

P.V. HOLAY'S INTERPRETATION OF THE R̥K-JYOTIṢĀ VERSES ON 19-YEAR YUGA

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(Received 15 January 2003; revised 11 August 2003)

The present paper is an attempt to re-examine the interpretation of *R̥k-Jyotiṣā* verses on the 19-year yuga by Prabhakar Vyankatesh Holay on a scientific perspective. The earlier interpretations also get highlighted in the process in yuga in order to emphasize the true rationale and the real astronomical phenomena underlying the verses that became evident through the work of Holay. Further, it is evident from the interpretations that the Vedic calendar had provisions for fixing the tithi and *nakṣatra* of the equinoxes and solstices as early as 2400 BC. The 19-year yuga in the *R̥k-Jyotiṣā* is of great importance when we think that the credit on discovery of the 19-year calendar is given to Greek scholar Meton in 430 BC.

Key words: Calendar, Lagadha, Meton Cycle, 19-year, *R̥k-Jyotiṣā*, Vedic Calendar

INTRODUCTION

The *R̥k-Jyotiṣā* verses by Prabhakar Vyankatesh Holay, was originally published in Marathi in 1986 and English in 1989.¹ His work succeeded those of SB Dikshit (1890)² and T S Kuppanna Sastri (1984)³. Even though Holay's work came after the authoritative interpretations of these erudite scholars it differed drastically from them in originality and novel insights. The merits of the work has remained unnoticed or ignored as is obvious from the little acceptance when we compare with the popularity of the work of Dikshit and Sastri. Present paper is an attempt to credit the discovery of 19-year luni-solar calendar to Lagadha instead of Meton.

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AIMS & OBJECTIVES OF R̥K-JYOTIṢA ENUNCIATED BY LAGADHA

*ityetan māsavarṣ āṇām muhūrtodayaparvaṇām |
dinaṛ tvayanamāsāṅgam vyākhyātamaḥlagadho 'bravit ||*

R̥k-Jyotiṣa, verse 29

“Lagadha has defined the calendar of lunar months, years, *muhūrtas*, *pakṣas* (*parvah*), days, *ayanās* (half-years) and the solar months in these verses”.

It's doubtlessly clear that Lagadha has enunciated the computational astronomy underlying the ancient calendar in these verses. All the verses as such must be of some calendric significance and any meaning added to it is a misfit and is of no relevance to the interpretation.

VERSES ON 19-YEAR YUGA

Out of 36 verses, a few have conflicting interpretations by Kuppanna Sastry and Prabhakar V. Holay. But no effort is taken to make a judgement as to which is the correct interpretation.

The relevant verse, according to Holay referring to 19-year yuga, is as follows:

*dviguṇam / prathamam saptamam cā hurayanādyam trayodaśa |
caturtha daśamam ca dviryugamādyam bahule 'pṛtau ||*

R̥k-Jyotiṣa, verse 8

Interpretation:

“The first, seventh and thirteenth *tithis* of the bright fortnight and the fourth and tenth of the dark fortnight are at the beginnings of the first five *ayanās*. These occur twice (i.e. these five are to be repeated for the next five *ayanās*)”

– TSK Sastry

“Years can be divided into five classes according to the beginnings of *ayanas* (semester of solar years). Such beginning of the *ayanas* falls in *śaḍahas* which begin with (i) 1st *tithi*, (ii) 7th *tithi*, (iii) 13th *tithi* of bright fortnight, and (iv) 4th *tithi*, (v) 10th *tithi* of dark fortnight” – P. V. Holay

Dikshit also had interpreted the verses as given later by TSK Sastry relying on Somākara’s commentary on the *Yājur jyotiṣa* – both the authors attempting to extract a meaning that suited the preconceived notion of a 5-year cycle.

