. 3102 to B.C. 1.)

B.C.	E 6.8.	uga,	Comm men Solar	ence- t of Year.	New n Solar ar.	maly at cement r Year.	B.C.		nga	Comm men Solar	aence- it of Year.	New n Solar ar.	maly at acoment r Year.
Year		Kaliy	Month and date.	Frac- tion of day.	First Moon i Yee	( 's ano commen of Solar	Ycar		Kaliy	Month and date.	Frac- tion of day.	First Moon 1 Ye	( 'a ano commet of Sola
8102	B.C.	0	15F	-57924	2.17013	4.71797	1501	B.C.	1601	29F	-84837	17.13408	20.26802
3101		1	15F	.83800	20.80902	11.76692	1401		1701	1.M	•72402	20.59572	8.74421
3001		101	16F	.71365	24.27066	0.24311	1301		1801	2M	-59967	24.05736	24.77498
2901		201	17F	:58980	27.73230	16-27388	1201		1901	3M	47532	27.51900	13.25117
2801		301	18F	.46494	1/66335	4.75007					The Carlos		1.00000
							1101		2001	4M	.35097	1.42000	172736
2701	a late	401	19F	.34059	5.12499	20-78084	1001		2101	5 M	-22662	4.91169	17.75813
2601		501	20F	-21624	8.58668	9.25703	901		2201	6M	.10226	8.37393	6.23432
2501		601	21F	·09189	12.04827	25.28780	801		2301	6 M	·97791	11.83557	22*265 09
2401		701	21F	.96754	15.50991	13.76399					Mr. Ale		Ref. and and
Contraction of the							701		2401	7M	·85856	15.29721	10-74128
2301		801	22F	-84319	18.97155	2.24018	601		2501	8M	-72921	18-75885	26.77205
2201		901	28F	.71883	22.43319	18-27095	501		2/601	9M	.60486	22-22049	15.24824
2101		1001	24E	.59448	25.89488	€-74714	401		2701	10 <b>M</b>	48051	25.68213	3.72443
2001		1101	25F	.47013	29.35647	22.77791					No.		
							301		2801	IIM	·35615	29.14377	19 75520
1901		1201	26F	.34578	3.28752	11.25410	201	Mi Const	2901	12M	28180	3.07482	5 23139
1801	ant sa Mi	1301	27F	·22148	6.74916	27.28487	101		3001	13M	·10745	6.536.46	24-26216
1701		1401	28F	.09708	10.21080	15.76106	Los Caller		3101	18M	.88310	9.99810	12-73835
1601		1501	28F	.97273	13.67244	4.28725							

NB:-Odd years in centuries B.C. should be converted into positive years before using Table VII. See instructions in NB, to Table XXII.

It will be seen that the Solar Year 0 K.Y. commenced on Feb. 15:57924. If to this be added the Sodhya of 2:1707 days we have, Feb. 15:5792+2:1707 == Feb. 17:75, or midnight between 17th and 18th Feb. B.O. 3:102, which was the moment of commencement of the Era, 0 Kaliyuga, according to Surya Siddhanta. See foot-note on p. (3) of the Text.

#### TABLE XVII.

#### Mean Places of Major Planets at Commencement of each Century from B.C. 1601 to B.C. 1 (K.Y. 1501 to K.Y. 3101.)

	Mars.	Mercury.	Jupiter.	Yenus.	Saturn.
B.C. 1601 K.Y. 1501 1501 1601 1401 1701 1301 1801 1201 1901 1101 2001 1001 2101 901 2201 801 2301 601 2501 501 2601 401 2701 301 2801 101 3001	63122 668392 1273662 187892 2484202 3089472 94742 700012 1305282 1910652 2515822 8121092 126362 731632 1336002 194-2172	73.0963 149:1148 225:1323 301:1503 17:1683 93:1863 169:2043 245:2223 321:2403 37:2563 113:2763 189:2943 265:3123 341:3203 57:3483 138:8663	207-2519 1-9965 156-7411 311-4857 106-2308 260-9749 55-7195 210-4641 5-2087 159-9533 314-6979 109-4425 264-1871 58-9317 213-6768 8-4209	$\begin{array}{c} 369{\cdot}6166\\ 198{\cdot}5007\\ 37{\cdot}4856\\ 236{\cdot}4709\\ 75{\cdot}4560\\ 274{\cdot}4411\\ 118{\cdot}4262\\ 312{\cdot}4113\\ 151{\cdot}3964\\ 350{\cdot}3815\\ 189{\cdot}36666\\ 28{\cdot}8517\\ 227{\cdot}3868\\ 66{\cdot}8219\\ 265{\cdot}3070\\ 104{\cdot}2921\\ 209{\cdot}97{\cdot}9\end{array}$	320-0274 101-9343 243-8412 25-7481 167-6550 309-5619 91:4688 283:3757 15-2826 157-1895 299-0964 81:0033 222:9102 4-8171 146:7240 288-6309 70.5978

#### EXPLANATION.

With the aid of these two tables it is possible to calculate solar dates, tithis and nakshatras for any date between H.C. 3102 and B.C. 1 and also any horoscope from B.C. 1601 to B.C. 1. The places of planets' nodes for any of these years can be easily deduced from the places given in Table XVII in the body of the book for the centuries 1 B.C. to A.D. 2000.



We will now present the reader with the working of two interesting problems in B.C. dates: our examples are taken from Dr. Fleet's article "The day on which Buddha died" in the Journal of the Royal Asiatic Society for 1909. I. The day on which Buddha died :--B.C. 483, Karttike Suhla 8.

		Commencement of Solar year.	First New Moon in Solar year.	Moon's Anom, a commence- ment of Solar Year.	<b>1</b>
(Contents p. 4) (Table VII, p. 7)	B.C. 501 Ma Add for 18 years.	rch 9.60 .66	22·22 10·66	15·25 16-66	
建设 化温泉	B.C. 483 May	ch 10.26	32.88 29.53 (Syn. M	on.) 31.91 27.55 ()	Anom. month)
			3.32	4·36 3·35	
Table VIII (Addi	tion for Kauttika Subla 8	in a maximuchich		7.71 (	Moon's Anomaly at First New- moon in Solar year B.C. 483.)
some previous month of the next month M	h was adhiku * is the same largasira).	as that for Sukla S	214-59	21.71	
			217.94	29-42 27-55 (1	Anom. month)
				1.87	
Sun's Equation f	or 218 days (Eye-Table)	- 18		- 13 (5	Sun's Equation)
Moon's Equation :	for 1.74 days (Eye-Table)	- 15		1.74	里品的新闻。1958
	Su	m - •28	28		
Add commenceme	ent of Solar year	1	217.66 March 10.26	NAME OF BRIDE	
Strate Margarit			,, 227-92		

By Table VIII (p. 11), 227 days from 1 March=13 Oct., and 92 day =(by Eye-Table) 22 hours.

.. On Dr. Fleet's hypothesis, the tithi on which Buddha died ended on 13 Oct. B. C. 483, at 22 hrs. after Sunrise =(according to our reckoning) 4 A.M. on 14th Oct.

II. Required the day of the Summer Solution in the year B.C. 483, (i.e., the commencement of the Buddhist vasua in that year.)

The Summer Solstice happens when the sun is at 90° Tropical Longitude. Table XVII—A. gives the Sun's sidereal longitude for every complete day of the Solar year, while the table in Sec. 284, p. (103) of the text gives us the difference between Indian sidereal and true tropical longitude for various epochs A.D. which we can apply, with sign reversed, to epochs B.C. Our epoch B.C. 483 preceded A.D. 520 by just 1003 years.

For 1000 years the movement of the precession is (by the Table in Sec. 281) 165 degrees.

.. 90° Tropical longitude in B.C. 483 corresponded to 90°+16.5°=106.5° Sidereal longitude.

By Table XVII - A, after 111 days complete, Sun's sidereal longitude is 107.26° - 1.10°==106.16°. For the balance :34 of a degree (106.5°--106.16°==34°) we may add (by Table XVII - O) :33 of a day.

... In B.C. 483 the sun attained 90° Tropical or 106:5° Sidereal longitude at 111:33 days of the Solar year.

Since the year commenced on March 10.26, we have, as the day of the Summer Solstice, March 10.26+111.38=

March 121-59=(by Table VIII) 29th June. This agrees with Prof. Jacobi's calculation, cited by Dr. Fleet los. cit.

\* The first New-moon in Solar year B.C. 483 being at 3.35 days, we learn from Table II, p. 2, that this was a year in which either Jyeshtha or Ashadha was Adhika. In fact Jyeshtha was Adhika.

## TABLE XI-B. Shortest Interval in Days, Ghatikas and NAKSHATRAS.

33R).

brder.	Names of Nakshatras.	Order	Ordinarily Vaisakha	Order	Ordinarily Jyeshtha	Order	Ordinarily Ashadha	Order	Ordinarily Sravan <b>a</b>	Order	Ordinarily Bhadrapad
Q	and the second of the second second second		NAME IN COMM		II		III		IV		Y
27123456789	Revati Asvini Bharani Krittika (Toueil Kinttigai) Rohini Mirgasira (Tamil Mirugasiram) Andra (Tamil Arudra or Tiruvadirai) Punarvasu Pushya (Tamil Pusam) Aslesha (Tamil Ayilyam)	3 4 5 6 7 8 10 11 12	$ \begin{array}{c} d, \ g, \ p \bullet \\ 0 \ 59 \ 21 \\ 2 \ 0 \ 4 \\ 3 \ 0 \ 47 \\ 4 \ 1 \ 30 \\ 5 \ 2 \ 13 \\ 6 \ 2 \ 56 \\ 7 \ 3 \ 39 \\ 8 \ 4 \ 22 \\ 9 \ 5 \ 4 \\ 1 \ 0 \ 5 \ 47 \\ \end{array} $	5 6 7 8 9 10 11 12 13 14	$\begin{array}{c} d, \ g, \ p, \\ 0 \ 48 \ 15 \\ 1 \ 43 \ 58 \\ 3 \ 49 \ 41 \\ 3 \ 50 \ 24 \\ 4 \ 51 \ 7 \\ 5 \ 51 \ 50 \\ 6 \ 52 \ 33 \\ 7 \ 58 \ 16 \\ 8 \ 53 \ 59 \\ 9 \ 54 \ 42 \end{array}$	7 8 9 10 11 12 13 14 15 16	$\begin{array}{c} 0, \ \ {\rm F}, \ \ {\rm p}, \\ 0 \ \ 37 \ \ 9 \\ 1 \ \ 37 \ \ 51 \\ 2 \ \ 38 \ \ 34 \\ 3 \ \ 39 \ \ 17 \\ 4 \ \ 40 \ \ 0 \\ 5 \ \ 40 \ \ 43 \\ 6 \ \ 41 \ \ 26 \\ 7 \ \ 42 \ \ 9 \\ 8 \ \ 42 \ \ 52 \\ 9 \ \ 43 \ \ 35 \end{array}$	0 10 11 12 13 14 15 16 17 18	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	11 12 13 14 15 16 17 18 19 20	$ \begin{array}{c} {\rm d.} & {\rm g.} & {\rm p.} \\ {\rm 0} & {\rm 14} & {\rm 56} \\ {\rm 1} & {\rm 15} & {\rm 39} \\ {\rm 2} & {\rm 16} & {\rm 32} \\ {\rm 3} & {\rm 17} & {\rm 5} \\ {\rm 4} & {\rm 17} & {\rm 48} \\ {\rm 5} & {\rm 18} & {\rm 81} \\ {\rm 6} & {\rm 19} & {\rm 14} \\ {\rm 7} & {\rm 19} & {\rm 57} \\ {\rm 8} & {\rm 20} & {\rm 40} \\ {\rm 9} & {\rm 21} & {\rm 23} \end{array} $
1011231456789	Magha (Jumil Magham) Purva Phalguni (Jumil Puram) Uttara Phalguni (Jamil Uttiram) Hasta (Tamil Iastam) Chitra (Tamil Chittirai) Svati Yisakha (Jumil Visakam) Anuradha (Jamil Anusham) Jyeshta (Jamil Kettai) Mula (Jamil Mulam)	13 14 15 16 17 18 19 20 21 22	11       6       30         12       7       13         5       13       7       56         14       8       39         15       9       22         16       10       5         17       10       47         18       11       30         19       12       13         20       12       56	15 16 17 18 20 21 22 23 24	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	17 18 19 20 21 22 23 24 25 26	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	19 20 21 22 23 24 25 26 27 1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2234567123	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
20 21 22 23 24 25 26 27	Purva Ashadha ( <i>Tamil</i> Puradam) Uttara Ashadha ( <i>Tamil</i> Uttiradam) Sravana ( <i>Tamil</i> Tiruvonam) Sravishta or Danishta ( <i>Tamil</i> Avittam) Satabhisaj or Sataraka ( <i>Tamil</i> Sadayam) Purva Bhadrapada ( <i>Tamil</i> Puratisadi) Uttara Bhadrapada ( <i>Tamil</i> Uttirattadi) Revati	23 24 26 27 1 1	21 13 39         22 14 22         23 15 5         24 15 48         25 16 3C         26 17 14         27 17 57         3 18 40         90 19 23	25 26 27 1 2 3 4 5	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2712345678	$\begin{array}{c} 20\ 51\ 28\\ 21\ 52\ 11\\ 22\ 52\ 54\\ 23\ 53\ 37\\ 24\ 54\ 20\\ 25\ 55\ 3\\ 26\ 55\ 46\\ 27\ 56\ 29\\ 26\ 57\ 12\\ \end{array}$	234567890	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4567890119	$\begin{array}{c} 20 & 29 & 16 \\ 21 & 29 & 59 \\ 22 & 30 & 42 \\ 23 & 31 & 25 \\ 24 & 32 & 8 \\ 25 & 32 & 51 \\ 26 & 33 & 34 \\ 27 & 34 & 17 \\ 28 & 35 & 0 \end{array}$

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Names of Y	logas.						YOU	GAS.				
	··· ··· ··· ··· ···		567 99 10 11 12 13 14	$\begin{array}{c} 0 58 57 \\ 1 50 26 \\ 2 46 55 \\ 3 43 25 \\ 4 39 54 \\ 5 56 28 \\ 6 32 58 \\ 7 29 22 \\ 8 25 51 \\ 9 22 21 \end{array}$	9 10 11 12 13 14 15 16 17 18	$\begin{array}{c} 0 \ 33 \ 17 \\ 1 \ 29 \ 46 \\ 2 \ 26 \ 16 \\ 3 \ 22 \ 45 \\ 4 \ 19 \ 14 \\ 5 \ 15 \ 43 \\ 6 \ 12 \ 13 \\ 7 \ 8 \ 42 \\ 8 \ 5 \ 12 \\ 9 \ 1 \ 41 \end{array}$	13 14 15 16 17 18 19 20 21 22	$\begin{array}{c} 0 & 12 & 37 \\ 1 & 9 & 6 \\ 2 & 5 & 35 \\ 3 & 2 & 5 \\ 3 & 58 & 34 \\ 4 & 55 & 4 \\ 5 & 51 & 38 \\ 6 & 48 & 2 \\ 7 & 44 & 32 \\ 8 & 41 & 1 \end{array}$	18 19 20 21 22 23 24 25 26 27	$\begin{array}{c} 0 \ 48 \ 26 \\ 1 \ 44 \ 56 \\ 2 \ 41 \ 25 \\ 8 \ 37 \ 54 \\ 4 \ 34 \ 24 \\ 5 \ 50 \ 53 \\ 6 \ 27 \ 23 \\ 7 \ 23 \ 52 \\ 8 \ 20 \ 21 \\ 9 \ 16 \ 50 \end{array}$	22 23 24 25 26 27 1 2 34	$\begin{array}{c} 0 & 27 & 46 \\ 1 & 24 & 16 \\ 2 & 20 & 45 \\ 3 & 17 & 15 \\ 4 & 13 & 44 \\ 5 & 10 & 14 \\ 6 & 6 & 43 \\ 7 & 3 & 13 \\ 7 & 59 & 41 \\ 8 & 56 & 12 \\ \end{array}$
	···· ···· ···· ··· ···		. 15 . 16 . 17 . 18 . 19 . 20 . 21 . 22 . 23 . 24	$\begin{array}{c} 10 \ 18 \ 50 \\ 11 \ 15 \ 20 \\ 12 \ 11 \ 49 \\ 18 \ 8 \ 18 \\ 14 \ 4 \ 48 \\ 15 \ 1 \ 17 \\ 15 \ 57 \ 46 \\ 16 \ 54 \ 16 \\ 17 \ 50 \ 45 \\ 18 \ 47 \ 15 \end{array}$	19 20 21 22 23 24 25 26 27 1	$\begin{array}{c} 9\ 58\ 10\\ 10\ 54\ 40\\ 11\ 51\ 9\\ 12\ 47\ 88\\ 14\ 40\ 36\\ 15\ 37\ 6\\ 16\ 33\ 35\\ 17\ 30\ 5\\ 18\ 26\ 34 \end{array}$	23 24 25 26 27 1 2 3 4 5	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1 2 3 4 5 6 7 8 9 10	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	567 89 10 11 12 13 14	$\begin{array}{c} 9 \ 52 \ 40 \\ 10 \ 49 \ 10 \\ 11 \ 45 \ 39 \\ 12 \ 42 \ 9 \\ 13 \ 38 \ 38 \\ 14 \ 35 \ 8 \\ 15 \ 31 \ 36 \\ 16 \ 28 \ 7 \\ 17 \ 24 \ 35 \\ 18 \ 21 \ 5 \end{array}$
			. 25 . 28 . 27 . 1 . 2 . 3 . 4 . 5 6 7 8	$\begin{array}{c} 19 \ 43 \ 44 \\ 20 \ 40 \ 13 \\ 21 \ 36 \ 43 \\ 22 \ 33 \ 12 \\ 23 \ 29 \ 41 \\ 24 \ 26 \ 11 \\ 25 \ 22 \ 40 \\ 26 \ 19 \ 9 \\ 27 \ 15 \ 89 \\ 28 \ 12 \ 8 \\ 29 \ 8 \ 37 \end{array}$	2 3 4 5 6 7 8 9 10 11 12	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	6789 1011 1213 1415 167	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11 12 13 14 15 16 17 18 19 20 21	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	15 16 17 18 19 20 21 22 23 24 25	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
	Names of Y	Names of Yogas.	Names of Yogas.	Names of Yogas.	Names of Yogas.	Names of Yogas.              5 $0.53.57$ 9              6 $1.50.26.10$ 11              7 $2.46.55.11$ 11              9 $4.39.54.13$ 13               9 $4.39.54.13$ 9 $4.39.54.13$ 9 $4.39.54.13$ 9 $4.39.54.13$	Names of Yogas.             5       0 53 57       9       0 33 17            6       1 50 26       10       1 29 46            7       2 46 55       11       2 26 16             9       4 39 54       13       4 19 14               9       4 39 54       13       4 19 14	Names of Yogas.       You            5       0       53       57       9       0       33       17       13              6       1       50       53       57       9       0       33       17       13               7       2       66       10       1       29       66       14               9       4       39       54       13       4       19       14       17                13       8       25       51       17       8       51       22       17       13       8       25       51       17       8       51       23       22       12       13       19       14       22       20       10       54       42       20       10       14       22       21       16       16       15       16       16       14       22       22       11 <td>Names of Yogas.         YOGAS.              5         0.58 57         9         0.38 17         13         0.12 37              6         1.50 26         10         1.29 46         14         1.9         6              7         2.46 55         11         2.26 16         15         2.5         5              9         4.39 54         13         4.19 14         17         5.65 34                9         4.39 54         13         4.19 14         17         5.65 34                 13         8.15 44         19         5.51 38                  12         7.39 22         16         7         8.42 20         6.48 2                      </td> <td>Names of Yogas.         YOGAS.  </td> <td>Names of Yogas.         YOGAS.          </td> <td>Names of Yogas.         YOGAS.          </td>	Names of Yogas.         YOGAS.              5         0.58 57         9         0.38 17         13         0.12 37              6         1.50 26         10         1.29 46         14         1.9         6              7         2.46 55         11         2.26 16         15         2.5         5              9         4.39 54         13         4.19 14         17         5.65 34                9         4.39 54         13         4.19 14         17         5.65 34                 13         8.15 44         19         5.51 38                  12         7.39 22         16         7         8.42 20         6.48 2	Names of Yogas.         YOGAS.	Names of Yogas.         YOGAS.	Names of Yogas.         YOGAS.