Classification of Years (Dikshit & Sastry):

Table 1

| Sl.No. | Name of year | Winter solstice | Winter solstice |
|--------|--------------------|-----------------|-----------------|
| 1. | <i>Samvatsara</i> | Māgha S (1) | Śrāvaṇa S (7) |
| 2. | <i>Parivatsara</i> | Māgha S (13) | Śrāvaṇa S (4) |
| 3. | <i>Idavatsara</i> | Māgha S (10) | Śrāvaṇa S (1) |
| 4. | <i>Anuvatsara</i> | Māgha S (7) | Śrāvaṇa S (13) |
| 5. | <i>Idvatsara</i> | Māgha S (4) | Śrāvaṇa S (10) |

Classification of Years (Holay):

Table 2

| Sl.No. | Name of year | Limits of <i>tithis</i> for the beginnings Luni-solar year |
|--------|--------------------|---|
| 1. | <i>Samvatsara</i> | Māgha S (1) to Māgha S (6) |
| 2. | <i>Anuvatsara</i> | Māgha S (7) to Māgha S (12) |
| 3. | <i>Parivatsara</i> | Māgha S (13) to Māgha K (3) |
| 4. | <i>Idvatsara</i> | Māgha K (4) to Māgha K (9) |
| 5. | <i>Idavatsara</i> | Māgha K (10) to Māgha K (15) |

Interpretation of Sastry is wrong if we consider it as per the observational calendar phenomena underlying the stated classification. Logical absurdity is that the classification of years needs only the *tithi* of the year beginning – either of the solstices or equinoxes, not both – the *tithi* of the subsequent *ayana* or half year. Scientifically, the observable luni-solar phenomena never satisfy the interpretation given by Dikshit and Sastry.

Table 3

| Sl. No. | Date | Winter Solstice | Date | Summer Solstice | Tithi limits |
|---------|------------|-----------------|------------|-----------------|----------------------------|
| 1. | 1.1.1190BC | Māgha S(1) | 5.7.1190BC | Srāvaṇa S(9) | Māgha S(1) to Māgha S (6) |
| 2. | 1.1.1189BC | Māgha S(12) | 5.7.1189BC | Srāvaṇa K(5) | Māgha S(7) to Māgha S (12) |
| 3. | 1.1.1188BC | Māgha K(9) | 5.7.1188BC | Srāvaṇa S(1) | Māgha S(13)to Māgha K (3) |
| 4. | 1.1.1187BC | Māgha S(4) | 5.7.1187BC | Srāvaṇa S(12) | Māgha K(4) to MāghaK (9) |
| 5. | 1.1.1186BC | Māgha S(15) | 5.7.1186BC | Srāvaṇa K(8) | Māgha K(10) to Māgha K(15) |

In contrast to the sequence [S1-S7-S13-K4-K10-S1-S7-S13-K4-K10] stated by Sastry, the actual observational phenomena is {S1-S9-S12-K5-K9-S1-S4-S12-S15-K8}. The *Rtuseṣa* or the 11 extra-lunar days (*tithis*) of the solar year is almost uniform for all years as it is based on the average orbital velocity of the Moon. But when we consider the half-year from solstice to solstice the *rtuseṣa* fluctuates depending on the position of the perigee of lunar orbit. For example in the above example of 1190 BC, the half yearly surplus of *tithis* is 8,(3), 8, (4), 7,(3), 8 – not 5.5 uniformly from winter to summer solstice and vice versa.

On the other hand the above data attests the correctness of the interpretation rendered by Holay in terms of the five zones of *rtuseṣa*. Considered up to BC 1172, the above data leads to the year sequence and cycle of 19 years as:

Table 4

| | | | | |
|----------------------|-----------------------|-----------------------|-----------------------|------------------------|
| 1. <i>Samvatsara</i> | 4. <i>Samvatsara</i> | 7. <i>Samvatsara</i> | 12. <i>Samvatsara</i> | 15. <i>Samvatsara</i> |
| 2. <i>Anuvatsara</i> | 5. <i>Parivatsara</i> | 8. <i>Parivatsara</i> | 13. <i>Idāvatsara</i> | 16. <i>Parivatsara</i> |
| 3. <i>Idvatsara</i> | 6. <i>Idāvatsara</i> | 9. <i>Idāvatsara</i> | 14. <i>Idvatsara</i> | 17. <i>Idāvatsara</i> |
| | | 10. <i>Anuvatsara</i> | | 18. <i>Anuvatsara</i> |
| | | 11. <i>Idvatsara</i> | | 19. <i>Idvatsara</i> |

Above data is quite revealing in respect of the first line of salutation verse “*pañcasamvatsaramayaṃ yugādhyakṣam prajāpatim*” – the meaning of the underlined part is explicitly written on the above table – the yuga of Lagadha

meant a cycle of 19 years in which the specific year ‘*saṃvatsara*’ had five appearances or 19 years constituted of five *saṃvatsara* – sequences” as in the above columns.

Classification of years as interpreted by Holay is advantageous in the matter of intercalation as it yields the rule of – intercalation only in *idavatsara* or *idāvatsara* – in the former intercalation it is at the end of the solar year and in the latter intercalation it is before summer solstice at the middle of the year.

ṚK-JYOTIṢA, VERSE 9

vasustvaṣṭā bhavo 'jaścamitraḥ sarpās vinaujalam |
dhātākas cāyanādasdyāścārthapañcamabhastvṛtuḥ||

This is another verse similar in import to the verse 8 and the interpretations by the predecessors of Holay are all wrong.

Interpretation:

“The *nakṣatras* at the beginnings of the ayanas are *Śraviṣṭhā*, *Citrā*, *Ārdrā*, *Pūrvapropṣṭapadā*, *Anurādhā*, *Asleṣā*, *Aśvinī*, *Pūrvāṣādhā*, *Uttaraphālgunī* and *Rohiṇī*”.

— T S K Sastry

This interpretation can be proved to be wrong in the same manner as shown in the case of verse 8. For the five years given above the solstice moon was in stars *Sraviṣṭhā*, *Viśākhā*, *Ārdrā*, *Uttarabhādra*, *Viśākhā*, *Pūrvāṣādhā*, *Mūla*, *Asleṣā* and *Aśvinī*.

Moreover TSK Sastry has not explained the second line despite his ability for emendation. Dikshit had to forego the Sanskrit grammar to explain “*arthapañcamabhastvṛtu*” as “seasons of 4.5 *nakṣatras*” instead of “half of the five *nakṣatra ṛtuseṣas* as rendered by Holay. The preceding verse gave the *tithi* limits for classification of years and here it is further explained in terms of lunar occupancy of stars, of course as the stellar group (instead of the *tithi* group of earlier verse) so as to have better observational confirmation.

Holay's approach has found consistency across the different verses that defined interpretation with calendar use and astronomical correctness in the matter of observation.

Classification of the years as earlier demands division of the stellar belt into five zones of 5.4 *nakṣatras* ($5.4 \times 5 = 27$). Ten half zones (*ardha – pañcanabhastvrtuḥ* = halved five sectors) shall be of 2.7 *nakṣatras* and the division may be described in terms of the 10 junction stars and that is what we see in this verse.

When we consider the summer solstice of these years we get also the five stars *Viśākhā*, *Pūrvaśādhā*, *Āśleṣā*, *Mūla* and *Aśvinī*. Instead of giving these particular stars of a specific period Lagadha has given the 10 junction-stars of the half-zones of 2.7 *nakṣatras* to facilitate observation of Moon at both the solstices.

Table 5

| Sl. No. | Name of Year | <i>Nakṣatra</i> Limits of Winter Solstice | Year | W. Solstice <i>Naks atra</i> | Classification |
|---------|--------------------|---|--------|------------------------------|--------------------|
| 1. | <i>Samvatsara</i> | 1 Śraviṣṭha-0.4 Aśvinī | 1190BC | Śraviṣṭhā | <i>Samvatsara</i> |
| 2. | <i>Anuvatsara</i> | 0.6 Aśvinī-0.8 Ārdrā | 1189BC | Ārdrā | <i>Anuvatsara</i> |
| 3. | <i>Parivatsara</i> | 0.2 Ārdrā-0.2 U.Phal | 1188BC | Viśakhā | <i>Idvatsara</i> |
| 4. | <i>Idvatsara</i> | 0.8 U.Phal-0.6 Anurādhā | 1187BC | Pūrvabhadra | <i>Samvatsara</i> |
| 5. | <i>Idāvatsara</i> | 0.4 Anurādhā-Śraviṣṭha | 1186BC | Āśleṣā | <i>Parivatsara</i> |

ṚK-JYOTIṢA, VERSE 14

*jau drā gaḥ khe s ve 'hi ro ṣā cin mū ṣ anyah sūmā dhā nah |
re mṛ ghā svā 'po 'jah kr ṣ yo ha jye ṣ thā ityṛ kṣā liṅgaiḥ ||14||*

Here the computation deciphered by Dikshit, Sastry and others of course does not necessitate emendations. Such meaning which are devoid of serious emendations never imply a 5-year cycle and the meaning is true in the case of 19-year yuga also. On the contrary, the meaning rendered by Holay and the certain critical verses rule out the possibility of 5-year yuga in the 36 verses of *Ṛ k-Jyotiṣa*. Verse 15 have bearing upon the interpretation of this verse as given in Table 6.

Table 6: Application of verse 14 to find *tithi* of Solstice

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---------|---------|--------------|---|---------------|----------------------|-----------------|------------|----------------------|
| Sl. No. | Star+10 | Col(2) mod27 | 23 rd star in parts of Sraviṣṭhā | Sl.No. Aṣvini | Star Winter Solstice | Col.5+ of Col.8 | Star | Star Summer Solstice |
| 1 | 22 | 22 | 22+38D | -5 | Śraviṣṭhā | 0 | Aṣvini | Hastā |
| 2 | 32 | 5 | 5+36D | 6 | Ārdrā | 11 | P.Phāl | Śraviṣṭhā |
| 2 | 42 | 15 | 15+34D | 16 | Svāti | 21 | U.Āśadhā | Ārdrā |
| 4 | 52 | 25 | 25+32D | 26 | U.Bhadra | 4 | Rohiṇī | Viśākhā |
| 5 | 62 | 8 | 8+30D | 9 | Aśleṣā | 14 | Citrā | U.Bhadra |
| 6 | 72 | 18 | 18+28D | 19 | Mūlā | 24 | Satātāraka | Aśleṣā |
| 7 | 82 | 1 | 1+26D | 2 | Bharanī | 7 | Puṇarvasu | Mūlā |
| 8 | 92 | 11 | 11+24D | 12 | U.Phāl. | 17 | Anurādhā | Bharanī |
| 9 | 102 | 21 | 21+22D | 22 | U.Āśadhā | 27 | Revatī | Bharanī |
| 10 | 112 | 4 | 4+20D | 5 | Mṛga | 10 | Maghā | U.Phāl |
| 11 | 122 | 14 | 14+18D | 15 | Citrā | 20 | P.Āśadhā | U.Āśadhā |
| 12 | 132 | 24 | 24+16D | 25 | P.Bhadra | 3 | Kṛtikā | Mṛga |
| 13 | 142 | 7 | 7+14D | 8 | Puṇarvasu | 13 | Hastā | Citrā |
| 14 | 152 | 17 | 17+12D | 18 | Jyesthā | 23 | Śraviṣṭhā | P. Bhadra |
| 15 | 162 | 0 | 0+10D | 1 | Aṣvini | 6 | Ārdrā | Puṇarvasu |
| 16 | 172 | 10 | 10+8D | 11 | P.Phāl. | 16 | Viśākhā | Jyesthā |
| 17 | 182 | 20 | 20+6D | 21 | U.Āśadhā | 26 | P.Bhadra | Aṣvini |
| 18 | 192 | 3 | 3+4D | 4 | Rohiṇī | 9 | Aśleṣā | P.Phāl |
| 19 | 202 | 13 | 13+2D | 14 | Citrā | 24 | Mūlā | U.Āśadhā |