Trove New Moon to ending Moment of each Nakshatra and Yoga. NAKSHATRAS.

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A Contraction of a						NANSHA	TRI	AD. COSTERAT						
Asvina	Order	Ordinarily Karttikå	Order	Ordinarily Margasira	Order	Ordinarily Pausha	Order	Ordinarily Magha	Order	Ordinarily Phalguna	Order	Chaitra, when no Adhika Masa.	Order	Chaitra when there is Adbika Masa.
VI d, g, p. 13 0 3 50 14 1 4 33 15 2 5 16 16 3 5 59 17 4 6 42 18 5 7 25 19 6 8 8 20 7 8 51 21 8 9 34 22 9 10 16	16 17 18 19 20 21 22 23 24 25	$\begin{array}{c} \textbf{VII} \\ \textbf{d. g. p.} \\ 0 \ 58 \ 26 \\ 1 \ 54 \ 9 \\ 2 \ 54 \ 52 \\ 3 \ 55 \ 35 \\ 4 \ 56 \ 18 \\ 5 \ 57 \ 1 \\ 6 \ 57 \ 4 \\ 7 \ 58 \ 27 \\ 8 \ 59 \ 10 \\ 9 \ 59 \ 53 \end{array}$	18 19 20 21 22 23 24 25 26 27	VIIX           d. g. p.           0 42 20           1 43 3           2 48 46           3 44 29           4 45 12           5 45 54           6 46 37           7 47 20           8 48 3           9 48 46	20 21 22 23 24 25 26 27 1 2	IX d. g. p. 0 31 14 1 31 57 2 32 40 3 33 22 4 34 5 5 84 48 6 35 31 7 36 14 8 37 57 9 38 40	22 23 24 25 26 27 1 2 3 4	$\begin{array}{c} \textbf{X} \\ \textbf{d. g. p.} \\ 0 \ 20 \ 8 \\ 1 \ 20 \ 50 \\ 2 \ 21 \ 34 \\ 8 \ 22 \ 16 \\ 4 \ 22 \ 59 \\ 5 \ 23 \ 42 \\ 6 \ 24 \ 25 \\ 7 \ 25 \ 8 \\ 8 \ 25 \ 50 \\ 9 \ 26 \ 34 \end{array}$	24 25 267 1 234 56	$\begin{array}{c} \textbf{XI} \\ \textbf{d. g. p.} \\ 0 & 9 & 1 \\ 1 & 9 & 44 \\ 2 & 10 & 27 \\ 3 & 11 & 10 \\ 4 & 11 & 53 \\ 5 & 12 & 35 \\ 6 & 13 & 19 \\ 7 & 14 & 1 \\ 8 & 14 & 44 \\ 9 & 15 & 27 \\ \end{array}$	27 1 2 3 4 5 6 7 8 9	XII d. g. p. 0 58 88 1 59 21 3 0 3 4 0 46 5 1 29 6 2 12 7 2 555 8 3 58 9 4 21 10 5 3	2345676910	XIII d. g. p. 0 47 51 1 48 14 2 48 57 3 49 40 4 50 23 5 51 6 6 51 49 7 52 32 8 59 14 9 53 57
<b>23</b> 10 10 59 <b>24</b> 11 11 42 <b>25</b> 13 12 25 <b>26</b> 13 13 8 <b>27</b> 14 13 51 <b>1</b> 15 14 34 <b>2</b> 16 15 16 <b>3</b> 17 15 59 <b>4</b> 18 16 42 <b>5</b> 19 17 25	26 27 1 23 4 5 6 7 8	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	12345678910	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	345 67 89 10 11 12	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	567 89 10 11 12 13 14	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	7 8 9 10 11 12 13 14 15 16	$\begin{array}{c} 10 \ 16 \ 10 \\ 11 \ 16 \ 53 \\ 12 \ 17 \ 35 \\ 13 \ 18 \ 19 \\ 14 \ 19 \ 1 \\ 15 \ 19 \ 44 \\ 16 \ 20 \ 27 \\ 17 \ 21 \ 10 \\ 18 \ 22 \ 53 \\ 19 \ 28 \ 35 \end{array}$	10 11 12 13 14 15 16 17 18 19	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	12 13 14 15 16 17 18 19 20 21	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
6 20 18 8 7 21 18 51 8 22 19 34 9 23 20 16 10 24 20 59 11 25 21 42 12 26 22 25 13 27 23 8 14 28 28 51 15 29 24 34	9 10 11 12 13 14 15 16 17	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11 12 13 14 15 16 17 18	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	13 14 15 16 17 18 19 20 21	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	15 16 17 18 19 20 21 22 23	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	17 18 19 20 21 22 23 24 25 26	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	20 21 22 23 24 25 26 27 1	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	22 23 24 25 26 27 1 2 3	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
26       0       7       6         27       1       3       36         1       2       0       5         2       2       56       35         3       3       5.3       4         4       4.49       33       5       5       4.6       3         5       5       4.6       3       5       6       42       32         7       7       39       1       8       8       35       31	4 5 6 7 8 9 10 11 12 13	0 42 56 1 39 25 2 35 55 3 32 24 4 28 54 5 25 28 6 21 52 7 18 21 8 14 51 9 11 20	8 9 10 11 12 13 14 15 16 17	$\begin{array}{c} 0 & 22 & 16 \\ 1 & 18 & 46 \\ 2 & 15 & 15 \\ 8 & 11 & 44 \\ 4 & 8 & 14 \\ 5 & 4 & 48 \\ 6 & 1 & 12 \\ 6 & 57 & 42 \\ 7 & 54 & 11 \\ 7 & 8 & 50 & 40 \end{array}$	12 13 14 15 16 17 18 19 20 21	0 1 36 0 58 6 1 54 35 2 51 5 3 47 34 4 44 3 5 40 32 6 37 2 7 33 81 8 30 1	GAS 17 18 19 20 21 22 23 24 25 26	$\begin{array}{c} 0 & 37 & 26 \\ 1 & 38 & 55 \\ 2 & 30 & 24 \\ 3 & 26 & 54 \\ 4 & 23 & 23 \\ 5 & 19 & 53 \\ 6 & 16 & 22 \\ 7 & 12 & 51 \\ 8 & 9 & 21 \\ 9 & 5 & 50 \end{array}$	21 22 23 24 25 26 27 1 2 2 3	$\begin{array}{c} 0 & 16 & 46 \\ 1 & 13 & 15 \\ 2 & 9 & 45 \\ 3 & 6 & 14 \\ 4 & 2 & 43 \\ 5 & 55 & 42 \\ 6 & 52 & 12 \\ 6 & 52 & 12 \\ 7 & 48 & 41 \\ 8 & 45 & 10 \end{array}$	26 27 1 2 3 4 5 6 7 8	$\begin{array}{c} 0 \ 52 \ 35 \\ 1 \ 49 \ 5 \\ 2 \ 45 \ 34 \\ 3 \ 42 \ 3 \\ 4 \ 38 \ 33 \\ 5 \ 35 \ 2 \\ 6 \ 31 \ 32 \\ 7 \ 28 \ 1 \\ 8 \ 24 \ 30 \\ 9 \ 20 \ 58 \end{array}$	34 56 7 8 9 10 11 12	$\begin{array}{c} 0 & 31 & 55 \\ 1 & 28 & 25 \\ 2 & 24 & 54 \\ 3 & 21 & 24 \\ 4 & 17 & 53 \\ 5 & 14 & 23 \\ 6 & 10 & 52 \\ 7 & 7 & 21 \\ 8 & 3 & 50 \\ 9 & 0 & 20 \end{array}$
<b>9 9</b> 32 0 <b>10</b> 10 28 30 <b>11</b> 11 24 59 <b>12</b> 12 21 28 <b>13</b> 18 17 58 <b>14</b> 14 14 97 <b>15</b> 15 10 57 <b>16</b> 16 7 25 <b>17</b> 17 3 55 <b>18</b> 18 0 24	14 15 16 17 18 19 20 21 22 23	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	18 19 20 21 22 23 24 25 26 27	$\begin{array}{c} 9 \ 47 \ 10 \\ 10 \ 48 \ 39 \\ 11 \ 40 \ 9 \\ 12 \ 36 \ 38 \\ 13 \ 33 \ 7 \\ 14 \ 29 \ 36 \\ 16 \ 26 \ 6 \\ 16 \ 22 \ 35 \\ 17 \ 19 \ 5 \\ 18 \ 15 \ 34 \end{array}$	22 23 24 25 26 27 1 2 3 4	$\begin{array}{c} 9 \ 26 \ 30 \\ 10 \ 22 \ 59 \\ 11 \ 19 \ 29 \\ 12 \ 15 \ 58 \\ 13 \ 12 \ 27 \\ 14 \ 8 \ 57 \\ 15 \ 5 \ 26 \\ 16 \ 1 \ 55 \\ 16 \ 58 \ 25 \\ 17 \ 54 \ 54 \end{array}$	27 1 2 3 4 5 6 7 8 9	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4 6 7 8 9 10 11 12 13	$\begin{array}{c} 9 \ 41 \ 39 \\ 10 \ 38 \ 9 \\ 11 \ 34 \ 38 \\ 12 \ 31 \ 8 \\ 13 \ 27 \ 37 \\ 14 \ 24 \ 6 \\ 15 \ 20 \ 36 \\ 16 \ 17 \ 5 \\ 17 \ 13 \ 35 \\ 18 \ 10 \ 4 \end{array}$	9 10 11 12 13 14 15 16 17 18	$\begin{array}{c} 10 \ 17 \ 29 \\ 11 \ 18 \ 57 \\ 12 \ 10 \ 28 \\ 13 \ \ 6 \ 56 \\ 14 \ \ 3 \ 27 \\ 14 \ \ 59 \ 55 \\ 15 \ 56 \ 25 \\ 16 \ 52 \ 53 \\ 17 \ 49 \ 24 \\ 18 \ 45 \ 52 \end{array}$	13 14 15 16 17 18 19 20 21 22	$\begin{array}{c} 9 \ 56 \ 49 \\ 10 \ 53 \ 18 \\ 11 \ 49 \ 48 \\ 12 \ 46 \ 17 \\ 18 \ 42 \ 47 \\ 14 \ 39 \ 16 \\ 15 \ 35 \ 45 \\ 16 \ 32 \ 15 \\ 17 \ 28 \ 44 \\ 18 \ 25 \ 13 \end{array}$
<b>19</b> 18 56 54 <b>20</b> 19 53 23 <b>21</b> 20 49 58 <b>22</b> 21 46 22 <b>23</b> 22 42 51 <b>24</b> 23 39 21 <b>25</b> 24 35 50 <b>26</b> 25 32 19 <b>27</b> 26 28 48 <b>1</b> 27 25 18 <b>2</b> 28 21 47 <b>3</b> 29 18 17	24 25 26 27 1 23 4 56 7	$\begin{array}{c} 19 \ 32 \ 43 \\ 20 \ 29 \ 13 \\ 21 \ 25 \ 42 \\ 22 \ 22 \ 12 \\ 23 \ 18 \ 41 \\ 24 \ 15 \ 10 \\ 25 \ 11 \ 40 \\ 26 \ 8 \ 9 \\ 97 \ 4 \ 38 \\ 28 \ 1 \ 7 \\ 28 \ 57 \ 37 \end{array}$	1 2 3 4 5 6 7 8 9 10 11	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5678910 111213 114 15	$\begin{array}{c} 18\ 51\ 24\\ 19\ 47\ 53\\ 20\ 44\ 22\\ 21\ 40\ 51\\ 22\ 37\ 21\\ 23\ 33\ 50\\ 24\ 30\ 20\\ 25\ 26\ 49\\ 26\ 23\ 18\\ 27\ 19\ 48\\ 28\ 16\ 17\\ 29\ 12\ 47\\ \end{array}$	10 11 12 13 14 15 16 17 18 19 20	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	14 15 16 17 18 19 20 21 22 23 24 25	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	19 20 21 22 23 24 25 26 27 2	$\begin{array}{c} 19 \ 42 \ 23 \\ 20 \ 38 \ 51 \\ 21 \ 35 \ 22 \\ 22 \ 31 \ 50 \\ 23 \ 28 \ 20 \\ 24 \ 24 \ 49 \\ 25 \ 21 \ 19 \\ 26 \ 17 \ 48 \\ 27 \ 14 \ 18 \\ 28 \ 10 \ 47 \\ 29 \ 7 \ 16 \end{array}$	23 24 25 26 27 1 23 4 5 6	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

		_	Strate and the state of the state	A Management of the second				U
Æ	XI-C.	Annual	Correction	(additive) fo	r Nakshatras and	Yogas A.D	1840-A.D	. 192

ABI

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A.D.	Nak d.	sbat gh.	ras. p.	d.	Yoga gh.	15. P•	A. D. d	csbat gh.	ras. P-	a.	Yoga gh.	s.: p.	A.D	Nal d.	cshat gh.	ras. p.	d.	Yog gh.	əs. p.	A. D.	Nal d.	csha gh	tras. . p.	A.	loga gh,	в. р.
1840 1841 1842 1843 1844	0 1 0 0 1	40 29 11 54 43	22 15 85 28 21	$     \begin{array}{c}       1 \\       2 \\       0 \\       1 \\       3     \end{array} $	15 46 10 41 12	7 5 25 23 20	1860 1 1861 0 1862 0 1863 1 1864 0	30 6 55 44 20	16 37 30 23 44	2 0 1 3 0	47 12 43 14 38	59 19 17 15 35	188 188 188 188 188	0 0 0 1 0 1 0 1 0 1 0 1	7 56 45 21 10	38 32 24 45 38	0 1 3 0 2	14 45 16 40 11	14 11 9 29 27	1900 1901 1902 1903 1904	0 1 0 1 2	$57\\46\\22\\11\\0$	38 26 46 39 82	1 3 0 2 3	47 18 42 18 44	6 3 24 21 19
1845 1846 1847 1848 1849	0 1 1 0 1	19 8 57 33 22	42 35 28 49 42	02312	36 7 38 2 83	41 38 36 57 54	1965 1 1866 1 1867 0 1868 1 1869 0	9 58 84 23 0	87 30 50 43 4	2 3 1 2 0	9 40 4 35 0	31 30 51 48 9	188 188 188 188 188	5 1 6 0 7 1 6 0 9 0	59 35 24 1 49	$     \begin{array}{r}             81 \\             52 \\             45 \\             6 \\             59         \end{array} $	3 1 2 0 1	42 6 37 2 33	$     \begin{array}{r}       24 \\       45 \\       43 \\       3 \\       1     \end{array} $	1905 1906 1907 1908 1909	0 1 0 0 1	36 25 2 51 39	58 46 7 0 58	1 9 0 1 3	8 49 8 34 5	39 87 57 55 58
1850 1851 1852 1853 1854	2 0 1 0 1	11 47 96 13 2	35 56 49 9 3	4 1 3 0 1	4 29 0 24 55	52 12 10 30 28	1870 0 1871 1 1872 0 1873 1 1874 1	48 37 14 3 51	57 50 11 4 57	1 3 0 1 3	81 26 57 28	6 4 24 22 20	189 189 189 189 189	0 1 1 0 2 1 3 1 4 0	38 15 4 52 29	52 12 5 58 20	8 0 1 3 0	3 28 59 30 54	58 19 17 14 84	1910 1911 1912 1913 1914	0 1 1 0 1	16 5 54 30 19	14 7 0 21 14	02302	30 1 32 56 27	13 11 8 29 27
1855 1856 1857 1858 1859	1 0 2 2 0	50 27 16 5 40	56 16 9 2 23	8 0 2 3 1	$26 \\ 50 \\ 21 \\ 52 \\ 16$	26 46 44 41 47	1875 0 1876 1 1877 2 1878 1 1879 1	20 17 6 42 31	18 11 4 24 18	0 2 3 1 2	52 23 54 18 49	40 98 35 56 54	189 189 189 189 189	5 1 6 2 7 0 5 1 0 5 0	18 7 43 32 8	12 5 26 19 40	2 3 1 2 0	25 56 20 51 16	32 30 50 48 8	1915 1916 1917 1918 1918	2 0 1 0 0	8 44 33 9 58	7 27 20 41 34	3 1 2 0 1	58 22 58 18 49	24 45 42 3 0

#### EXPLANATION.

In the N.B. to Sec. 263, p. (95) of the text additive tables for Nakshatras were promised with the next edition. The convenience of having additive formula for the current epoch A.D. 1840 to A.D. 1920 is so great that the necessary tables are presented to the reader in the above addenda as Tables XI-B. and XI-C. Examples will now be given, showing how these tables should be used.

I. Required the ending moment of Nakshatra Krittika for the month of July 1910 (vide p. 232 of Tables).

			all list		C	's An	om.
		d.	gh.	p.	đ.	gh.	<b>p.</b>
(Table XII, p. 15) Jyeshtha New Moon. (Table XI-B, previous page) Shortest interval from Jyeshtha	June	7	39	7	2	30	40
New Moon to No. 3 Krittika Nakshatra.		26	6	10	26	6	10
Add Nakshatra correction for 1910 (XI-C. Supra.)		0	16	14	0	16	14
	June	34	1	31	28	53	4
(Table IX-7, p. 23.) Nakshatra Eqn. for Anom. of 1 19 47			- 6	20	27	33	17 (1 Anom. Month.)
10-10-1-10-10-10-10-10-10-10-10-10-10-10	June	33	55	11	1	19	47

Krittika Nakshatra ended on June 33, i.e., on 3 July 1910, at 55 ghatikas 11 palas after mean Lanka Sunrise. If we want local time, we should use Table XIII.

II. R	lequised the	e ending moment o	f Yoga Vyatipata	(No. 17) in Ja	uly 1910.
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and the second		all show		e	)'s An	10m.		C.	s An	ORO.
	d	gh.	p.	d.	gh.	p.		d.	gh.	p.
(Table XII, p. 151.) Ashadha New Moon.	uly 7	10	67	84	68	29		4	29	13
(Table X1 - B, previous page) Shortest interval from Ashadha		89.01	10.5		11000			9.11	1	in the second
New stoon to No. 17 Vyaupata Yoga.	3	58	34		58	34		3	58	34
(X1-U. Supra) Add Yoga correction for A. D. 1910.	0	30	13	(	) 30	13		Ø	30	13
Include IX i p 20a) Sunte Vorre For for 20 d 27 ab 1 1 ab 05 p	-	20	1.4		07	10			= 0	
, p. 20b, Moon's Yoga Eqn. for 8 d. 59 gh. 25 p19 gh. 40 p.	11	98	44	63	21	10		0	00	0
Sum - 18 gh. 15 p.	- 10	18	15	(	⊙'s ¥	loga	Equ.)	+	1	25
1		21	29					8	59	25
	ulv 11	21	29					8	59	2

i. s., No. 17 Yoga Vyatipata ended at 21 gh. 29 p. after mean Lanka Sunrise on 11 July 1910.