R̥k-JYOTIṢA, VERSE 15

*jāvādyam saih samam vidyūtpurvārdhe pūrvasūttare |
bhadanāmsāccaturdasī kāsṭhānāmdevinākalāḥ ||15||*

Holay's tr.: "Know that Jāvādi list (RVJ. 14 *jauadrāghaḥ*) is balanced. Former (letter) is for the lunar *nakṣatra* at the beginning of the first half-year; the latter is for the latter half. *Bhāmsās* and *bhādāna kalās* are to be adjusted at the ends of 14th *tithis* (for computing the exact number of days in solar years)". Holay has also added a note: "The last quarter of this verse is, *kāsṭhānamde vinākalāḥ*. The text is thousands of years old. This portion of the text is in the then current Sanskrit language. We can only guess and tell the meaning of this portion. It may be "the last *kalā* of the solar year (126th) leaves no fraction which can be measured in *kāsṭhās*"

Nakṣatra have been enumerated beginning with *Aśvini* at intervals of five and they represent a table that enables the ascertaining of the mean solar and lunar nakṣatra parts at the end of the *parvas* – results of verses 10-13 and this has been explained by TSK Sastry. Holay has given its other application as indicated in verse 15 and applying specifically the 19-year yuga.

It is important to note that:

1. Interpretation of Holay brings in no complex computation such as to work out the expired parts of *nakṣatra*. He has tried to give simple rules that bring out the parameters like *tithi* and *nakṣatra* of solstices and *parvas*, which were important in deciding the time of sacrifices.
2. It must be noted here that TSK Sastry had opted to place his commentary on *R̥k-Jyotiṣa* along with the verses and meaning from *Yajur-jyotiṣa*. In fact with the 5-year yuga assumption of earlier scholars it was impossible to interpret the *R̥k-Jyotiṣa* verses consistently despite the scores of emendations.
3. Most of the emendations were aimed at making the *R̥k-Jyotiṣa* verses give a meaning comparable to that of the *Yajur-jyotiṣa* verses.

RK-JYOTIṢA, VERSE 4

*nirekaṃ dvādas ārdh'ā bdam dviguṇam gatasamjñīkam |
ṣaṣṭhyā ṣaṣṭhyā yutam dvāvyām parvaṇām rāsīrucyate ||4||*

Here we have another verse that when correctly interpreted without altering the terms, brings out the 19-year cycle implicit in the calendar (*kalā vidhāna sāstram*) of Lagadha:

As deciphered by Holay, the meaning is (independent wording):

“Reduce one from the 12 *parvans* of every half year and add a carry over of 2- the groups of sixty *parvans* arising thus (successive addition of 11 and carry over 2) is known by the name *rāṣi* ”

Taken in conjunction with verse 23 which is a continuation and offers the rationale of the 4th verse:

*tadardham dinabhāgānām sadā parvaṇi parvaṇi |
ṛtuseṣam tu tadvidyāt samkyāya sahaparvaṇām ||23||*

“Each of those (11) *parvans* (that forms the *rāṣis*) constitutes the *ṛtuseṣa* at the rate of half-a-*tithi* (which totals of 11 *tithis* in a year)”.

Both these verses together facilitates the computation of the *tithi* of solstices as given in Table 7. Number of 12 *parvans* in a half-year reduced by one gave twice the number of *ṛtuseṣa* in *tithis*. As is evident from the Table 7 this could have been true only in the case of a 19-year yuga.

Interpretation (TSK Satry): In contrast to the above, TSK Sastry says that it is the formula to compute the total number of *parvas* elapsed. If the ordinal number of the year in the yuga is n , the *parva-rāṣi* = $[(n-1) * 12 + (m)] * 2 + p + 2$ where m is the number of months elapsed the n th year and p the remaining *parvan* if any. The number 2 indicates the intercalary *parvas* after 60 *parvas*. With such details as here employed in the formulae there was no need for the formula at all – a formula is necessary where there is a need for simplifying

Table 7

| 1 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------------------|-----------------------------------|---|--------------------|-------------------|----------|--------------------|
| Sl. No. of Half-year | 11 <i>parvan</i> per half-year | Balance from Previous yuga +Col.3 | =Col.4 (MOD 60) | Tithi= Col.5/2 | Solstice | Intercala- tion |
| 1 | | 2 | 2 | 1 | W | |
| 2 | 11 | 13 | 13 | 7 | S | |
| 3 | 22 | 24 | 24 | 13 | W | |
| 4 | 33 | 35 | 35 | 18 | S | |
| 5 | 44 | 46 | 46 | 24 | W | |
| 6 | 55 | 57 | 57 | 29 | S | I ₁ |
| 7 | 66 | 68 | 8 | 5 | W | |
| 8 | 77 | 79 | 19 | 10 | S | |
| 9 | 88 | 90 | 30 | 16 | W | |
| 10 | 99 | 101 | 41 | 21 | S | |
| 11 | 110 | 112 | 52 | 27 | W | |
| 12 | 121 | 123 | 3 | 2 | S | I ₂ |
| 13 | 132 | 134 | 14 | 8 | W | |
| 14 | 143 | 145 | 25 | 13 | S | |
| 15 | 154 | 156 | 36 | 19 | W | |
| 16 | 165 | 167 | 47 | 24 | S | |
| 17 | 176 | 178 | 58 | 30 | W | |
| 18 | 187 | 189 | 9 | 5 | S | I ₃ |
| 19 | 198 | 200 | 20 | 11 | W | |
| 20 | 209 | 211 | 31 | 16 | S | |
| 21 | 220 | 222 | 42 | 22 | W | |
| 22 | 231 | 233 | 53 | 27 | S | I ₄ |
| 23 | 242 | 244 | 4 | 3 | W | |
| 24 | 253 | 255 | 15 | 8 | S | |
| 25 | 264 | 266 | 26 | 14 | W | |
| 26 | 275 | 277 | 37 | 19 | S | |
| 27 | 286 | 288 | 48 | 25 | W | |
| 28 | 297 | 299 | 59 | 30 | S | I ₅ |
| 29 | 308 | 310 | 10 | 6 | W | |
| 30 | 319 | 321 | 21 | 11 | S | |
| 31 | 330 | 332 | 32 | 17 | W | |
| 32 | 341 | 343 | 43 | 22 | S | |
| 33 | 352 | 354 | 54 | 28 | W | |
| 34 | 363 | 365 | 5 | 3 | S | I ₆ |
| 35 | 374 | 376 | 16 | 9 | W | |
| 36 | 385 | 387 | 27 | 14 | S | |
| 37 | 396 | 398 | 38 | 20 | W | |
| 38 | 407 | 409 | 49 | 25 | S | I ₇ |
| 39 | 418 | 420 | 0 | 1 | | |

the computations – and it is crystal clear that here there was no complication at all in the computation of the total number of *parvas*. Why to take the ordinal number – subtract one – then multiply by 12 – then add the months – then add remaining *parvan* – add 2, it's really doubtful.