## Addendum. TABLES XI-D and XI-E. Shortest Interval in days and decimals of a day

## from new moon to ending moment of each Nakshatra and each Yoga.

#### EXPLANATION.

Tables XI-D and XI-E, which are printed on the next two pages, are the additive tables promised in N.B. to 8. 263, p. (95) of the Text. One of the intervals in Table XI-D, as well as the result of the application of Table XI-E, " should be added to the moment of new moon in order to ascertain the ending moment of any *nakshatra* or *yega*. Though the tables are, as a whole, additive, it should be remembered that in using Table XI-E, the correction corresponding to the decimal portion of the argument should be *subtracted* from the correction corresponding to the integral number of days after which the first new moon appears in each solar year. Where great accuracy is not essential, it is unnecessary to calculate the correction corresponding to the decimal portion of the argument. The argument for Table XI-E is always the day of the First New Moon in the Solar Year. When the First New Moon is less than a day old in the Solar Year, prefix 0 to the argument. Thus, for A.D. 1915 (First New Moon in Solar Year, 0.9855) the Nakshatra correction is 2.9089 - (.0733+.0004) = 2.1352; and the Yoga correction is 4.1036 - (.13641+.00076) = 4.07319.

#### EXAMPLES.

The examples on the previous page will first be worked out with the aid of Tables XI-D and XI-E on the next two pages.

I .- Required the ending moment of Nakshatza Krittika for the month of July 1910. (see Tables, p. 232.)

	Month.	Day.	Fraction	C's Anom.
(Table X, p. 126) Jyeshtha New Moon, A.D. 1910	. June	7,	or day. .65	Clays, 0.535
(Table-XI D, next page). Shortest interval from Jyeshtha New Moon to No. 8. Krittika Nakshatra		+ 26	·10	+ 1976
	- 10			28.61 - 27.55 (1 Anom. Month.)
(Table XI-E). The first New Moon in the Solar Year being, according to Table X, at 25-91 days, this is the argument for Table XI-E (next page). The Nakshatra correction for A.D. 1910-11 is, therefore by Table XI-E, 0-34				1-06
minus •07=		+	•27	+ *27
Table (IX-j). Nakshatra equation corresponding to	June	34	.02	1.33
('s Anom. of 1.50 days			11	
And the second	June	33	.91	

i.e., (by Eye-table) the Nakshatra Krittika in July 1910 ended on June 33, that is, on 3 July, at 55 ghatikas after mean sunrise.

II .- Required the ending moment of Yoga Vyatipata (No. 17) in July 1910. (see Tables, p. 232.)

(Table X, p. 126.) Ashadha New Moon, A.D. 1910	July days 7-18	⊙'s Anom. days. 25.91	( 's Anom. days. 0.53
(Table XI-D next page), Shortest interval from Ashadha New Moon to No. 17 Vyatipata Yoga (Table XI-E). Applying, as before, the argument for A D 1910-11 and 95.91 to the Yoga contaction	+ 3.98	+ 8.98	+ 3.98
table in XI-E, we have 0.63 minus 13=	+ -50	+ .50	+ '50
	July 11.66	89.45	8.96
Table IX-(i): $\bigcirc$ 's Yoga equation for 89d. 27 gh.= $+1\frac{1}{2}$ gh. Table IX-(i): $\bigcirc$ 's Yoga equation for 8d. 59 gh.= $-19\frac{3}{3}$ gh.	=July 11, 391gh.	or 89d. 27gh.	or 8 days 57½ gh. +1½gh. [④'s
-18½ gh.	-18igh.		Table IX-(i)
			8 days, 59 gh.

Ending moment of No. 17 Vyatipata Yoga, July 11, 21 igh. after mean (Lanka) sunrise.

N. B .--- The difference between this result and that arrived at on the last page is due to the fact that in the present working we have used only two decimal places for mean ending moments and anomalies.

We see that the method is applicable to Nakshtras and Yogas in any year, B.C. or A.D., not merely in the years A.D. 1840-A.D. 1920, as in Tables XI-B and XI-C on the three previous pages.

Continued on page 12.

Addendum.

## TABLE XI-D. Shortest Interval in Days, from New-Moon to ending NARSHATRAS.

10

		. (	rdinarily		Ordinarily		Ordinaril		Irdinarily	-	Ordinarily	-	Ordinaril	X	Ordinarily	Ordinarily
rder	Names of Nakshatras	Inder	Vaisakha	Order	Jyeshtha	Order	Ashadha	Order	Sravana	Orde	Bhadrapada	Orde	Asvina	Orde	Karttika E	Margasira
•	and the second	~	I	Ĭ	II	•	III	1	IN		¥		¥I		XII .	VIII
27123456789	Revati Asvini Bharani Krittika Rohini Mirgasha Ardra Punarvasu Aslesha	3456789 10111	$\begin{array}{c} 0.9892\\ 2.0011\\ 3.0130\\ 4.0249\\ 5.0368\\ 6.0188\\ 7.0607\\ 8.0726\\ 9.0845\\ 10.0954\end{array}$	567890112 111213 14	0.8041 1.8160 2.8279 3.8398 4.8518 5.8637 6.8756 7.8875 8.8094 9.9113	7 8 9 10 11 12 13 14 15 16	$\begin{array}{c} 0.6190\\ 1.6309\\ 2.6428\\ 3.6548\\ 4.6367\\ 5.6786\\ 6.6905\\ 7.7024\\ 8.7143\\ 9.7262\end{array}$	9 10 11 12 13 14 15 16 17 18	0.4339 1.4458 2.4578 3.4697 4.4816 5.4935 6.5054 7.5173 8.5292 9.5412	$   \begin{array}{r}     11 \\     12 \\     13 \\     14 \\     15 \\     16 \\     18 \\     20 \\   \end{array} $	$\begin{array}{c} 0.248.5\\ 1.2608\\ 2.2727\\ 3.2546\\ 4.2065\\ 5.3084\\ 6.3203\\ 7.3322\\ 8.3442\\ 9.3561\end{array}$	13 14 15 16 17 18 19 20 21 22	$\begin{array}{c} 0.0638\\ 1.0757\\ 2.0376\\ 3.0995\\ 1.1114\\ 5.1233\\ 6.1352\\ 7.1473\\ 8.1591\\ 9.1710\\ \end{array}$	16 17 18 19 20 21 22 23 24 25	0.8906 18 1.9025 19 2.9144 20 3.9263 21 4.9382 22 5.9502 23 6.9621 24 7.9740 25 8.9359 26 9.9978 27	0.7055 1.7174 2.7293 8.7412 4.7532 5.7651 6.7770 7.7889 8.8008 9.8127
10 11 12 13 14 15 16 17 18 19	Magha Purva Phalguni Uttana Phalguni Hasta Svati Yisakha Anuradha Muia	13 14 15 16 17 18 20 21 20	$\begin{array}{c} 11\cdot 1083\\ 12\cdot 1202\\ 13\cdot 1322\\ 14\cdot 1441\\ 15\cdot 1560\\ 16\cdot 1679\\ 17\cdot 1798\\ 18\cdot 1917\\ 19\cdot 2036\\ 20\cdot 2156\end{array}$	15 16 17 19 20 21 22 23 24	10-9232 11-9352 12-9471 13-9590 14-9709 15-9328 16-9947 18-0046 19-0186 20-0305	17 18 20 21 22 22 22 22 22 22 22 22 22 22 22 22	$\begin{array}{c} 10\mbox{-}7\mbox{-}382\\ 11\mbox{-}7\mbox{-}501\\ 12\mbox{-}7\mbox{-}630\\ 13\mbox{-}7\mbox{-}39\\ 14\mbox{-}7\mbox{-}858\\ 15\mbox{-}7\mbox{-}77\\ 16\mbox{-}8096\\ 17\mbox{-}8216\\ 13\mbox{-}8335\\ 19\mbox{-}8454\\ \end{array}$	19 20 21 22 23 24 25 26 27 1	$\begin{array}{c} 10{\cdot}5{\cdot}5{\cdot}5{\cdot}1\\ 11{\cdot}5{\cdot}5{\cdot}5{\cdot}0\\ 12{\cdot}5{\cdot}7{\cdot}6{\cdot}9\\ 13{\cdot}5{\cdot}8{\cdot}8\\ 14{\cdot}6{\cdot}0{\cdot}7\\ 15{\cdot}6{\cdot}12{\cdot}6\\ 16{\cdot}6{\cdot}24{\cdot}6\\ 17{\cdot}6{\cdot}3{\cdot}6\\ 18{\cdot}6{\cdot}4{\cdot}8{\cdot}\\ 19{\cdot}6{\cdot}6{\cdot}3\\ 19{\cdot}6{\cdot}6{\cdot}3 \end{array}$	21 22 23 24 25 26 27 1 23	$\begin{array}{c} 10.3689\\ 11.3799\\ 12.3918\\ 18.4037\\ 14.4156\\ 15.4276\\ 16.4395\\ 17.4514\\ 18.4633\\ 19.4752\\ \end{array}$	23 24 25 26 27 1 23 45	$\begin{array}{c} 101829\\ 111948\\ 122067\\ 132186\\ 142306\\ 152425\\ 162544\\ 172613\\ 182783\\ 192901 \end{array}$	237 12345678	$\begin{array}{ccccccc} 11{\cdot}0097 & 1 \\ 12{\cdot}0216 & 2 \\ 13{\cdot}0336 & 3 \\ 14{\cdot}0455 & 4 \\ 15{\cdot}0574 & 5 \\ 16{\cdot}0693 & 6 \\ 17{\cdot}0812 & 7 \\ 18{\cdot}0931 & 6 \\ 19{\cdot}1050 & 9 \\ 20{\cdot}1169 & 10 \end{array}$	$\begin{array}{c} 10.8246\\ 11.8366\\ 12.8485\\ 13.8604\\ 14.8723\\ 15.8842\\ 16.8961\\ 17.9080\\ 18.9199\\ 19.9319 \end{array}$
20 21 22 23 24 25 25 27	Purva Ashadha Uttara Ashadha Sravana Sravishta Satabhisaj Purva Bhadrapada. Uttara Bhadrapada. Revati	23244	21-2275 22-2394 23-2518 24-2632 725-2751 26-2870 27-2990 28-8109 29-3228	2527	21-0424 22:0543 23:0662 24:0781 22:0900 26:1019 27:1139 28:1258 329:1377	27 1 2 3 4 5 6 7 8	$\begin{array}{r} 20.8573\\ 21.8692\\ 22.8811\\ 23.8930\\ 24.9049\\ 25.9169\\ 26.9288\\ 27.9407\\ 28.9526\end{array}$	2345 678 910	20.6722 21.6841 22.6960 23.7079 24.7199 25.7818 26.7437 27.75566 28.7675	4 5 6 7 8 9 10 11 12	<ul> <li>204871</li> <li>214990</li> <li>225109</li> <li>225109</li> <li>215313</li> <li>255464</li> <li>265586</li> <li>275052</li> <li>255821</li> </ul>	67 89 10 11 12 13 14 15	20·3020 21·3139 22·3259 23·3378 21·3497 25·3616 26·3735 27·3854 28·3978 23·4093	9 10 11 12 13 14 15 16 17	$\begin{array}{c} 24 \cdot 1239 \ 11 \\ 22 \cdot 1408 \ 12 \\ 23 \cdot 1527 \ 13 \\ 24 \cdot 1646 \ 14 \\ 255 \ 1765 \ 15 \\ 26 \cdot 1884 \ 16 \\ 27 \cdot 2003 \ 17 \\ 128 \cdot 2123 \ 18 \\ 29 \cdot 2242 \ 18 \end{array}$	20:9438 21:9557 22:9676 23:9795 24:9914 ; 26:0033 27:0153 ; 28:0272 ; 28:0272 ; 29:0391
1	Names of Yogas.		a and						YOGA	s.						
27123456789	Vaidhriti Vishkamba Priti Ayushmat Saubhagya Sobhana Atiganda Sukarman Dhriti Sula		0.8992           1.8407           2.7822           3.7237           4.6652           5.6067           6.5482           7.4896           8.4411           9.3726		0         0.5548           1:4963         1:4963           2:4378         3:3793           3:43208         5:9622           5:6:2037         6:2037           7:1452         7:8:0667           3:9:0352         9:0352	13 14 15 16 17 18 20 21 22	0.2104 1.1519 2.0934 8.0349 3.9763 4.9178 5.8593 6.8008 7.7423 8.6838	18 19 20 21 22 23 24 25 26 27	$\begin{array}{c} 0.8075\\ 1.7490\\ 2.6905\\ 3.6319\\ 4.5734\\ 5.5149\\ 6.4564\\ 7.3979\\ 8.3394\\ 9.2809\end{array}$	20202020	2 0:4631 3 1:4046 4 2:3460 5 3:2875 6 4:2290 7 5:1705 1 6:1120 2 7:0535 3 7:9950 4 8:0365	22712345678	$\begin{array}{c} 0.1187\\ 1.0601\\ 2.0016\\ 2.9431\\ 3.8846\\ 4.9261\\ 5.7676\\ 6.7091\\ 7.6506\\ 8.5921\end{array}$	4 6 7 8 10 11 12 13	0.7157 £ 1.6572 £ 2.5987 12 13 1.44817 12 5.4221 13 6.3647 14 7.3062 14 8.2477 16 9.1891 17	0.8713           1.3128           2.2543           3.1958           4.1373           5.0783           6.9618           7.9032           8.8447
10 11 12 13 14 15 16 17 18	Ganda	111111111111111111111111111111111111111	5 10.3141 3 11.2556 7 12.1971 3 13.1386 9 14.0801 0 15.0316 1 15.9630 2 16.9045 3 17.8460 1 13.7875	19 20 20 20 20 20 20 20 20 20 20 20 20 20	9 99697 109112 11:527 2 12:7943 3 13:7357 1 1:6771 5 15:6186 6 16:5601 7 17:5016 1 18:4431	23 24 25 26 27 1 23 45	9-6253 10-5668 11-5033 12-4498 13-3912 14-8327 15-2742 16-2157 17-1572 18-0987	1 2 3 4 5 6 7 0 9 10	$\begin{array}{c} 102224\\ 11\cdot 1639\\ 12\cdot 1053\\ 13\cdot 0468\\ 13\cdot 9883\\ 14\cdot 9298\\ 15\cdot 8718\\ 16\cdot 8128\\ 17\cdot 7543\\ 18\cdot 6958 \end{array}$	11111	5 9:8780 6 10:8195 7 11:7609 8 12:7024 9 13:6439 0 14:5854 1 15:5269 2 16:4684 3 17:4099 4 18:3514	9 10 11 12 13 14 15 16 17	9.5335 10.4750 11.4165 12.8580 13.2995 14.2410 15.1825 16.1240 17.0655 18.0070	14 15 16 17 18 20 21 21	10-1306         11           5         11-0721         15           5         12-0136         20           7         12-0551         2           3         13-8966         25           3         13-8966         25           3         13-8966         25           3         15-7796         24           16-7211         24         17-6625           3         18-6040         27	9.7862           10.7277           11.6693           12.6107           13.5522           14.4937           15.4952           16.3766           17.3181           7           18.2596
20 21 22 23 24 25 26 27	) Siya Siddha Sadhya Subha Subha Sukla Brahman Indra Vaidhriti	20	5 19.7290 3 20.6705 7 21.6120 4 22:5535 2 23:4950 3 24:4365 4 25:3779 5 26:3194 3 27:2609 7 28:2024 3 29:1439	11111	2 19:3846 3 20:3261 4 21:2676 5 22:2091 5 28:1606 7 24:0920 3 25:0835 9 25:9750 0 26:9165 1 27:8580 2 28:7393	678901112 1121345 115	19-0402 19-9817 20-9232 21-8647 23-8061 23-7476 24-6891 25-6306 26-5721 27-5136 28-4551 28-4551	11 12 13 14 15 16 17 18 19 20	$\begin{array}{c} 19.6378\\ 20.5788\\ 21.5202\\ 22.4617\\ 23.4032\\ 94.3447\\ 25.2862\\ 26.2277\\ 27.1692\\ 28.1107\\ 29.0523\end{array}$	11111100000000	5         19:2929           6         20:2343           7         21:1738           8         2:51173           9         23:0538           0         24:0303           1         24:9418           2         5:8833           3         26:8248           4         27:7663           5         28:7078	19 20 22 22 22 22 22 22 22 22 22 22 22 22	18:9484 19:8899 20:8314 21:7729 22:7144 23:6159 24:5974 25:5389 26:4804 27:4219 28:8653 29:3048	2222	1         19:5455           20:42870         5           21:4285         5           7         22:3700           1         23:3115           2         24:2530           3         25:1945           3         25:1945           3         25:1945           5         27:0774           3         28:0189           4         28:9604	19-2011           20-1426           310-841           420-256           532-9056           724-8501           825-7915           926-7330           027-6745           128-6160

4

### Moriant of each Nakshatra and Yoga. NAKSHATRAS.

1.44	-A	1	IN AL D	-DAA	AP T TP'UT D				Marine Carl Marine
RE	rilinarily	E	Ordinarily	V 54	Ordinarily	F	Chaitra,	H	Chaitra
de		de		de	Y 11	de	when no	de	when there
0	Pausha	6	Magha	õ	Fnalguna	ð	Adhika	ő	Masa
	IX		X		XI		XII	TE.	XIII
20	0.5204	22	0.3353	24	0.1502	27	0.9771	2	0.7920
21	1.5323	23	1.3472	25	1.1622	1	1.9890	3	1.8039
22	20112	24	R-3711	20	3-1860	N O	4-01-98	5	3.8277
20	4'5681	20	4.3830	-1	4.1979	4	5.0247	6	4.8396
25	5.5800	27	5.3949	2	5.2098	5	6.0365	7	5.8516
26	6.5919	1	6.1068	3	6.2217	6	7.0186	8	6.8635
27	7.6038	2	7.4187	4	7.2336	7	8.0605	9	1 7.8754
	0.0276	3	0.1.196	0	0-2575	8	10.0813	11	9.8992
	2 0 210	1	JIIIO		1 2010	-	10 0010		
3	10-6396	5	10.4545	7	10.2694	10	11.0962	12	10.9111
4	11.6515	6	11.4664	8	11.2313	11	12.1081	13	11.9230
5	12.6634	7	12.4783	9	12.2932	12	13.1200	14	129330
07	156979	8	14-5021	10	14-9170	10	1511439	16	14:9588
8	15:6991	10	15.5140	12	15.3290	15	16-1558	17	15.9707
9	16-7110	11	16.5260	13	16.3409	16	17.1677	18	16.9826
10	17.7230	12	17.5379	14	17.3528	17	18:1796	19	17.9945
11	18.7349	13	18.5498	15	18.3647	18	191915	20	19.0064
12	19.1409	14	19.9014	10	19.9100	13	20-2004	41	20 0160
13	20 7587	15	20*5736	17	20-3385	20	21.2153	22	21.0303
14	21 7706	16	21.5855	18	21.4004	21	22.2273	23	22.0422
15	22.7825	17	22.5974	19	22.4124	22	23 2392	24	23.0511
16	28.7944	18	23.6094	20	23:4243	23	24.3011	25	24.0660
19	24.0001	20	24.0215	20	24.4004	25	26-2749	27	26.0898
19	26.8302	21	26.6451	23	26.4600	26	27.2868	1	27.1017
20	27.8421	22	27.6570	24	27 4719	27	23.2987	2	28.1137
21	28.8540	28	28.6689	25	28.4838	1	29-3107	3	29.1256
				26	29-1957				
					and the second				
					YOGAS	•			
12	0.0269	17	0.6210	21	0.2796	26	0-8767	3	0.5323
13	0.9684	18	1.2420	22	2.1696	21	1.8182	4	1.4131
15	2-8514	20	3.4485	24	8.1040	2	3.7011	6	3.9567
16	3.7929	21	4.3900	25	4.0455	3	4.6426	7	4-2932
17	4.7314	22	5.3314	26	4.9870	4	5.5841	8	5.2397
18	5.6759	23	6.2729	27	5.9285	5	6.5255	9	6.1812
20	0.01/3	24	P-2144 9-1550	1	7-8115	17	8+4086	11	8.0642
21	8.5003	26	9.0974	3	8.7530	8	9.3501	12	9.0057
Re			Sale Sale Sale		Subsection of	Yal.		- AND	
22	9.4418	27	10.0389	4	9.6945	9	10.2916	13	9.9472
23	10.3833	1	10.9804	D	10.6360	10	19.1745	14	11.9301
25	12/2663	43	12.8634	7	12:5190	12	13.1160	16	12.7716
26	13-2078	4	13.8048	8	13.4604	13	14.0575	17	13 7181
27	14.1493	5	14.7463	9	14-4019	14	14.9990	13	14 6546
1	15.0907	6	15.6878	10	15.8484	15	15.9405	19	15.5961
40	16:0322	4	17:5703	10	10.2349	10	17.8235	20	17.4701
4	17.9152	9	18-5123	13	18-1679	18	18.7650	22	18-4206
24	Carlos Par	130	A started				and the		
-5	18.8567	10	19-4538	14	19.1094	19	19.7065	23	19 3621
0	20.7907	10	20.3953	10	20-9924	21	21:5.894	A4	21 2150
R	21.6812	13	22.2783	17	21.9338	22	22.5309	26	22.1865
9	22.6227	14	23.2197	18	22.8753	23	23.4724	27	23.1280
10	28.5642	15	24.1612	19	23.8168	24	24.4134	1	24.0695
11	24.5056	16	25.1027	20	24.7583	25	25.3554	2	25.0110
12	26-2996	10	26.0857	23	20.0998	20	27.0394	0	26-9620
14	27.3301	19	27.9272	23	27.5828	1	28.1799	5	27.8855
15	28.2716	20	28-8687	24	28.5213	2	29-1214	6	28.7769
16	29.2131			25	5 29-1858				

## TABLE XI-E. ANNUAL CORRECTION

Argument:-Date of appearance of 1st New-Moon each Solar Year according to Table X.

The correction corresponding to the decimal portion of the argument should be subtracted from the Nakshatra or Yoga correction corresponding to the integral portion; thus the Nakshatra correction corresponding to an argument 28:53=0.11 minus .04:=0.07.

#### NAKSHATRAS.

Arg	. Corrn.	Arg. Corrn.	Arg. Corin.	Arg. Corrn.	Arg. Corrn.
0	2.20800	.01 .00075	·30 ·02244	.59 .04413	·88 ·06582
1 .	2.13410	·02 ·00150	·31 ·02319	·60 ·04488	·89 ·06657
2 :	2.05930	03 .00221	·32 ·02394	·61 ·04563	·90 ·06732
3	1.98450	·04 ·00299	·33 ·02468	·62 ·04638	·91 ·06807
4	1.90970	·05 ·00374	·34 ·02543	.63 .04712	·92 ·06882
5	1.83490	·06 ·004 49	·35 ·02618	64 04787	93 06956
6	1.76010	.07 .00534	36 02095	CC 04802	94 07031
1	1.68531	08.00598	.20 -02010	67 102019	90 07100
8	1.01049	100 100749	30 .09917	·68 -05086	·07 ·07956
	1.00000	10 00120	GG ONDER	000000	
10	1.46089	·11 ·00823	.40 .02992	·69 ·05161	·98 ·07330
11	1 38609	·12 ·06398	·41 ·03067	70 '05286	·99 ·07405
12	1.31129	·13 ·00972	.42 .03142	.71 .05811	
13	1.23649	·14 ·01017	·43 ·03216	·72 ·05386	
14	1.16163	·15 ·01/22	•44 03291	·73 -05460	STAT TO STATE
15	1.08639	·16 -01197	.45 .08366	.74 .05335	
16	1.01209	17 -01272	·40 ·03441	75 00010	
17	0.93729	18 .01340		177 -05760	
10	0.79760	10 -0149E	-49 -03665	.78 (05884	
13	0.19109	20 01200	40 00000		
20	0-71288	21 .01571	·50 ·03740	·79 ·05909	
21	0-63808	22 .01646	·51 ·03815	·80 ·05984	
22	0.56328	·23 ·01720	-52 .03890	·81 ·06059	A HELL MARK
23	0.18818	-24 -01795	·53 ·03964	·82 ·06134	
24	0.41368	·25 ·01870	·54 ·04039	·83 ·06208	
25	0.33888	·26 ·01945	·55 ·04114	·84 ·06283	
26	0.26408	27 .02020	·56 ·0±189	85 06353	
27	0.18928	28 .02094	· 57 ·04264	-86 ·00435	
28	0-11448	.28 .03199	.00 .07030	01 00000	
no	0.00000				
29	0.03968		manual		
29	0.03968		YOGAS.	and the	
29 0	0-03968 4·11086	<b>01</b> 00139	YOGAS. .30 01176	·59 .08212	·88 ·12/49
29 0 1	0-03968 4-11086 3-97117	• <b>01</b> •00139 <b>02</b> •00278	<b>YOGAS.</b> .30 ·01176 ·31 ·01315	• <b>59</b> .08212 • <b>60</b> •08351	-88 -12349 -89 -12388
29 0 1 2	0-03968 4-11086 3-97117 3-83198	•01 •00139 •02 •00278 •03 00417	<b>YOGAS.</b> .30 01176 .31 01315 .32 01454	•59.08212 •60.08351 •61.08491	•88 •12349 •89 •12388 •90 •12527 •91 •19555
29 0123	0-03968 4-11036 3-97117 3-83198 3-69279	01 00139 02 00278 03 00417 04 00557 05 00696	YOGAS. 30 01176 31 01315 32 01454 33 04593 34 04732	•59.08212 •60.08351 •61.04491 •62.08630 •63.08769	*88 *12349 *89 *12388 *90 *12527 *91 *12666 *92 *19805
29 01234	0-03968 4-11036 3-97117 3-83198 3-69279 3-55360 3-11444	•01 •00139 •02 •00278 •03 00417 •04 •00557 •05 •00696 •06 •00835	YOGAS. 30 01176 31 01315 32 04454 33 04593 34 04732 35 04872	•59.08212 •60.08851 •61.08491 •62.08630 •63.08769 •64.08908	*88 *12/49 *89 *12388 *90 *12527 *91 *12666 *92 *12805 *93 *12845
29 0123456	0.03968 4.11086 3.97117 3.83198 3.69279 3.55360 3.41441 3.27522	•C1 •00139 •O2 •00278 •O3 00417 •O4 •00557 •O5 •00696 •O6 •00835 •O7 •00974	<b>¥ OGAS.</b> <b>:30</b> 04176 <b>:31</b> 01315 <b>:32</b> 04454 <b>:33</b> 04593 <b>:34</b> 04732 <b>:35</b> 04872 <b>:36</b> 05011	<b>59</b> .08212 <b>60</b> .08351 <b>61</b> .0491 <b>62</b> .08630 <b>63</b> .08769 <b>64</b> .08908 <b>65</b> .09017	*88 12/49 *89 12388 *90 12527 *91 12666 *92 12805 *93 12945 *94 13054
29 01234567	0-03968 4-11086 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603	•C1 •00139 •O2 •00278 •O3 00417 •O4 •00557 •O5 •00696 •O6 •00835 •O7 •00974 •O8 •01113	<b>¥ OGAS.</b> <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150	*59.08212 *60.08351 *61.04491 *62.08630 *63.08769 *64.08908 *65.09917 *66.099186	*88 12/49 *89 12388 *90 12587 *91 12666 *92 12805 *93 12945 *94 13054 *95 13223
29 012345678	0-03968 4-11086 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684	•01 •00139 •02 •00278 •03 00417 •04 •00557 •05 •00696 •06 •00835 •07 •00974 •08 •01113 •09 •01258	YOCAS. 30 04176 31 01315 32 0454 33 04593 34 04732 35 04872 36 05011 37 05150 38 05289	•59 .08212 •60 .08351 •61 04491 •62 .08630 •63 .08769 •64 .08908 •65 .09317 •66 .09186 •67 .09326	*88 12249 *99 12388 *90 12527 *91 12666 *92 12805 *93 12946 *94 13054 *95 13223 *96 13362
29 0123456789	0-03968 4-11086 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O5 00835 O7 00974 O8 01113 O9 01258 10 01392	YOGXS. 30 04176 31 01315 32 0454 33 04593 34 04732 35 04872 36 05011 37 05150 38 05289 39 05428	•59 .08212 •60 .08351 •61 04491 •62 .08630 •63 .08769 •64 .08908 •65 .09317 •66 .09186 •67 .09326 •68 .09465	<ul> <li>88 12349</li> <li>89 12388</li> <li>90 12527</li> <li>91 12666</li> <li>92 12805</li> <li>93 12946</li> <li>93 12946</li> <li>94 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> </ul>
29 0123456789	0-03968 4-11086 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O5 00835 O7 00974 O8 01113 O9 01258 10 01392	YOGAS. 30 04176 31 04315 32 04454 33 04593 34 04732 35 04872 36 05011 37 05150 38 05289 39 05428	•59 .08212 •60 .08351 •61 03491 •62 .08630 •63 .08769 •64 .08908 •65 .09347 •66 .09186 •67 .09326 •68 .09465	-88 12349 89 12388 90 12527 91 12666 92 12805 -93 12946 93 12946 95 13828 96 13362 97 13601
29 0123456789 10	0-03968 4-11086 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765 2-71846	01 00139 02 00278 03 00417 04 00557 05 00696 06 00835 07 00974 08 01113 09 01258 10 01392 11 01392	<b>YOGAS.</b> .30 04176 ·31 01315 ·32 04454 ·33 04593 ·34 04732 ·35 04872 ·36 05011 ·37 05150 ·38 05289 ·39 05428 ·40 05588	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09347</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09601</li> <li>.70 .09601</li> </ul>	88 12249 89 12988 90 12527 91 12666 92 12805 93 12946 93 12946 94 13084 95 13223 96 13362 97 13601 98 13641 97 13601
29 0123456789 101	0-03968 4-11086 3-97117 3-83198 3-69279 3-5360 3-41441 3-27522 3-13603 2-39684 2-85765 2-71846 2-57927 9-1000	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 C11 01530 C12 01670 C13 0190	<b>YOGAS.</b> <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04733 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05446	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09316</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09743</li> <li>.71 .08859</li> </ul>	88 12249 59 12988 90 12527 91 12666 92 12946 93 12946 93 12946 93 13084 95 13223 96 13362 97 13601 98 13641 99 13760
29 0123456789 101122	0.03968 4.11036 3.97117 3.43198 3.69279 3.55360 3.41441 3.27532 2.7532 2.71846 2.57927 2.4008 9.40039 0.4005 0.4	•C1 •00139 O2 •00278 •O3 00417 •O4 •00557 •O5 •00696 •O6 •00835 •O7 •0974 •O8 •01133 •O9 •01258 •I0 •01392 •11 •01530 •12 •01670 •13 01809 •14 •01949	<b>YOCAS</b> . <b>30</b> 04176 <b>31</b> 04315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05846 <b>33</b> 05985	<ul> <li>.59 .08312</li> <li>.60 08351</li> <li>.61 04491</li> <li>.62 08630</li> <li>.63 08769</li> <li>.64 08908</li> <li>.65 09017</li> <li>.66 09186</li> <li>.67 09326</li> <li>.68 09465</li> <li>.69 09604</li> <li>.70 09743</li> <li>.71 09852</li> <li>.72 10032</li> </ul>	<ul> <li>88 12249</li> <li>89 12388</li> <li>90 12527</li> <li>91 12666</li> <li>92 12366</li> <li>92 12366</li> <li>93 12946</li> <li>94 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
29 0123456789 1011234	0-03968 4-11036 3-9717 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765 2-71846 2-57927 2-14008 2-30089 3-16170	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 C11 01530 C12 01670 C13 01809 C14 01949 C15 02088	<b>YOCAS</b> . <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 0454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04873 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05955 <b>44</b> 06124	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 04491</li> <li>.62 .08630</li> <li>.63 08769</li> <li>.64 08908</li> <li>.65 09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09713</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> </ul>	<ul> <li>88 12/49</li> <li>89 12527</li> <li>91 12666</li> <li>92 12868</li> <li>90 12527</li> <li>91 12666</li> <li>92 12965</li> <li>93 12945</li> <li>94 13084</li> <li>95 13228</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13760</li> </ul>
29 0123456789 101123145	0-03968 4-11086 3-9717 3-83198 3-69279 3-55360 3-41444 3-27522 3-13603 2-99684 2-85765 2-71846 2-57927 2-4008 2-30089 3-16170 2-02251	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 C11 01530 C12 01670 C13 01809 C14 01949 C15 02087 C16 02227	<b>YOCAS</b> . <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04654 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 06872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06263	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 04491</li> <li>.62 .08630</li> <li>.63 08769</li> <li>.64 08908</li> <li>.65 09147</li> <li>.66 09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09743</li> <li>.71 .09832</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> </ul>	<ul> <li>88 12/49</li> <li>89 12388</li> <li>90 12527</li> <li>91 12666</li> <li>92 12805</li> <li>93 12946</li> <li>94 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
29 0123456789 101123456 101123456	0.03968 4.11036 3.97117 3.83195 3.69279 3.55360 3.41441 3.27522 3.13603 2.99684 2.85765 2.71846 2.57927 2.44008 2.30089 2.16170 2.02251 1.68332	01 00139 02 00278 03 00417 04 00557 05 00895 06 00835 07 00974 08 01113 09 01258 10 01392 11 01530 12 01670 13 01899 14 01949 15 02028 16 02227 17 02366	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06288 <b>46</b> 06493	<ul> <li>.59 .04212</li> <li>.60 .08351</li> <li>.61 .0491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09347</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09743</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10139</li> </ul>	88 12249 99 12988 90 12527 91 12666 92 12946 93 12946 93 12946 94 13084 95 13223 96 13362 97 13601 98 13361 99 13760
29 0123456789 10112345167	0-03968 4-11036 3-97117 3-5360 3-41441 3-27522 3-13603 2-99684 2-57927 2-44008 2-57927 2-44008 2-30089 2-16170 2-02251 1-88332 1-74418	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O3 00835 O7 00974 O8 01113 O9 01253 10 01392 '11 01530 '12 01670 '13 01809 '14 01949 '15 02058 '16 02297 '17 02366 '18 02505	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 01454 <b>33</b> 01593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 035688 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06493 <b>47</b> 06542	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09346</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09601</li> <li>.70 .09713</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> </ul>	88 12249 89 12988 90 12527 91 12666 92 12805 93 12946 93 12946 94 13084 95 13223 96 13362 97 13601 98 13641 99 13780
29 0123456789 1011234567 11123456789	0.03968 4.11036 3.97117 3.55360 3.41441 3.27532 3.13603 2.99684 2.5765 2.71846 2.57927 2.44008 2.30089 3.16170 2.02251 1.88332 1.74413 1.60494	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02038 16 02227 17 02366 18 02505 19 02645	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 04135 <b>32</b> 0454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05648 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06283 <b>46</b> 06493 <b>47</b> 06542 <b>48</b> 066421 <b>48</b> 066421 <b>49</b> 065422 <b>48</b> 0666421 <b>49</b> 065422 <b>48</b> 0666421 <b>49</b> 065422 <b>48</b> 0666421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>49</b> 065422 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 0665421 <b>48</b> 06655555555555555555555555555555555555	<ul> <li>59 .08212</li> <li>60 .08351</li> <li>61 .04491</li> <li>62 .08630</li> <li>63 .08769</li> <li>64 .08908</li> <li>65 .09346</li> <li>67 .09326</li> <li>68 .09465</li> <li>69 .09604</li> <li>70 .09743</li> <li>71 .09852</li> <li>72 .10222</li> <li>73 .10161</li> <li>74 .10300</li> <li>75 .10439</li> <li>76 .10578</li> <li>77 .10798</li> </ul>	88 12249 59 12988 90 12527 91 12666 92 1280 93 12946 94 13084 95 18228 96 13362 97 13601 98 13641 99 13780
29 0123456789 101123456789 101123456789	0-03968 4-11036 3-97117 3-55360 3-41441 3-27532 3-13603 2-99684 2-85765 2-71846 2-57927 2-44008 2-30089 2-30089 2-16170 2-02251 1-88332 1-74413 1-60494 1-46575	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02058 16 02227 17 02366 S18 02505 19 02645 -20 02784	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 04315 <b>32</b> 04543 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05548 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06263 <b>48</b> 066423 <b>48</b> 066423 <b>48</b> 066423 <b>49</b> 06542	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09917</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09743</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .0578</li> <li>.77 .10798</li> <li>.78 .20851</li> </ul>	<ul> <li>88 12249</li> <li>89 12388</li> <li>90 12527</li> <li>91 12666</li> <li>92 12946</li> <li>93 12946</li> <li>94 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
29 0123456789 101123456789 101123456789	0-03968 4-11036 3-97117 3-69279 3-55360 3-41441 3-275322 3-313603 2-99684 2-85765 2-71846 2-57927 2-44008 2-30089 2-16170 2-02251 1-74413 1-60494 1-46575 1-224555 1-224555 1-224555 1-224555 1-224555 1-224555 1-224555 1-224555 1-2245555 1-2245555 1-224555 1-224555 1-224555555 1-22455555 1-22455	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 0113 O9 01258 10 01392 C11 01530 C12 01670 C12 01670 C13 01809 C14 01949 C15 03088 C16 02227 C17 02366 C18 02505 C19 02645 C20 02784	<b>YOCAS</b> . <b>30</b> 04176 <b>31</b> 04315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05548 <b>41</b> 05707 <b>42</b> 05845 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06988 <b>46</b> 06542 <b>48</b> 066423 <b>47</b> 06542 <b>48</b> 06642 <b>48</b> 066424 <b>48</b> 06642 <b>48</b> 06642 <b>49</b> 06542 <b>48</b> 06642 <b>49</b> 06542 <b>49</b> 0	<ul> <li>.59 .08212</li> <li>.60 08351</li> <li>.61 04491</li> <li>.62 .08630</li> <li>.63 08769</li> <li>.64 08908</li> <li>.65 09326</li> <li>.68 09465</li> <li>.69 09604</li> <li>.70 09743</li> <li>.71 09852</li> <li>.72 10022</li> <li>.73 10161</li> <li>.74 10300</li> <li>.75 10439</li> <li>.76 .0578</li> <li>.77 .10798</li> <li>.78 .20851</li> </ul>	<ul> <li>88 12249</li> <li>89 12388</li> <li>90 12527</li> <li>91 12666</li> <li>92 12865</li> <li>93 12946</li> <li>94 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
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29 0123456789 101123456789 101123456789 201222	0-03968 4-11036 3-97117 3-83198 3-69279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765 2-71846 2-37927 2-44008 2-30089 2-1670 2-02251 1-88332 1-74413 1-60494 1-32656 1-18737 1-04818 1-04	01 00139 02 00278 03 00417 04 00557 05 00895 06 00835 07 00974 08 01113 09 01258 10 01392 11 01530 12 01670 13 01899 14 01949 15 02088 16 02227 17 02366 18 02505 19 02655 20 02784 21 02923 -22 03063 -22 03063	YOGAS. 30 04176 31 01315 32 04454 33 04593 34 04732 35 04872 36 05011 37 05150 38 05289 39 05428 40 05568 41 05707 42 05846 43 05985 44 06124 45 06268 46 06493 47 06542 48 06681 49 06820 50 06969 51 07098 52 07238	<ul> <li>.59 .03212</li> <li>.60 .08351</li> <li>.61 .03491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09147</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09601</li> <li>.70 .09713</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10996</li> <li>.80 .11135</li> <li>.81 .11271</li> </ul>	88 12249 99 12988 90 12527 91 12666 92 12805 93 12946 94 13084 95 13223 96 13362 97 13601 98 133641 99 13780
29 0123456789 101123456789 101123456789 201223	0-03968 4-11036 3-97117 3-5360 3-41441 3-27522 3-13603 2-99684 2-85765 2-71846 2-57927 2-4008 2-16170 2-02251 1-88382 1-74413 1-66494 1-46575 1-32656 1-18737 1-04818 0-90899	01 00139 02 00278 03 00417 04 00557 05 00696 06 00835 07 00974 08 01113 09 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02058 16 02297 17 02366 18 02505 19 02645 20 02784 21 02923 22 03691 22 03691	<b>YOGAS.</b> <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04733 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 035689 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06243 <b>46</b> 06681 <b>49</b> 06820 <b>50</b> 06959 <b>51</b> 07098 <b>52</b> 07238 <b>53</b> 07377	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09147</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.68 .09465</li> <li>.69 .09601</li> <li>.70 .09743</li> <li>.71 .09882</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10996</li> <li>.80 .11135</li> <li>.81 .11274</li> <li>.82 .11418</li> </ul>	88 12249 89 12988 90 12527 91 12666 92 12805 93 12946 93 12946 94 13084 95 13223 96 13362 97 13601 98 13841 99 13780
29 0123456789 101123456789 101123456789 20122224	0-03968 4-11036 3-97117 3-55360 3-41441 3-27522 3-13603 2-99684 2-57927 2-4008 2-57927 2-4008 2-30089 2-16170 2-02251 1-88332 2-30089 3-16170 2-02251 1-88332 1-74418 1-60494 1-46575 1-32656 1-18737 1-04818 0-908990 0-769800	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 '11 01530 '12 01670 '13 01809 '14 01949 '15 03088 '16 02227 '17 02366 '19 02655 '19 02655 '19 02655 '20 02784 '21 02923 '22 03633 '23 03291 '24 03340	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 01454 <b>33</b> 01593 <b>34</b> 04732 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 03568 <b>41</b> 05767 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06283 <b>47</b> 06542 <b>48</b> 06681 <b>49</b> 06820 <b>50</b> 06939 <b>51</b> 07098 <b>52</b> 07238 <b>53</b> 07377 <b>54</b> 07316	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .09908</li> <li>.65 .09346</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09601</li> <li>.70 .09713</li> <li>.71 .09832</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10139</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .1096</li> <li>.80 .11135</li> <li>.83 .11558</li> </ul>	88 12249 59 12988 90 12527 91 12666 92 1286 93 12946 94 13084 95 13223 96 13362 97 13601 98 13641 99 13750
29 0123456789 101123456789 101123456789 201222245 201222245	0-03968 4-11036 3-97117 3-55360 3-41441 3-275360 3-41441 3-27532 3-13603 2-99684 2-37927 2-44008 2-30089 2-16170 2-02251 1-88332 1-74413 1-60494 1-74413 1-60494 1-32656 1-18737 1-04818 0-908399 0-76980	01 00139 02 00278 03 00417 04 00557 05 00696 06 00835 07 00974 08 01113 09 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02058 16 02227 17 02366 18 02505 19 02645 20 02784 21 02923 22 03063 23 03291 24 03340 25 03480 26 03618	<b>YOGAS</b> . <b>30</b> 04176 <b>31</b> 04135 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05648 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06283 <b>46</b> 06493 <b>47</b> 06542 <b>48</b> 06681 <b>49</b> 06820 <b>50</b> 06959 <b>51</b> 07098 <b>52</b> 07238 <b>53</b> 07377 <b>54</b> 07516 <b>55</b> 07655	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .04491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09346</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09743</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .0578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10966</li> <li>.80 .11135</li> <li>.84 .11553</li> <li>.84 .11692</li> </ul>	88 12249 59 123527 91 12666 92 1280 93 12946 94 13054 95 13223 96 13362 97 13601 98 13641 99 13750
29 0123456789 101123456789 101123456789 2012223456789 2012223456789	0-03968 4-11036 3-97117 3-27522 3-5360 3-41441 3-27522 3-55360 3-41441 3-27522 3-27522 2-71846 2-57927 3-44008 2-30089 2-30089 2-30089 1-62491 1-46575 1-32656 1-18737 1-04818 0-90899 0-76980 0-76	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 01113 O9 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02038 16 02227 17 02366 18 02505 18 02505 19 02645 20 02784 21 02923 23 03291 24 03840 25 03480 25 03480	<b>YOCAS</b> . <b>30</b> 04176 <b>31</b> 04315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05548 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06283 <b>45</b> 06681 <b>48</b> 06682 <b>48</b> 066820 <b>50</b> 066929 <b>51</b> 07098 <b>52</b> 07238 <b>53</b> 07377 <b>54</b> 07575 <b>56</b> 07795	<ul> <li>.59 .08212</li> <li>.60 08351</li> <li>.61 04491</li> <li>.62 .08630</li> <li>.63 08769</li> <li>.64 08908</li> <li>.65 099167</li> <li>.66 09186</li> <li>.67 .09226</li> <li>.68 .09465</li> <li>.69 09604</li> <li>.70 .09743</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10996</li> <li>.80 .1135</li> <li>.81 .11274</li> <li>.82 .11413</li> <li>.83 .11553</li> <li>.84 .11692</li> <li>.85 .11831</li> </ul>	<ul> <li>88 12249</li> <li>89 123527</li> <li>91 12666</li> <li>92 12946</li> <li>93 12946</li> <li>94 13054</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
29 0123456789 101123456789 101123456789 20122222222222222222222222222222222222	0-03968 4-11036 3-97117 3-63279 3-55360 3-41441 3-27522 3-13603 2-99684 2-85765 2-71846 2-57927 2-44008 2-30089 2-63068 1-74413 1-66494 1-46575 1-32656 1-18737 1-04818 0-90899 0-769800 0-649142 0-35223	C1 00139 O2 00278 O3 00417 O4 00557 O5 00696 O6 00835 O7 00974 O8 0113 O9 01258 I0 01392 I1 01530 I2 01670 I3 01809 I4 01949 I5 03088 I6 03227 I7 02366 I8 02505 I9 02645 I9 02645 I9 02645 I2 009784 I1 02923 I2 03633 C2 0363 I2 0363 I3 0363 I2 0363 I2 0363 I3 0363 I2 036	<b>YOGAS.</b> <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 055658 <b>41</b> 05707 <b>42</b> 05866 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06985 <b>44</b> 06124 <b>45</b> 06985 <b>43</b> 06493 <b>47</b> 06542 <b>48</b> 06681 <b>49</b> 06820 <b>50</b> 069689 <b>51</b> 07098 <b>52</b> 07238 <b>53</b> 07377 <b>54</b> 07516 <b>55</b> 07655 <b>56</b> 07795 <b>57</b> 07934	<ul> <li>.59 .03212</li> <li>.60 .08351</li> <li>.61 .03491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09147</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.69 .09604</li> <li>.70 .09713</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10996</li> <li>.11274</li> <li>.82 .11274</li> <li>.82 .11274</li> <li>.82 .11553</li> <li>.84 .11692</li> <li>.85 .11831</li> <li>.86 .11970</li> </ul>	<ul> <li>88 12/49</li> <li>89 12527</li> <li>91 12666</li> <li>92 12808</li> <li>90 12527</li> <li>91 13666</li> <li>92 12805</li> <li>93 13084</li> <li>95 13223</li> <li>96 13362</li> <li>97 13601</li> <li>98 13641</li> <li>99 13780</li> </ul>
29 0123456789 01123456789 101123456789 20122222222222222222222222222222222222	0-03968 4-11036 3-97117 3-5360 3-41441 3-27522 3-13603 2-99684 2-35765 2-71846 2-357927 2-44008 2-357927 2-44008 2-30089 2-617927 2-44008 2-30089 2-16170 2-02251 1-88332 1-74413 1-60494 1-46575 1-32656 1-18737 1-04818 0-908399 0-76980 0-35223 0-21004	01 00139 02 00278 03 00417 04 00557 05 00696 06 00835 07 00974 08 01113 09 01258 10 01392 11 01530 12 01670 13 01809 14 01949 15 02088 16 02297 17 02366 18 02505 19 02645 20 02784 21 02923 22 03663 23 06291 24 03840 25 03480 26 03619 27 03758 28 03897 29 04036	<b>YOGAS.</b> <b>30</b> 04176 <b>31</b> 01315 <b>32</b> 04454 <b>33</b> 04593 <b>34</b> 04732 <b>35</b> 04872 <b>36</b> 05011 <b>37</b> 05150 <b>38</b> 05289 <b>39</b> 05428 <b>40</b> 05568 <b>41</b> 05707 <b>42</b> 05846 <b>43</b> 05985 <b>44</b> 06124 <b>45</b> 06282 <b>48</b> 06681 <b>48</b> 06681 <b>48</b> 06681 <b>48</b> 06681 <b>48</b> 06681 <b>50</b> 06959 <b>51</b> 07085 <b>52</b> 07238 <b>53</b> 07377 <b>54</b> 07516 <b>55</b> 07655 <b>56</b> 07795 <b>57</b> 07934 <b>58</b> 08073	<ul> <li>.59 .08212</li> <li>.60 .08351</li> <li>.61 .0491</li> <li>.62 .08630</li> <li>.63 .08769</li> <li>.64 .08908</li> <li>.65 .09147</li> <li>.66 .09186</li> <li>.67 .09326</li> <li>.68 .09465</li> <li>.68 .09465</li> <li>.70 .09743</li> <li>.71 .09852</li> <li>.72 .10022</li> <li>.73 .10161</li> <li>.74 .10300</li> <li>.75 .10439</li> <li>.76 .10578</li> <li>.77 .10798</li> <li>.78 .20851</li> <li>.79 .10996</li> <li>.11274</li> <li>.11274</li> <li>.11274</li> <li>.11553</li> <li>.44 .11652</li> <li>.1253</li> <li>.84 .11652</li> <li>.85 .11831</li> <li>.86 .11970</li> <li>.87 .12109</li> </ul>	88 12249 99 12988 90 12527 91 12666 92 12805 93 12946 94 13084 95 13223 96 13362 97 13601 98 13841 99 13780