MEAN POSITION OF SUN & MOON (VERSES 10-13 & 21)

Lagadha defined the luni-solar orbit with reference to the leap year of 366 days consisting of 372 *tithis* (t) across the 27 *nakṣatras*. Each tithi got further divided into 9 units called *bhāṃsas* (which we shall denote in this paper by the letter b) so that each *nakṣatra* is expressed in terms of the integer units of lunar motion relative to Sun.

$$\begin{aligned} \text{Orbit} &= 372t = 3348b^\circ \\ 1 \text{ } nakṣatra \text{ (N)} &= 3348/27 = 124b^\circ \\ 1 \text{ } parva \text{ (p)} &= 15t = 135b^\circ = N + 11b^\circ \end{aligned}$$

Verse 10 depicts the practical application of the above orbit in defining the mean sun and moon. Up to 11 *parvas* we get Sun in b° as $11N + 121 b^\circ$ but for the expiry of 12p, we get $12N + 132 = 13N + 8 b^\circ$, when the Sun covers 12p, multiplication by 11 gives 8 *bhāṃsas* of the *nakṣatra* on which the solstice occurs – this is the main content of the verse 10. Import of the second half of the second line is: When the Moon is opposite Sun (for *parvas* ending in full moon as *parva* or half lunation means 13.5 *nakṣatras*) Moon covers half of solstice *nakṣatra* at the expiry of the *parva* or half *nakṣatra* needs to be added to the *bhāṃsa* of Sun to get Moon's *bhāṃsas* in the *nakṣatra* of solstice.

EXAMPLE:

1. Sun at the expiry of the 5th *parva* = 5N & 55 b°
Moon at the expiry of the 5th *parva* = 72N & 55 $b^\circ + 62 b^\circ$ i.e.,
18 *nakṣatras* and 117 *bhāṃsas* in Citra *nakṣatra*.
2. Sun at the expiry of the 125th *parva* = 125N & 1375 $b^\circ = 17N+11N$
+ 11 $b^\circ = 1N+11 b^\circ$

Moon at the expiry of the 125th parva = 1N & 11 b° + 13N + 62 b° = 14N + 73 b° i.e., 14 *nakṣatras* and 73 *bhāṃsas* or 73 b° in Maghā *nakṣatra*.

For the year of 1190 BC given earlier the 125th parva expires with the full moon on JD = 1288620.780653 (20.01.1185 BC, 1214PM IST).

Sun occupied the first *pāda* of Śatabhiṣak and Moon 3rd *pāda* of Maghā.

In the case of a 5-year cycle, the 2nd yuga begins (5th January 1185 BC) not at all on the solstice day and therefore any stipulation of solstice in terms of *tithi* or *nakṣatra* as interpreted by TSK Sastry has no relevance with a 5-year yuga.

New moon of 2nd yuga → Solstice Sun + 4°

New moon of 3rd yuga → Solstice Sun + 8°

It's apparent that the *parva* computations and the count of *nakṣatras* shall have no connection with the respective solstices and the computational zero point of *śraviṣṭhādi* of the first yuga. Unless there is the 19-year yuga after which the sun and moon returns to the initial point of computation, the computations of mean sun and moon in terms of *nakṣatras* and *bhāṃśas* shall be meaningless *nakṣatras* of 124 *bhāṃśas* cannot be defined relative to the new moons and in the case of five year yugas no consistent definition of solar or lunar orbit is possible from a fixed point on the ecliptic and new moon. The fact that the *Vedāṅga Jyotiṣa* verses declare the beginning of the yuga as coincident with new moon, winter solstic and *śraviṣṭhādi* alone denies the possibility of a 5-year yuga and in turn advocates a 19-year yuga.

ṚK-JYOTIṢA, VERSE 32

māghasūklapravṛttasya pauṣakṛṣṇasamāpinā |
yugasya pañcamasyeha kālajñānaṃ nibodhatā ||32||

“The fifth *saṃvatsara*-yuga begins with Māgha sūklapakṣa and ends with *pauṣakṛṣṇapakṣa* according to this calendar (of 19 years)”

Holay has given a right interpretation of the verse as given by Bhaṭṭotpala in relation to the 5th *saṃvatsara* yuga of 19-year cycle. TSK Sastry and others had to involve a number of emendations to make the verse fit with a five year cycle.