Continued from page 9.

Adendum.

III .- Required the ending moment of No. 17 Anuradha Nakshatra in June 184 A.D. (see Tables, p. 282).

(Table X, p. 48). Ashadha New Moon, A.D. 484	days. June 9.67	('s Anom. days. 4.50 + 3.95
(Table XI-D, overleaf) Shortest Interval from Ashadha New Moon to No. 17 Anuradha Nakshatra	+10.74 + .38	+10.74 + .38
(Eye-Table) ( 's tithi equation for Anom. of 19.57 days, reduced to Nakshatra Equation, is	June 20-79 + ·38 June 21-17	19.57

Our Nakshatra Anuradha (No. 17) ended on 21 June, A.D. 484, at 17, i.e., 10 ghat. after mean sunrise.

N.B.—In using the Eye-Table for Nakshatra and Yoga equations, we should first of all find the equation as if we were investigating a tithi, and then reduce the tithi equation to a Nakshatra or Yoga equation according to the scale furnished by the Eye-Table. We give another example to illustrate this.

TV-	-Required the	endina	moment o	f Yoga Suk	a (No. 24	4) in Jun	0 184 A.D.	(ree Tables, p	). 232).	
-----	---------------	--------	----------	------------	-----------	-----------	------------	----------------	----------	--

	days.	⊙'s Anom. days.	( 's Anom. days.	
(Table X, p. 48). Ashadha New Moon, A.D. 484	June 9.67	+59.06	+ 3.95	
(Table X1-D, overleaf). Shortest interval from Ashadh New Moon to No. 24 Yoga Sukla (Table XI-E, overleaf). Yoga correction for A.D. 484.8	a + 10.57 5	+10.57	+10.57	
is that corresponding to an argument of 24.39 days, i. 0.77 minus 05	e = + 0.72	+0.72	+ 0.72	
And the State of the State of the State of the	June 20.96	94.74	+19.74	
(Eye-Table) Sun's tithi equation for 94-74 days, is040 This with sign reversed (for Yoga), and reduced to scal	l. le +:03(1		+ 0.08	(O's Yoga Equation )
(Kye-Table). Mcon's tithi eqn. for 19-77 days is + 41d. This, reduced to scale of Yoga equation, becomes	+•35d.		19-77	
Sum of Sun's and Mcon's Yoga equations	+•38 + •38			
Ending moment of our Yoga No. 24, Sukla,	June 21-34=	=20igh. after mean	sunrise on 21 J	une, A.D. 484



# INDIAN CHRONOLOGY (SOLAR, LUNAR AND PLANETARY) B.C. 1 to A.D. 2000.

## PART I.

# Relations between Indian Astronomy and Indian Chronology.

N.B.—Decimal parts of a day may be converted into ghatikas and palas (naligais and vinadis) by means of Table XIX, and into hours and minutes by means of Table XX.

## CHAPTER I.

## THE SYNOLICAL MONTH AND THE INDIAN SOLAR YEAR.

1. Astronomical Constants.—A regular treatise on astronomy always closes with a chapter on astronomical constants, *viz.*, those elements of calculation which are of use in predicting astronomical events. A book on astronomical computation, like the present one, must begin, not end, with astronomical constants.

2. First Astronomical Constant.—The Moon's Synodical Month or Lunation.—The first astronomical constant we have to know in Hindu astronomy is the moon's synodical month of  $29\frac{1}{2}$  days. The exact length of this period, according to the Sárya Siddhânta,\* which we shall always follow, except when otherwise stated, is  $29\cdot530587946$  days. The ancient Hindu astronomers purposely calculated this period to what we should now call nine places of decimals in order that there might be no error even after thousands of years. The period fixed by modern astronomy does not differ from the above in the first six decimal places, and as '0000008, the actual difference, is  $\frac{1}{100}$  of a second, it follows that the difference between European and Indian astronomy in 5,000 years or 61,844 synodical months may amount to 4,260 seconds or a little over 1 hour and 11 minutes. We shall see, when we come to compute new moons, that, in practice, the difference between the European and the Indian computation of new moons is very much less. [Vide Sec. **118**, Rule (3) infra.]

**3.** What is a Synodical Month ?—A synodical month or lunation is the interval between one new moon and another. You are apt to imagine that this is the period in which the moon travels once round the earth. It is not so. It is the period in which the moon gains one complete revolution over the apparent or visible motion of the sun : and as this is a most essential fact, which you should thoroughly understand in order to work any problem in Indian dates intelligently, we will spend some time in considering it.

The moment of new moon is the moment when sun and moon have the same longitude, *i.e.*, are at the same distance measured from a fixed point in the heavens. When once

<sup>\*</sup> The Surya Siddhanta, the best known system of Indian astronomy, is believed to have been current in its present form since the 11th Century A.D. and is the standard for all India. Numerous other Siddhantas are extant, but only one of them, the First Arya Siddhanta, is referred to in the present work, in addition to the Surya Siddhanta.



this moment is past, the moon resumes her journey at the rate of, say, 13 degrees a day and the sun resumes his at the rate of one degree a day. It follows that the moon gains twelve degrees over the sun in a day and therefore she gains 360 degrees in about 30 days. All these figures of days are approximate, but they will enable us to picture to ourselves what takes place. The synodical month, then, is the period during which the moon gains 360 degrees over the sun, and its exact length is 29:530587946 days.

4. The Solar Year .- The next astronomical constant which we have to study is the solar year, the length of which, according to the Súrya Siddhânta, is 365-258756484 days. You have probably heard that the length of the year, according to modern astronomy, is 365.2422408 days, that the Julian calendar made out the year to be 365.25 days, i.e., .00776 of a day in excess of the correct figure ; that to rectify this error, Pope Gregory in 1582 ordered the dropping out of 10 days and the British Parliament in 1752 \* similarly dropped out 11 days, and that to avoid a recurrence of the error, we now drop out three leap years out of every hundred. You may be inclined to wonder that the Hindu astronomers adopted for their solar year a period which is not less than one ghatika in excess of the modern astronomical year. The year of 365.2422408 days is, however, a tropical year, whereas the Hindu astronomical year is an anomalistic † year, and we should really compare the Hindu year with the modern anomalistic year, which we seldom hear of in practice, but the correct length of which is 365.2596296 days, being an excess of .001 day over the Hindu year. This no doubt makes a difference of several days in the course of four or five thousand years, but as the Hindu year is essentially lunar and not solar, not much practical inconvenience is caused by the difference.

Perhaps you would like to know the practical difference between a tropical and an anomalistic year. A tropical year is that which brings the *seasons* round at the same time of the year, whereas an anomalistic year is that which brings back the sun's *anomaly*, *i.e.*, the rate at which he moves round the earth. This rate varies according as the sun is near to, or removed from, his perigee, *i.e.*, the point when he is nearest the earth, and once a year the sun returns, as it were, to his old pace. Now this varying pace of the sun is very important for calculating the moment of new moon, as well as for calculating the moment of sunrise, and this is probably why the Hindu astronomers reckon the course of the sun by the anomalistic, instead of by the tropical, year.

5. The Decursus of the Hindu Solar Reckoning.—Hindu astronomers reckon the present chronology from the midnight between 17th and 18th February 3102 B.C., which is commonly called the beginning of *Kaliyuga*. On the morning of 18th February 3101 B.C., that is one year later, one complete Hindu solar year had run out by 6.13 a.m., *i.e.*, at 25875 of the day. As however the Hindu day is always reckoned from sunrise, mean sunrise for the whole of India being at 6 a.m., the first year is reckoned to have been completed at 18 minutes (or exactly 00876 of a day) Indian time of the day, on 18th February 3101 B.C. At this moment the year 1 of Hindu chronology began. You probably think it

<sup>\*</sup> This was the occasion when the NEW STYLE (more fully explained in Ch. XXVI, Secs. 231 to 241, " Vara or Week-day ") was introduced.

<sup>†</sup> Strictly speaking, a sidercal year, but the designation anomalistic year is more suitable at this stage in order to lead up to the sun's anomaly.





Was the year 2 which began on 18th February 3101 B.C., and not the year 1; but the Hindus generally reckon completed or expired years, and not current years, as the European calendar does; and this is another point which you should thoroughly understand. The first year of the Hindu chronology, which began on 18th February 3102 B.C., is, according to Hindu reckoning, the year 0. By adding 3101 to an English calendar year A.D. you can always arrive at the corresponding (expired) year of Kaliyuga. Thus the present year 1910 A.D. is K.Y. 5011. For a B.C. year, the K.Y. equivalent is obtained by subtracting it from 3102, not 3101.

6. Correspondence between A.D. and K.Y. years.—Tables VI, VII, and X exhibit in a very simple and intelligible manner the correspondence between A.D. and K.Y. years. Advantage is there taken of the fact that a century year A.D. corresponds to a century year K.Y. increased by 1. Thus 100 A.D. corresponds to 3201 K.Y., 1900 A.D. to 5001 K.Y., and so on.

If you reckon 365:258756484 days for every Hindu year, you will find that the commencement of 3101 K.Y. fell on 16th March, 1 B.C., at 15379 of the day. The Hindu astronomers, however, have to drop 2:1706944 days out of this reckoning, because the Indian Solar Year 0 Kaliyuga really began 2:1707 days before the moment above assigned for its commencement. This dropping out or correction is called *Sodhya*,\* and we shall meet with it again.

It thus happens that 3101 K.Y. commenced in 1 B.C. on 13th March at 9831 of the day after mean sunrise (6 a.m.). From this point Tables VI, VII, and X will carry us on regularly through every year up to 2000 A.D.

## CHAPTER II.

## FIXING THE MOMENT OF MEAN NEW MOON.

7. At the first moment of K.Y. 0, according to the Sûrya Siddhânta, the sun and moon had the same mean longitude, that is, the moon was *new* at that instant. At the first moment of 1 K.Y.,  $365 \cdot 258756 \cdot 484$  days would have passed, that is 12 synodical months, and in addition 10  $\cdot 891701134$  days. That is, at the first moment of K.Y. 1, the moon was not new as she was at the first moment of K.Y. 0, but she was  $10 \cdot 891701134$  days =  $18 \cdot 638886812$  days after the commencement of K.Y. 1. In this way in every Hindu year the first mean new moon would occur  $18 \cdot 63889$  days later than in the previous year. In the year K.Y. 2 a mean new moon occurred  $2 \times 18 \cdot 63889$  days =  $37 \cdot 27778$  days later than the commencement of the year, but as this period exceeds a synodical month, the *first* mean new moon in K.Y. 2. The day of occurrence of the first mean new moon in each successive year after 0 K.Y. and occurred  $3 \cdot 46164$  days after the commencement of the year. We follow the table

<sup>\*</sup>The Sodhyo should, properly speaking, be applied to every year, including year 0 Kaliyuga. The point should be borne in mind when calculating solar dates and uthis in any year. B.C. The nature of the correction called Sodhya is explained in Sec. 86.

through 200, 300, etc., years, till we find that in 3000 K.Y. the first mean new moon occur red 15.25746 days after the commencement of the solar year. For 3101 K.Y. (or 1 B.C.) we reckon the time of occurrence of the first mean new moon thus —

							Daya.
For 3000 years	•••			•••			15.25746
For 100 years	***		***		·····		12,00000
For 1 year			Sector Sector	-	Sugara Sugar		19.69999
			Deduct 1 com	pleted sy	nodical month	L	37*85799 29•58059
				0.150	Remainder		7.82740
than it does by	nean co	ne solar y nputation	(vide Sec. 66	infra)		H	- 2.1707
Occurrence of first m	ean new	moon in	K.Y. 3101 (1	B.C.)			9-99810 da

That is, in 1 B.C., the first mean new moon of the Hindu solar year occurred almost exactly 10 days (properly 10 days less '0019 of a day) after the commencement of the solar year.

8. From 1 B.C. we can follow the occurrence of the first mean new moon in each successive year according to the Tables VI and VII, the figures in which have merely to be added up suitably for each year. Thus if we require the date of the first mean new moon in the current solar year K.Y. 5011, we proceed according to the tables :--

For K.Y. 5001, 16'70809 days. (Tab. VI). For 10 years, 9'20534 (Tab. VII).

For K.Y. 5011, 25.91343

That is, the first mean new moon in the year A.D. 1910-11, K.Y. 5011, occurs 25.91843 days after the commencement of the solar year, and as the solar year itself commences, as we may see from other columns of the same tables, on Ap. 12.62041

i.e., on April 13.20797

+.58756

it follows that the addition of 25.91343 days,

or 39.12140 days from 1 April, in other words 9.12140 days in May 1910, will give us the time of occurrence of the first mean new moon in K.Y. 5011. We may, if we like, convert the decimal places into *ghatikas* and *palas* or *hours* and *minutes*, according to Table XIX or XX, and we shall have as the result, 9th May 1910, 7 ghatikas and 17 palas or 2 hours and 55 minutes. This is the time of occurrence of *mean* new moon. About the *actual* ending moment of this or any other new moon tithi, we shall learn presently.

N.B.-For the meaning of ghatika and pala, See Sec. 130 infra.

## CHAPTER III.

### SUN'S AND MOON'S ANOMALY AND ACTUAL MOMENT OF NEW MOON.

9. We computed the time of occurrence of the first mean new moon in K.Y. 5011, and we arrived at the result, 7 ghațikas and 17 palas after mean sunrise on 9th May 1910. If now we look into a Panchângam, computed from the English Nautical Almanac, like Mr. Srauti's Tiruvâdi Panchângam or Messrs. Râghava Châri & Son's Nungumbaukam Panchângam, we shall find the time of occurrence of the new moon in May 1910 to be 9th May, 13 ghațikas and 2 palas after sunrise. It is encouraging that we are so near the Panchângam result, but we are not near enough. The Panchângams in question are calculated The latitude and longitude of Kumbakonam and Madras, respectively, whereas our calculation is for mean sunrise (6 a.m.) at the Equator on the meridian of Ujain, which is accepted by Hindu astronomers as a starting point in the same way as Greenwich is accepted by modern English astronomers. It is known that Madras time is 18 minutes or 45 palas in advance of Ujain time, and, further, sunrise at Madras on the 9th May 1910 is noted in the Panchingam as occurring 12 minutes or 30 palas before 6 a.m. These two circumstances account for a difference of 75 palas or 1 ghațika and 15 palas between our mean time and the Panchingam time, but there is still a difference of 4 ghațikas and 30 palas or .0750 of a day to be accounted for.

10. We account for it thus. Although mean new moon occurs every 29.53059 days, the actual new moon does not recur at exactly this interval. About the time when the moon is due to become new, she may be fast, or she may be slow, and we have to take this circumstance into consideration. Hindu astronomers have devised a table of the moon's anomaly which enables us to calculate exactly by how many degrees the moon is in advance of, or behind, her mean position at new moon or at any other time. The original tables of the moon's anomaly and equation of the centre, as these constants are called, will be found in Professor Jacobi's standard article on the subject in Vol. I of the *Epigraphia Indica*. For the sake of practical convenience, we may convert the degrees into time and further calculate the anomaly for each '001 of the equation, and the result will be our Table IX. This table shows us exactly what time should be added to or deducted from mean time in order to arrive at the actual moment of occurrence of new moon.

11. To use this table, you should know the moon's anomaly at the time you are dealing with, and the moon's anomaly is determined for centuries and odd years in the same way as the *mean* moment of the first new moon is determined for every solar year. The moon completes an anomalistic month, that is, returns to a particular pace round the earth in 27.5546 days, and in a solar year the moon's anomaly increases by 365.25875 less  $13 \times 27.5546 = 7.04896$  days as shown in Table VII, Column 4. In 100 years the anomaly increases by 16.03078 days and we calculate, as before, the anomaly for the commencement of the solar year K.Y. 3101 (B.C. 1).

		inga.
For 3000 years	1.1	12.49527
For 100 years		16.03078
For 1 year		7.04896
For \$101 K.Y	***	35.57501
Deduct one completed anomalistic month	A.4.4	27.5546
		8.02041

Add the moon's anomaly at the first instant of K.Y. 0, which, according to the Sûrya Siddhanta, was 90° from perigee or 6.8886 days, and deduct Sodhya 2.1707 days, 4.7179

4.7179 12.73831 days.

**12**. The result, 12:7383 days, is just what we find entered in Table VI as the moon's anomaly at the commencement of K.Y. 3101 (B.C. 1). From this point we go on, year by year and century by century, till we reach 1600 A.D., when a correction, or *bija*, introduced by the

Afindu Astronomer Ganesa Daivajna, comes into operation. The effect of this *bija* is to rule the annual increase of the moon's anom. from 7.04896 d. to 7.04898 d. or by 2 seconds of time every year, and also to diminish the length of the anomalistic month from 27.5546 to 27.55459797 or .000002 d., *i.e.*,  $\frac{1}{5}$  of a second every month. As a result of this correction, the anomaly for the commencement of K.Y. 5011 (1910-11 A.D.) is 2.1759 days. As the first new moon in the same year occurs (*vide* Section 8 *supra*) on the 25.9184th day after the commencement of the year, the anomaly for the time of the first new moon is 25.9134

		28.0903
Deduct completed	anomalistic	month-27.5546

.5347 of a day.

+ 2.1759

13. As new moon is the moment when the moon has gained exactly  $360^{\circ}$  over the sun, we have, in determining this moment as well as the moon's anomaly at this moment, to take account of the sun's pace as well as the moon's. The sun's pace depends on his position in the anomalistic year, and that we know (Sec. 4) is the Hindu solar year. We also know that at the time of occurrence of the first new moon in K.Y. 5011 the sun had advanced 25.9134 days in the anomalistic year. We simply look for the corresponding equation in the table of sun's anomaly (Table IX-c) and we find it to be midway between +.145 and +.144. We put down +.1445 as the equation we require and add thereto .5347, the moon's anomaly already found. Net moon's anomaly, .6792.

We look in the table of moon's anomaly (Table IX-a) against  $\cdot 679$  of a day and we find the equation to be between  $-\cdot 059$  and  $-\cdot 060$ . The actual anomaly entered in the table is  $\cdot 677$ , and as our anomaly is  $\cdot 679$ , we take a suitable equation by proportional parts, *i.e.*,  $\cdot 0592$ .

We now add the total of sun's and moon's equations (+.1445 - ...0592), or +.0853 to the mean time already found, 9.1213\* d, and obtain 9.2066, *i.e.*, 12 ghatikas 24 palas after mean sunrise on 9th May 1910. For the present we might be satisfied with this result, which agrees with sufficient closeness with that (13 ghatikas 2 palas) of the Nautical Almanac and the Panchangams based thereon; for if we add the effect of longitude and local sunrise, already adverted to in Section 9 supra, our local time for the ending moment of the new moon tithi will be 13 ghatikas 39 palas after sunrise.

14. The reasons for the various processes whereby we arrive at the actual ending moment of any titbi will be clear to us when we come to Chapter XXIII "Theory of anomalies and equations," but one word on the subject may perhaps be usefully said before we close this chapter. The reader will observe that each anomaly table in our Table IX is divided into four equal portions, two having additive equations and two subtractive. Each equation, as given in the table, consists of three decimal places, the first two being given in vertical columns and the third in a horizontal column. The horizontal column is not necessary when all we want to know is how many hours or how many ghatikas after sunrise a

<sup>\*</sup> The reader should note that two fractions of the day are usually quoted for the moment of occurrence of any astronomical event, tithis, makshatra, yoga, karama, etc. The first fraction (in this case '9134) is part of a period of time reckoned from the beginning of the solar year, while the second fraction (in this case '1215) is the time of the day, reckoned from mean Lanka sunrise, 6 a.m. The difference between the two fractions is (as will be seen from Sec. 8 supra) the fraction of day marking the commencement of the solar year, one of the data entered in Table X.

new moon or other tithi occurred, and consequently, the horizontal place of the equation, namely, its third decimal place, is omitted in the Eye-table at the end of the book. On the other hand, when such a course is necessary for very accurate work, a *fourth* figure may be added to the third shown in the horizontal column by noting the difference between two successive anomalies and taking a proportional part of the difference between the corresponding equations. Thus, supposing we want the equation for a **(**'s anomaly of 7.25 days: the anomalies and equations next to those we want are—

Inasmuch as the difference in *anomaly* between 7.077 and 7.25 is .173 which is  $\frac{173}{198}$ 

= 9 of the tabular difference, we can add 9 to the lower equation and take 4139 as the equation corresponding to C's anomaly, 7.25 days.

We should note that sometimes the *lesser anomaly has the higher equation*. Thus, supposing we require the equation for (sAn, 20.375 d). We note the following as the nearest anomalies :

( 's An. 20.210 d. ... ( 's An. 20.577 d. ... Diff. 297 d. Eqn. +414 d. ... Eqn. +413 d. ... Diff. 001 d.

Our anomaly is lower than 20 577 by  $\cdot 202$ , which is  $\frac{\cdot 202}{297} = \cdot 7$  of the difference. We therefore *add* 7 as a fourth figure to the equation +  $\cdot 413$  and take +  $\cdot 4137$  as the equation we require.

In all cases we should add to, or subtract from, the equation corresponding to the anomaly from which we took the difference. In this case, if we had taken the difference from 20.280, it would have been .095 and the proportional part  $\frac{.095}{.297}$  = .3, which we should deduct from the fourth place of .414. Thus our equation would be + .414 minus .0003 = +.4137, the same as before.

The same observations apply to solar anomalies.

15. For ordinary results, we do not require a fourth place in the equation, and we can take the nearest three place equation that we can find in Table IX and thus, by means of a simple sum in addition or subtraction, discover, without a moment's trouble, the actual from the mean moment of a tithi or nakshatra. Even then we shall be far more accurate than by any of the rough-and-ready methods now in use.

## CHAPTER IV.

### THE SOLAR MONTHS.

16. The solar months of the Indian calendar are named in Table II. The reader will note that the Tamil names of months are practically the same as the Bengal names, but that the first Bengal month *Vaisākha* gives the name to the second Tamil month and so on, the last Bengal month *Chaitra* being the first Tamil month *Chiltirai*.

Also, the Malayalam names of months are generally the same as the signs of the zodiac : the first two are called *Medam* and *Edavam* instead of *Mesham* and *Rishabham*.

But whether in the Tamil country or in Malabar or in Bengal, the measure of the solar months is the same. Like the solar year, each solar month ends at a *fraction of the day*, that is, at the moment when the next sankranti takes place. For purposes of computation, the *sankranti*, as well as the month to which it gives its name, is reckoned from the very

moment at which the previous month ends. But in practice in the Tamil country, when a sankranti takes place after sunset, the next month begins next day; and when the sankranti occurs before sunset, *that* is the first day of the next month, and the old month loses a day. We shall have occasion, when dealing with the use of the tables, to note some of the practical consequences of the working of this rule, and we shall mention at the same time the corresponding rules in other parts of India. (Secs. **144**, **145** *infra*.)

**17.** Note that the solar months in the Indian calendar, which have 30 days each, are placed at fairly regular intervals, and that the months with 31 days each, as also those with 29 days each, are arranged continuously. Thus the series is :

30	30
31	29
31	29
31	29
31	29
	29
	30

which is fairly symmetrical. Owing, however, to the working of the rule about *sankrantis* before and after sunset, a month may have occasionally an extra day, and solar months with 32 days are not infrequent, as we may see from Table XII. Any consequent confusion can always be avoided if you invariably determine *the fraction of day* at which a month ends and the next begins.

#### CHAPTER V.

## THE LUNAR MONTHS IN RELATION TO SOLAR MONTHS

18. The lunar months are the *doors* to the Indian calendar, but the solar months are the *hinges* on which the doors move. Every lunar month takes its name in Bengal from the solar month *in* which it occurs, and in the Tamil country from the *next* solar month after that in which it occurs.

19. Thus the lunar Vaišākha *must* begin sometime in the solar Vaišākha (Bengal) or sometime in the solar *Chittirai* (Tamil). The lunar month being only 29:53 days in length, there may be two new moons between the beginning and end of a solar month, and in this case *both* receive the same name, the first being called *Adhika* and the second *Nija* or true. The second is called 'true' because it immediately precedes a sankrânti. *Adhika* months occur ordinarily once in three years, as may be seen from Tables X and XII.

**20.** More rarely, that is about once or twice a century, a lunar month may begin and end without a solar month beginning between, and then some lunar month must be suppressed as there is no hinge on which this particular door can turn. The suppressed lunar month is said to be  $kshaya^*$  or in defect.

21. We will now take three examples illustrating the different kinds of lunar years: (1) a year consisting of twelve lunar months, corresponding to as many solar months; (2) a year consisting of thirteen lunar months, which will include an *adhika*, *i.e.*, an extra or *intercalary* lunar month; (3) a year of thirteen lunar months, exhibiting two intercalary or *adhika* lunar months and one suppressed or *kshaya* lunar month.

\* Beginners find great difficulty in understanding *adhiha* and *hshaya* months, because the idea is so utterly unlike anything in any other calendar; but the examples given on the next and following pages will enable the reader to cross safely over this *pons asinorum* of the Indian calendar.





## SCHEME OF MONTHS IN K.Y. 5011, A.D. 1910-11.

Lun	ar Months	A.D. Date and Frac- tion of Day of mean New Moon.	Day and Fraction of Day of Solar Year when mean New Moon occurs, also Sun's Anomaly for New Moon.	Day and Fraction of day of Solar Year when Sankranii occurs: names of Solar Months com- mencing at each sankranti. S.M.=SOLAR MONTH	Moon's Anomaly at moment of each mean New Moon. (To the ('s An. at first new moon of Solar Year add 1.976 days for each lonar month)
		<b>A.D. 1910.</b> Indian Solar Year commences Ap. 13-2080. (Tab. X, p. 126.)		K.Y. 5011. Mesha sankianti Vaisa- kha S.M.; Chittirai and Medam S.M.; solar year begins.	
1.	Yaisakha	May 9.1214.	25-9134 (Tab. X.)	30 9353. Vrishabha sank. Jyeshta S.M.; Vai- kasi or Edavam S.M.	0.534 (Table X.)
2.	Jyeshta	June 7-6520.	55-14-10	62.3555. Mithuna sank. Ashada S.M.; Ani S.M.	2.610
з.	Ashada	July 7.1826.	84.9746	94:0003. Karkata sank. Sravana S.M.; Adi S.M.	4-486
4.	Sravana	Aug. 5.7132.	114-5052	125:4755. Simha sank. Bhadra- pada S.M.; Avani S.M.	6.462
Б.	Bhadrapada.	Sep. 4.2437.	144-0357	156:4942. Kanya sank. Asvina S.M.; Purattasi S.M.	8.438
6.	Asvina	Oct. 3.7743.	173-5663	186-9355. Tula sank. Kartika S.M. (Beng.); Aippasi S.M.	10-414
7.	Karttika	Nov. 2·3049.	203-0969	216-8289. Vríschika sank. Marga- sira S.M; Kartigai S.M.	12.390
8.	Margasira	Dec. 1.8355.	232-6275	246.3192. Dhanus sank. Pausha S.M.; Margali S.M.	14-366
9,	Pausha	Dec. 31·3661. A.D. 1911.	262-1581	275-6369. Makara sank. Magha S.M.; Tai S.M.	16-342
10.	Magha	Jan. 29-8967.	291-6887	305.0850. Kumbha sank. Phal- guna S.M.; Masi S.M.	18-318
11.	Phalguna	Feb. 28-4273.	321-2193	384.9058. Mina sank. Chaitra S.M.; Panguni S.M.	20 294
12.	Chaitra	Mar. 29.9579.	350-7499	365-2587. Mesha sank. Vaisakha S.M. ; Chittirai S.M.	22 270

N.B.—The main point to which the reader's attention should be directed is that the lunar month following a new moon has its name determined by its occurring *before* a particular sankranti. Thus, a lunar month commencing at any time between 0 day of the solar year and the 30 9353rd day is called **Yaisakha**; similarly, a lunar month commencing at any time between 156 4942 days and 186 9355 days of the solar year is called **Asvina** and so forth. The lunar month commencing before the Mesha Sankranti is called **Chaitra**.

22. For the first we shall select the current Indian year K.Y. 5011, A.D. 1910-11; for the second we shall select last year, K.Y. 5010, A.D. 1909-10; and for the third, because there has been no suppressed month since A.D. 1822, and there will be none again till A.D. 1963, we will select the very first year of our chronology, K.Y. 3101, B.C. 1.

23. The solar year K.Y. 5011, A.D. 1910, which is a normal year, opens, as every year does, with the *Mesha Sankranti* or entrance of the sun into the Indian *first point* of Aries, from which our celestial longitudes are reckoned. We have already seen how this moment is determined, namely, by the successive addition of 365 25875 days since the first moment of the year 0 Kaliyuga, less the sodhya of 2 1707 days. The Mesha Sankranti determines all kinds of solar years in use in India, and it also determines directly the lunar year, since the first lunar month Chaitra is defined to be that whose commencement precedes the Mesha Sankranti and the first day of the lunar year is that on which Chaitra Sukla Pratipada or the first tithi of the bright fortnight of Chaitra was current at sunrise. In our scheme of months in Table X and elsewhere the reader will observe that the lunar month Chaitra begins in a previous solar year, and so it stands last among the lunar months of that year.

The moment of the Mesha Sankranti marks the commencement of the solar month Vaisakha in Bengal, of the solar month Chittirai in the Tamil country, and of the solar month Medam in Malabar, Travancore, and Cochin.

Each month begins and ends with a sankranti, and the second and other sankrantis are named in the order of the signs of the zodiac, *Vrishabha*, *Mithuna*, etc.

24. There is no difficulty about the lunar months in A.D. 1910-11, since the new moons and sankrantis occur *alternately*, each *door* having its own *hinge* to turn on. If you like to calculate the actual moment of occurrence of each new moon, it will be a useful exercise for you to do so, and you can use the anomalies noted in columns 2 and 4.

Lunar Months	A.D. Date and Frac- tion of Day of mean New Moon.	Day and Fraction of Day of Solar Year when mean New Moon occurs, also Sun's Anomaly for New Moon.	Day and Fraction of Day of Solar Year when san kranti occurs; names of Solar Months commencing at each sankranti. S.M.=SOLAR MONTH.	Moon's Ano-Sum of Sun's maly at mo- ment of each mean New Moon. [See this col. on p.(9).]
	A.D. 1909. Indian Solar Year commences. Ap. 12-2492 (Tab. X).		K.Y. 5010. Mesha sankranii Vai- sakha S.M.; Chittirai or Medam S.M. Solar Year begins.	and grant a str
1. Yaisakha	Ap. 20.2288	7-2745 (Tab. X).	309353. Vrishabha sank. Jyoshta S.M.; Vai- tasior Edayam S.M.	2.401(Tab.X)
2. Jyeshta	May 19.7543.	36-8051.	62:3555. Mithuna sank. Ashada S. M.; Ani S.M.	4-377.

## SCHEME OF MONTHS IN THE YEAR AD 1909-10, K.Y. 5010.



(11)



SCHEME OF MONTHS IN THE YEAR A.D 1909-10, K.Y. 5010.

Lunar Months	A.D. Date and Frac- tion of Day of mean New Moon.	Day and Fraction of Day of Solar Year when mean New Moon occurs, also Sun's Anomaly for New Moon.	Day and Fraction of Day of Solar Year when sankranti occurs, names of Solar Months commencing at each sankranti. S.M.=SOLAR MONTH.	Moon's Ano-Sum of Sun's maly at mo- and Moon's ment of equation each mean New Moon. IX a to e).
3. Ashada	<b>A.D. 1909.</b> June 18 <sup>.</sup> 2849	66-3357	K.Y. 5010. 94-0009. Karkata sankranti Sra- yana S.M.; Adi S.M.	6.35.3
4. 5.] Sravana {	July 17-8155 Aug. 16:3461	95*8663 125*3970 	125-4755. Simha sank. Bhadra- pada S.M.; Avani S.M.	$\begin{array}{c c} 8.329 \\ \hline 10.305 \\1253(\bigcirc' 8 \text{ Eq.}) \\ \hline 10.160 \\ \hline4470 \end{array}$
6. Bhadrapada.	Sep. 14.8767	154.9275	156.4942. Kanya sank. Asvina S.M.; Purattasi S.M.	12-281
7. <u>Asvina</u>	Oct. 14.4073	184-4581	186-9355. Tula sank, Karttika S.M. (Beng.); Aip- pasi S.M. (Tam.).	14:257
8. Karttika	Nov. 12 9379	213-9886	216-8289. Vrischaka sank. Marga- sira S.M.; Kartigai S.M. (Tam.).	16-233
9. Margasira	Dec. 12.4685	243-5192	246-3192. Dhanus sank. Pausha S.M.; Margali S.M.	18:209
10. Pausha	Jan. 10 9990	273-0498	275.6369. Makara sank. Magha S.M.; Tai. S.M.	20.185
11. Magha	Feb. 9.5296	302-5804	305.0850. Kumbha sank. Phal- guna S.M.; Masi S.M.	22:161
12. Phalguna	Mar. 11.0602	332-1110	334-9053. Mina sank. Chaitra S.M.; Panguni S.M.	24-137
13. Chaitra	Ap. 9.5908	361-6416	865-2587. Mesha sank. Vaisakha S.M.; Chittirai S.M.	26.113

**25.** In this year, as in 1910-11, the lunar months, up to Sråvana, alternate with the solar months; but between the *Sankråntis* due at 94·30008 d. and 125·4755 d. of the solar year, we have two mean new moons at 95·8663 d. and 125·3970 d., respectively. We may satisfy ourselves by computation of the anomalies, as shown above, that the second new moon really precedes the sankrånti at 125·4755 d. In such a case both the new moons receive the same name (here *Sråvana*), and the first is called *Adhika Sråvana*, the second *Nija Sråvana*. After this, the numerical order of the lunar months is disturbed, for the 6th new moon is called Bhådrapada, whereas in 1910-11, the 5th is Bhådrapada, and the remaining new moons for the year being 13 instead of 12.

We now pass to the third example.

\* Actual moment of occurrence of new moon after allowing for solar and lunar a omaly.





## SCHEME OF MONTHS FOR 1 B.C., K.Y. 3101.

Lunar Months	Date of mean New Moon by Christian era and fraction of day.	Day of Solar Year when mean N 6 w M 0 0 n occurs ; also Sun's anomaly.	Day of Solar Year when sankranti occurs, a is o dates of com- mencement and end of Solar Months. S.M.=Solar Month.	Moon's ano- maly at moment of New Moon.	San's and Moon's equations (by Table IX a to v).
1. Yaisakha	1. B.C. Indian Solar Year commences Mar. 13:9831 (Table X, page 24) Mar. 23:98	9-99810	<ul> <li>K.Y. 3101.</li> <li>Mesha sankranti Vaisakha S.M.; Chittirai or Madam S.M.</li> <li>30.93528.</li> <li>Vrishabha sank.</li> <li>Jyoshta S.M.; Vaikasior Edayam S.M.</li> </ul>	22:736	and Aline
2. Jyeshta	Apr. 22.51	39-52869	62.3555. Mithuna sank. Ashada S.M. ; Ani S.M.	24.712	a harris
3. Ashada	May 22.04	69-05928	94-0003. Karkata sank. Sra- vana S.M.; Adi S.M.	26.688	ALVEN BU
4. Sravana	June 20.57	98.58986	125.4755. Simha sank. Bhadra- pada S.M.; Avani S.M.	1.109	Service Sa
5. Bhadrapada.	July 2010	128-12045	156.4942. Kanya sank. Asvina S.M.; Purattasi S.M.	3.085	
6. 7. } Asvina {	Aug. 18 63 Sep. 17 16		186-9355. Tula sank. Karttika S.M.; Aippasi S.M.	5.061 7.037	-1724 )
8. Karttika	Oct. 16 <sup>.</sup> 69	*186-5972 216-71221 	316-8289. Vrischika sank. Marga- sira S.M; Kartigai		-+120) -+5844 -+1288 $3855$ }
9. Margasira	Nov. 15-23	246-24280 	246-3192. Dhanus sank. Pausha S.M.; Margali S.M.	10.989 	
Pausha	(Kshaya)		275.6369. Makara sank. Magha S.M.; Tai S.M.		
10. Magha	Dec. 14:176	275-77339 	305.0850. Kumbha sank. Phal- guna S.M.; Masi	2:965 + .0391	+.0391
11. Phalguna	Jan. 13-29	$\frac{-2710.1319}{305.30398} + .2501$	S.M. 334.9053. Mina sank. Chaitra	14-941 + ·1193	+1193 +1308
12: ) Chaiting (	Feb. 11.82	305·5540 334·83457 *+·4710	S.M.; Panguni S.M.	15:060 16:917 + :1685	$+^{\cdot 2501}$ $+^{\cdot 1685}$ $+^{\cdot 3025}$
13. } Chattra	Mar. 18.35	335-8055 364-36515	365-2587. Mesha sank. Vaisakha S.M.; Chittrai or Medam S.M.	17:085 18:893	+.4710

\* Day and fraction of day, marking exact moment of actual New Moon, after allowing for anomaly.

26 In this year there is nothing specially worthy of note till we reach Asvina: but for that month there is an Adhika Asvina just as we had an Adhika Srávana in A.D. 1909. There is a peculiarity about Nija Asvina in the year B.C.1, which we must note carefully. The mean Nija Asvina at 187.1816 days is not before the sankranti at 186.9355 days, but the actual new moon, after calculation of anomalies, is found to be before 187.1816 days and is therefore Nija Asvina, not Karttika. Generally speaking, when a nija or adhika month is within '6 day on either side of a sankranti, calculation, or at least a consideration, of the anomalies is necessary before we can determine its true character.

27. Passing Åśvina, in the year 1 B.C., we find that each of the subsequent mean new moons is within '6 day of a sankrånti, and we must therefore calculate the anomalies in order to be quite sure whether each new moon is on this or that side of a sankrånti. Having made these calculations, we find that between two sankråntis at 246.3192 d. and 275.6369 d. there is no new moon, although there is a new moon just under six ghatikas (095 d.) after the second sankrånti. Had this new moon preceded the sankrånti ever so little, instead of following it, or had our method been inaccurate at this stage to the extent of 2 hours, the consequences we are about to state would not have followed. As it is, there is no new moon between the two sankråntis at 246.3192 d. and 275.6369 d., and therefore the lunar month which has no hinge to turn on is shut; this fact is expressed by saying that *Pausha* lunar month is *kshaya* or suppressed.

**28.** How do we know that the lunar month to be suppressed is *Pausha* and not any other? Because that is the first new moon which we are unable to place *before* a sankranti. We find that *Mågha* and *Phålguna* are each followed by a sankranti, though a long way off, and between the sankrantis at 334.9053 d. and 365.2587 d. there are again two new moons, that is to say Chaitras, the first of these being *adhika* and the second *nija*. Here also we note that appearances are deceptive, for the mean new moon at 334.8346 is apparently a Phålguna, but the calculation of the anomalies shows it to be an *adhika Chaitra*.

29. Generally, (1) a *kshaya* month is preceded and followed, though not immediately, by an *adhika* month; (2) there are, as a rule, only one or two *kshaya* months in a century; (3) the *kshaya* months must be calculated from the mean moment by means of anomalies before we can prove them to be *kshaya*; and (4) only one of three months, Mårgasira, Pausha, and Mågha, can be *kshaya*, because these are the three lunar months which turn on solar months of 29 days each.

The following table enables us to know an *adhika* month or a *kshaya* month by mere inspection of the date of occurrence of the first new moon in a solar year :--

Names of Lunar Months.	Ending moments of Solar Months.	Periods of Lunar Months.	Limits of Adhika and Kshaya Months.
	an a		The lunar month noted in column I will be an <i>adhika</i> month if first New Moon in Solar Year
Yaisakha	30.93528 d.	29.53059 d.	before 1.40469 d.
Jyeshta	62.35555 d.	<b>59.06117</b> d.	" <b>3·29</b> 428 d.

			(44)	<u> </u>
Names of Lunar Months.		Ending Days of Solar Months,	Periods of Lanar Months.	Limits of Adhika and Ksbaya Months.
Ashada		94·00028 d.	88-69176 d.	The lunar month noted in column I will be <i>adhika</i> if first New Moon in Solar Year occurs before 5'40851 d.
Sravana		125.47555 d.	118·12235 d.	,, 7·35320 d.
Bhadrapada		156·49417 d.	147.65293 d.	" 8·84122 d.
Asvina		186-93555 d.	177·18358 d.	" 9·75201 d.
Karttika		216.82888 d.	206471411 d.	10-11475 d. The lunar month noted in column I will be <i>kshaya</i> if first New men in Solar year occurs
Margasira	1999 (P. 1997) 1999 (P. 1997) 1999 (P. 1997)	216-31916 d.	236·24470 d.	after 1007446 d. and before 1011475 d.
Pausha		275*63694 d.	265·77529 d.	before 1007447 d.
Magha		305*08499 d.	295-30588 d.	{ after 9747910 d. and before 986164 d. The lunar month noted in column I will be adhika if first new moon in solar year occurs
Phalguna		· 334-90527 d.	324·83647 d.	{ after 9.77912 d. and before 10.06880 d.
Chaitra		365-25875 d.	354·86705 d.	{ before 10.89170 d.

N.B.-All the figures in column 4 are obtained by subtracting the corresponding figures in column 3 from those in column 2.

**30.** We see that if the first new moon in a solar year occurs before 1.40469 days (the difference between 30.93528 and 29.53059) of the solar year, there will be a second new moon before the end of the first solar month. Reasoning in the same manner, we see that if the first new moon in a solar year occurs after 1.40469 days, but before 3.29438 days of the solar year, there will be two new moons between the commencement of the first and second solar months, that is, there will be an *Adhika* as well as a *Nija Jyeshtha*. Similar reasoning will enable us to connect the possibility of occurrence of the several *adhika* and *kshaya* months with the occurrence of the first new moon before or between the days mentioned in the fourth column. It will be a useful exercise for the reader to try and reason out for himself each line of this table. For determining *mean* intercalations and *mean* suppression, the table can be used as it stands; and taken with suitable anomalies, it is a safe and reliable guide for ascertaining true *adhika* and true *kshaya* months. We believe that this is the first time that so simple a method has been aunounced for recognizing *adhika* and *kshaya* months.

TITHIS.

**31.** Tithis are in use over the whole of India for religious purposes and over the greater part of it for civil purposes also. To understand *tithis* thoroughly is to have mastered the system of Hindu chronology. Hence "Tithis" take the lead in the second title of this work.

**32.** A lunation or synodical month is divided into thirty tithis or lunar days of equal mean length. The names of tithis are familiar to all Hindus, but they are given for convenience of reference on the same page as Table II. The first fifteen tithis, corresponding to the bright half of the month, are called *Sukla paksha*; and the second fifteen are called *Krishna paksha* or *Bahula paksha*. The last or 30th tithi is new moon or Amavasya, and it is

called sometimes by the name of the month of which it marks the end, and sometimes by the name of the following month. Thus the moment of Amâvâsyâ, which marks the beginning of Vaišâkha and which in this work is invariably called the "Vaišâkha new moon" is the same as the ending moment of the 30th tithi of Chaitra. In an inscription\*" Vaišâkha Amâvâsyâ" often means the Amâvâsyâ at the end of Vaišâkha, but for convenience of computation, the first new moon in the solar year is in this work called the Vaišâkha new moon, while the 30th tithi of Vaišâkha is called the Jyeshtha new moon, and so on with the rest of the lunar months. (See remarks by Dr. Thibout, Indian Antiq., Ap. 1895, p. 88.)

**33.** To find the mean ending moment of a particular *tithi*, all you have to do is to add the corresponding duration in days, according to either Table II or the Eye-table, to the moment of the previous new moon.

Thus, to find the mean ending moment of the 18th tithi of Mågha lunar month, called *krishna* or *badi* (contraction for *bahula divasa*) *Tritiya* in K.Y. 5010, A.D. 1909-10, we proceed as follows:—

Magha new moon, A.D. 1910 (Table X) February	9.5296 d.
Duration of 18 tithis (Table II or Eye-table)	17.7188 d.
Mågha 3 badi, i.e., end of 18th tithi February	27·2479 d.

The mean tithi in question ended at .2479 of the 27th day of February, A.D. 1910.

**34**. For the *actual* ending moment of the tithi, we add the equations of sun's and moon's anomalies.

Add for 18 tithis	Anomaly at ne 302.58 d. 17.72 d.	w moon. ( A.D. 1910, February 17.718 d. $\bigcirc$ Eq. for 320.30 d = + :1491 d (Eq. for 12:473 d=:1332 d	27•2479 d.
	320.30 d. Deduct	39.879 d. 27.555 (1 anom. month.) + .0159 d.	+ ·0159 d.
		12.324 d. +.1491 (@'s equation.)	27·2638 d.
		12:473	

27.2638 d. or, in ghatikas and palas, 15 ghatikas 50 palas after mean sunrise on 27th February 1910. This is the absolute ending moment of Magha *badi* 3, in K.Y. 5010.

## CHAPTER VI. NAKSHATRAS.

**35.** The system of quoting dates by Nakshatras is as old as that of quoting by tithis and has prevailed in India from equally ancient times. There are twenty-seven nakshatras or lunar mansions through which the moon passes in her monthly journey

\* That is, on the amanta system or the system of reckoning lunar months from New Moon to New Moon. There is also another system, prevalent in certain parts of India, of reckoning the lunar months from Full Moon to Full Moon, hence called the *purnimanta* system. On this system, which in all probability was more widely current formerly than it is now, the New Moon is at the middle of a lunar month and the two halves of each month are properly designated its two *pakshas* or wings, one on either side of new moon. Also, the new moon at the end of the mannar Chaitra lunar month, for instance, would, on the *purnimanta* system, be properly called the "Vaisakha new moon." As explained eisewhere, it is sometimes a difficult question whether a lunar month, referred to in an inscription, is to be understood in the *amanta* or in the *purnimanta* sense. See Sections **107** to **111** *infra*. through the stars. For purposes of astronomical computation, the moon is supposed to spend an equal amount of time in each of the 27 nakshatras; and as the total period of the moon's journey through the stars occupies 27:32166 days, it follows that the mean duration of each

nakshatra is  $\frac{27\cdot32166}{27} = 1.01191$  days, *i.e.*, 1 day and nearly 18 minutes. Thus, if we know the ending moment of a particular nakshatra, all we have to do to find out the ending moment of the next nakshatra, or, for that matter, of any other nakshatra, is to add as many times 1.0119 days as there are nakshatras between the ending moment which we know and the ending moment which we wish to find out. Having found this ending moment, we have next to add or subtract the moon's equation of time according to her anomaly at the ending moment of the nakshatra. We should remember that the sun's anomaly and the sun's equation of time do not enter into the calculation of the ending moment of nakshatras, because we are now concerned with the moon's own journey among the stars and not with the space gained by her over the sun.

36. When all we wish to know is the nakshatra for a particular tithi we may ascertain this directly from the mean tithi. The mean tithi, as we know, gives us the moon's longitude minus the sun's longitude. If to any tithi, therefore, we add the sun's longitude, we shall get the moon's longitude and this will enable us to find out the nakshatra corresponding to the longitude. The sun's longitude for nakshatras for every whole day of the solar year is given in the last column of the calendar (Table VIII); while the sun's longitude for decimals of a day is given in Table V. (The process of determining the sun's longitude for the purpose of nakshatras consists, briefly, in making 360° equal to 29.53059 day-spaces, and allowing for the sodhya of 2.1707 days. This conversion is necessary in order that we may add the moon's less the sun's longitude, which is calculated at the rate of 360° for 29.53059 days, to the sun's own longitude). To give an example, supposing we wish to find the nakshatra corresponding to the 27th day of February, A.D. 1910, which we found was the 18th tithi of lunar Magha, ending at 2487 of the day, after sunrise, we proceed to determine the sun's longitude for the nakshatra. From the tithi we know that the sun's longitude for solar anomaly for the tithi is 320.30 days. The corresponding sun's longitude for nakshatra is as follows :---

For 320 days (according to Table VIII) 25 6960 days.

For '30 day (according to Table V) '0242 "

Add moon's less the sun's longitude, i.e., the equivalent of 18 tithis in days 17.7183 43.4385

0.5900

10.4

Deduct the equivalent of 360° of the moon's longitude 29:5306 18:9079

We look in Table III for the nakshatra equivalent of 13.9079 days in lunation space. We find this to be number 13, whose longitude extends from 13.12470 to 14.21843. Now, No. 13 nakshatra is called *Hasta*, which is therefore the nakshatra current at the ending moment of our tithi.

**37**. When we wish to find the *current* nakshatra corresponding to a tithi, the above method may be varied by converting the tithi into degrees at the rate of 12° for each tithi and adding the sun's longitude from Table XVII A and C, as in the example in Sec. **287**.

**38**. When we wish to find the *ending moment* of a nakshatra, the following method is preferable. This method, which is very simple, is indicated in Table XI which is provided in ghatikas and palas as well as in decimals of a day. To use this table, we should know the number of the nakshatra and the number of the new moon which the nakshatra follows, *i.e.*, whether it is the 1st, 2nd, 3rd, or 4th new moon, and so on, and then under the new moon in question we look out the "interval" opposite the number of the given nakshatra. The next step is to deduct from the interval so found the equivalent (according to the Correction Table in Table XI) of the time of occurrence of the first new moon in the Solar Year (given in Table X). The result, added to the date of the New Moon, gives us the mean ending moment of the nakshatra (Table IX j to l) corresponding to the moon's anomaly, and if we wish further to have the absolute ending moment in local time, we add or subtract the corrections according to Table XIII for the given latitude and longitude.

First New Moon in Solar Year (Table X) Add for Kârttika New Moon ( ,, ) Add commencement of Solar Year ( ,, )	Days. 25·9134 177·1835 April 13·2080	C s Anomaly Days. 0.535 11.856
Days from April 1 A.D. 1909	216.3049	States and Serve
"Interval" corresponding to No. 19 Måla" Nakshatra under Kårttika (No. 7 Days. New Moon)—Table XI 6.1353		
Deduct equivalent of 25.9134 accord- ng to the correction table in Table XI.		
$\begin{array}{rcrcr} & & & & & & \\ & & & & & \\ & & & & & \\ & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & & & & \\ & & & & &$		
"		
+ 4.1920	+ 4.1970	+ 4.197
Days from April 1	220.5019	16.588
Nakshatra equation (Table IX-k) for anomaly of 16.588 days is + 2465	+ '2465	
And a series of the second	220.7484	days from Ap. 1.



Naksha

That is (by Tables VIII and XIX) 44 ghatikas 54 palas after mean sunrise 6th November, A.D. 1910.

N.B.-For the years A.D. 1840 to A.D. 1919 we can get the ending moment of any Nakshatra yet more quickly from Tables XI and XII in the following manner :---

days gh. palas. 2 18 18 C's Anom. 12 23 28 (Table XII) Karttika New Moon 1910, November d. gh. p.7 Nak. interval No. 19 (Table XI-A, col. VII) 6 8 Deduct for Nak. 1910-11 (Table XII, last col.) 18 56

> 11 49 4 11 49 4 11 49

> > 16 35 17

7

30 Nak. Equation for C's Anom. of 16 d. 35 gh. 17 p. (Table IX-l) + 14 50

6 44 57 The ending moment is Nov. 6, 44 ghatikas 57 palas after Ujain sunrise, which only differs by 3 palas from the result above arrived at.

42. If we want this in local time, say at Tanjore (Lat. 11°) we have to add as correction, according to Table XIII [Lat. 11° (Tanjore)-208th day of Hindu Solar Year, on 6th Nov., when the Solar Year, commences on 13 April]+994 seconds of time=41 palas.

44 ghatikas 54 palas+41 palas -45 ghatikas 35 palas, after sunrise at Tanjore on 6th November, A.D. 1910.

This is the absolute ending moment of "Mûla" Nakshatra in Lunar Kârttika, A.D. 1910 (Kaliyuga 5011), according to the Surya Siddhanta. According to Mr. Srauti's Panchangam, which is based on the Greenwich Nautical Almanac, the absolute ending moment is 52 ghatikas 24 palas and according to the Kanjanur "Panchangam (No. 28)" it is 47 ghatikas 16 palas.

43. Suppose that in the same month we required to know the ending moment of No. 13 "Hasta" Nakshatra, instead of No. 19 "Mula", we would have to take the " Interval" in Table XI for No. 13 and deduct therefrom the equivalent of 25.9184, i.e., 1.9883, which is the same for all months and all nakshatras throughout the Solar Year 1910 A.D. Against No. 13 under the 7th New Moon in Table XI there are two "Intervals", i.e., 0.0638 and 27.3854. We take the second interval as we cannot deduct 1.9383 from the first interval.

27:3854 -1:9383 (Annual Nak. Corrn.)	Days. 216*3049	('s Anomaly. 0.535 11.856
25.4471	+ 25.4471	+ 25.447
	241.7520	37.838 - 27.555 (1 an. month.)
(Tab. IX—I)	2915	10.283

241.4605 days from 1st April, i.e.,

by Tables VIII and XIX) 27 ghatikas 38 palas after mean sunrise on 27th November, A.D. 1910.

**44.** Lastly, if we want the ending moment of No. 15 " Svåti " Nakshatra in the same month, we find two "intervals" for No. 15 in Table XI, from each of which 1.9383 can be deducted. In other words, there will be two "Svåti's" in Lunar Kårttika 1910; one about 2.08 minus 1.94 or at '14 of a day after new moon and the other at 29.41 minus 1.94 or 27.47 days after new moon. The equation for the mean anomaly of the first Svåti will be that for an anomaly of 0.53 + 11.86 + .14 = 12.53 days : in this case the equation is -.118. The absolute ending moment of the first Svåti will be '305 + .14 - .118 = .327 or  $.19\frac{3}{4}$  ghatikas after mean sunrise on the new moon day, *i.e.*, the 216th from 1st April, or 2nd November, A.D. 1910.

The equation for the ('s mean anomaly at the ending moment of the second Svåti will be that for (0.53+11.66+27.47-27.55)=12.81 days; that is, by Table IX-*j*, the equation will be -.138.

The absolute ending moment of the second Svati will then be

 $216 \cdot 3049 \\ 27 \cdot 47 - \cdot 138 = + 27 \cdot 332$ 

243.6369 days from April 1,

i.e., (by Tables VIIIand XIX) 381 ghatikas on 29th November, A.D. 1910.

This is midway between Mr. Srauti's time (864 ghatikas) and the "Kanjanur" time (41 ghatikas) for the nakshatra in question.

N.B .- We have not corrected our result for local time.

**45**. Besides the system of the division of the moon's path among the stars into 27 equal nakshatra spaces, there are two others, called Garga's system and Brahma's system, by which the sidereal month of 27.32166 days is divided into 27 convenient but *unequal* stages. Our Table III gives the collective duration of the nakshatras according to the unequal systems, and the ending moment of each nakshatra according to either of these systems can be found by adding the corresponding collective duration to the ending moment of the last Nakshatra Revait, which should be first determined. We have also given in Table III the names of the deities presiding over the several nakshatras.

**46**. It is sometimes found that an extra Nakshatra *Abhijit* is interpolated between Nos. 21 and 22. Its duration is shown in Table III in the column dealing with "Brahma's System".

# CHAPTER VII.

47. A yoga is the time during which the sun and moon together accomplish 13 degrees 20 minutes of space. There are thus 27 yogas which together make 360°. . The names of all the yogas are given in Table III, from which it will be seen that the collective duration of 27 yogas is 25.42022 days.

**48.** Unlike tithis and nakshatras, the yogas do not represent the stages of the actual motion of any heavenly body or of a set of heavenly bodies. They are thus the result of a mathematical rather than of an astronomical conception. If we draw a line

where a represents the motion of the moon in a given time and b the motion of the sun in the same time, it follows that a-b is the moon's elongation or the space gained by the

moon over the sun in the given time. If we regard separately the spaces travelled by the sun and the moon in this time, we might say that together they have done a+b. This a+b, then, is the yoga, while a-b is the tithi. To derive the yoga from the tithi, we make use of the formula

#### a-b+2b=Yoga.

just as we derived the nakshatra from the tithi by means of the formula a-b+b. (Sec. 36 supra.)

49. Supposing we want to determine the yoga current at the ending moment of the tithi for 27th February 1910, we proceed as follows. We have found *supra* (Sec. 33) that the 18th tithi ended at '2479 day on 27th February, 1910, and that the corresponding solar day was 320'30 days, while the corresponding moon's anomaly was 12-324 days.

In accordance with the formula a-b+2b, we add twice the sun's longitude to the tithi.

The sun's longitude for 320.30 days is calculated as follows :--

For 320 days (last column of Table VIII) For 30 day (Table V, sun's longitude)	25*6960 0242	
Multiply this by 2 Deduct completed lunation		25.7 <b>2</b> 02 51.4404 29.5306
Add equivalent of 18 tithis (Table II)		21·9098 17·7183
Deduct completed lunation		39·6281 29·5306
	94 - S	10.0975
(Table III) whose space ends at	•	10.9372

This, therefore, was the yoga current at the ending moment of our tithi.

N.B.

-Or as in Sec. 37, the sun Sun's longitude for 320 day Do. 30 day	's longitue ys y	le may be 	calculated 	directly from		313-2534 ° -2957
Twice O's longitude						313·5491° == 627·0982° == 216°
Deduct completed circles			•••		•••	843·0982 720°
('s Yoga longitude	1					123.0982

From the Eye-table we see that the current Yoga was Ganda.

#### Easy Method for Yogas.

**51.** A very simple method of determining the ending moment of any Yoga is indicated in Table XI which is to be used in precisely the same manner for Yogas as for Nakshatras. We proceed to show how Table XI should be used for Yogas for any year, any lunar month, and any yoga. We take the solar year, A.D. 1910-11, the Lunar month Karttika, and Yoga "Ayushmat".

For the year 1910-11 A.D., the correction corresponding to 25 9134 (first new moon in solar year) according to the Yoga correction table, is determined as follows :----

Correction corresp	onding to	25	-	3.4797
17 11	and the second second	·91	=	·1267
11	Part and a second second	.0034	-	·0005

hus :--



In Lunar Karttika, A.D. 1910, there are two yoga "intervals" for No. 3 "Ayushmat", from each of which 8.6537 can be deducted. Let us calculate the mean and absolute ending moments of each of these "Ayushmats".

First New Moon in solar year	···· ····	Days. 25.9134 177.1835	Days. 0.535 11.856
First No. 3. Yoga : Interval 3.8846 Correction3.6069		203-0969	12:391
Net Interval + ·2777		+ .2777	+ .278
Commencement of solar year	. Ap.	203-3746	12.669 or 12., 40gh., 10 p. O'sEqn. + 7gh. 55p.
<ol> <li>(1) O's Yoga Equation for Anom. of 203.3746 days, <i>i.e.</i>, 208d., 22gh. is, by Table IX—<i>i</i>, + 7gh., 55p.</li> <li>(2) C's Yoga Equation for Anom. of 12d., 48gh. 5p. is, by Table IX-<i>i</i>, -5gh. 10p.</li> </ol>	Ap. or 216d.	216*5826 .84gh. 57p.	12d., 48gh. 5p.
(2) Sum of $O's + C's$ Equations = 2gh. 45p.	+	zgn. 45p.	

216d., 37gh. 42p. from 1 April,

*i.e.* (by Tables VIII and XIX) 37 ghatikas 42 palas after mean sunrise on 2 November, A.D. 1910 (Lanka time).

This is the absolute ending moment (according to Sûrya Siddhânta) of the first Ayushmat Yoga in the lunar month of Karttika, Kaliyuga 5011 (expired).

52. For the second " Âyushmat " yoga of the same lunar month, we proceed as follows :--

			('s Anom.
		Days	Days.
Kårttika New Moon Net "interval" for No. From Deduct yoga correction for the year	 3 yoga : 1 29·3048 	203.0969	12.381
a freeze and and and	25.6979	25.6979	25.698
		228.7948	38.079
	0	or 228 d., 47gh, 41p.	27.555
Commencement of solar year	r April 13·2080	or 13d., 12gh. 29p.	10.524 or
		242d., 0gh. 10p.	10d., 31gh. 30p.
(1) O's Yoga Eqn. (Table	IX-i) for 228d.	· Martin and a station	⊙'s Eqn. + 5gh. 12p.
48gh. is + 5gh. 12p.	California (California)		10d., 36gh. 42p.

A OL MON	(22)					6	Ì
<ul> <li>(2) By Table IX-i, ('s Yo 10d., 36gh., 42p. is-</li> <li>(8) Sum of ⊙'s and ('s Y -9gh., 56p.</li> </ul>	24 oga Eqn., for —15gh., 8p. Yoga Equations = —	12d., 0gh., 10 — 9gh. 50	9p.				
<i>i.e.</i> , (by Tables VIII and XIX) 50 A.D. 1910.	241 ghatikas 14 palas	d., 50gh. 14 after mean	p. from 1 sunris	1 April e on 2	, 7 Nov	vemb	er,
<b>53</b> . For the years A.D. means of Tables IX- <i>i</i> , XI-A, and X	1840 to A.D. 1919 XII. Thus, for "V	) yogas may yatipata"y d. gh.	be calcu oga in $A$ $\odot$ p. d. g	lated ve pril, A. 's An. (h. p.	ry rea D. 19 ( d	dily   10 :	by
Table XII, Chaitra new moon, A.I.	). 1910, April d. gh.	<b>9 35</b> p.	27 361	38 30	26	6 -	48
(Table XI-A, col. XIII, (Chaitra folig. Interval for No. 17 "Vyatîpâta" ya Deduct Yoga correction for the yea	Adhika masa) oga 1749 ur (Table XII) 10	25 45					
	16 48	40 + 16 48	40 16	48 40	16	48	40
Tab. IX–i⊙'s Yoga eqn. for 18d. 11	g8gh. 25p,	26 24	7 378 * 365	<b>2</b> 7 10 15 30	42 † 27	55 33	28 20
", C's Eqn. for 15d, 13gh. 43 Sum of ⊙'s and C's Eqns.	p. + 7gh. 40p. 	- 0	13 45	11 40	15	22 8 0's Fo	8 25

That is, "Vyatîpâta" yoga in April 1910 ended at 23 ghațikas, 22 palas after mean sunrise on 26 April.

April

54. Yogas in their astronomical sense are not very much in use at present, but certain astrological yogas (Amritayoga; Siddhayoga, Maranayoga) are much more in use, being based on combinations of Nakshatras with certain week-days.

Apart from inscriptions in the Vikrama Era, where yogas are freely cited, one hears of the yoga proper in such auspicious combinations as the following :--

Kapilá Shashthi, i.e., the combination of Bhadrapada Krishna Shasthi (in a year in which either Bhadrapada or some previous lunar month is adhika) with Nakshatra Rohini and Yoga Vyatipata on a Tuesday. The combination is proverbially rare and supposed to be very difficult to foresee, but it can be easily predicted by means of the present method. Look in Table X for Bhådrapada mean new moon (in a year having this or some previous month as adhika) falling on a Wednesday, mean ending moment being less

26 23 22

15 13

43

<sup>\*</sup> The deduction of the period of an entire solar year is made here.

<sup>†</sup> The deduction of the period of an entire anomalistic lunar month is made here.



than '50, and calculate *Rohini* Nakshatra and *Vyatipata* Yoga for that month. Of course the tithi, the nakshatra, or the yoga may fall on Monday or Wednesday, and then there will be no *Kapilashashti*.

Ardhodaya yoga, i.e., a combination on a Sunday by day-time, of Nakshatra Rohin? Yoga Vyatipâta, and Mâgha amavâsyâ (i.e., the amavâsyâ at the end of lunar Mâgha).

Champa Shashthi, i.e., a combination on a Sunday or Tuesday of Margasira sukla Shashti with Nakshatra Satabhishaj and Yoga Vaidhriti.

Mahâmahâ Varunî, i.e., a combination of Phâlguna krishna trayodasî with Saturday and Nakshatra Satabhishaj and Yoga Subha.

Dasahari, i.e., a combination in the forenoon of Jyeshtha sukla dasami with Wednesday (or Tuesday) and Nakshatra Hasta and Yoga Vyatipata.

Mahâsivarâtri, i.e., Magha krishna chaturdasî combining at midnight with Sunday or Tuesday and Yoga Siva.

N.B .- See further Chapter XVI below.

C's Eq Sum of

## CHAPTER VIII.

## KARANAS, AHAS AND TYAJYAM.

#### Karanas.

55. The list of *karanas* is given in Table III. Every tithi is divided into two *karanas*, and the ending moment of the second of every set of two *karanas* coincides with the ending moment of a tithi. For the other *karana* all we have to do is to add half a tithi, '49217 day, to the last mean tithi, as well as to the corresponding solar and lunar anomalies and calculate from these data the absolute ending moment of the *karana*.

Thus on 27 Febr For the 37th kar	uary 19 ana (Ba	10 the mean ava) add	. tithi (1 	8th) endec	l at 	***	·2479 day. ·4922
Sun's anomaly 3	days. 20·30 ·49	Moon's an	omaly	days. 12-324 -492			•7401 day
uation-0840.	20.79;	⊙'s Eqn. +'	1501.	12.816 + .1	50 = 12.96	6	
f the equations + 1	50108	340 = ····	••••••••••••••••••••••••••••••••••••••	<i>H</i> (1997)		•	.0661

\*8062 day

i.e., the karana Bava ended at 48 ghatikas 22 palas on 27 February 1910.

56. Properly speaking, two karanas ought to be shown in the panchangam, corresponding to every tithi: but the panchangams in practice mark only that karana whose ending moment is 30 ghatikas or less from sunrise. If the tithi itself ends at 30 ghatikas or less from sunrise, the same ending moment is entered in the panchangams against both tithi and karana. In the above case, *i.e.*, 27 February 1910, the 36th karana Vishti (called Bhadra in the Tamil country) will be found marked in the panchangams as having the same ending moment as the tithi.