Sastry's emended the verses as:

māghasūkla prapannasya pauṣakṛṣṇa samāpinā |
yugasya pañcavarṣasya kālajñānām pracakṣate ||

The meaning derived speaks nothing except that the five year yuga begins with Māgha bright half and Pauṣa dark half – something that is well understood from the other verses and as such two lines out of 36 got wasted if we accept the emendations and meaning of TSK Sastry.

COMPUTATION OF EQUINOXES – CONCLUDING PART OF RK-JYOTIṢA

Rk-Jyotiṣa, verse 31

viṣuvaṃ tadguṇaṃ dvābhyām rūpahīnaṃ tu ṣaḍguṇaṃ |
yadlabdhaṃ tāni parvāṇi tadardhaṃ tithirbhavet ||31||

After examining the meanings given by both TSK Sastry and PV Holay, the correct meaning may be interpreted thus:

“One less than twice the ordinal number of the equinox multiplied by six gives the number of solar *parvans* and half of these *parvans* give the additional *tithis* for the equinox”.

Example: Considering the 10th equinox: $(10 \times 2-1) \times 6 = 114$: Additional *tithis* = $114/2 = 57 = 3 \text{ parvan} + 12$: So the equinox falls on the 12th *tithis* of the dark half of 118th *parva*. This computation may be verified from the Table 8(b) in which the cycle beginning with 1190 BC is depicted the 10th equinox of which the 4th October 1186 BC coincides with the 12th *tithi* of the dark half.

We have already seen the meaning of the verse 32, which says that the 19-year yuga ends with the *kṛṣṇapakṣa* of Pauṣa. By the above rule the *tithi* of the 38th equinox may be determined as $(38 \times 2-1) \times 6 = 450$: Additional *tithis* = $450/2 = 225 = 15 \text{ parva}$. It's obvious that the autumnal equinox of 1172BC coincided

with new moon and as such the winter solstice also must have coincided with new moon as autumn to winter was only 88.3 days in 12th century BC and around. Kārttika, Mārgaśīrṣa and Pauṣa thus filled up the interval between autumnal equinox and winter solstice. The computational method therefore applies of the 19-year yuga perfectly.

ṚK-JYOTIṢA, VERSE 33

trīyām navāmimcaiva paurṇamāsim trayodaśim |
śaṣṭim ca viṣuvam prokto dvadaśyām ca samam bhavet ||

S. B. Dikshit has translated the verse as: “The equinox occurs on the 3rd, 9th, 15th, 6th and 12th *tithis* (and again on these very *tithis* in the same order)”

TSK Sastry says: “The *Viṣuva* is declared to occur in the bright fortnight at the end of the *tithis* -- *trīya*, *navamī*, full moon and in the dark fortnight at *śaṣṭhī* and *dvadaśī*. This is repeated once again”.

Holay has interpreted the verse as of similar in meaning to verse 8, i.e., the *tithis* represent the lower limit of the five groups of six *tithis* at the vernal equinox that leads to the same classification of years into five types.

Table 8a

| Sl.No. | Name of year | Tithi limits as per Verse | Tithi limits of V. Equinox |
|--------|--------------------|---------------------------|--------------------------------|
| 1 | <i>Samvatsara</i> | S (3) to S (8) | Jyeṣṭhā S (3) to S (8) |
| 2 | <i>Anuvatsara</i> | S (9) to S (14) | Jyeṣṭhā S (9) to S (14) |
| 3 | <i>Parivatsara</i> | S (15) to K (5) | Jyeṣṭhā S (15) to K (5) |
| 4 | <i>Idvatsara</i> | K (6) to K (11) | Jyeṣṭhā K (6) to K (11) |
| 5 | <i>Idāvatsara</i> | K (12) to S (2) | Jyeṣṭhā K (12) to Āṣāḍha S (2) |

Table 8b

| Sl. | Date | V. Equinox | Classification | Date | A. Equinox |
|-----|---------------|------------|--------------------|---------------|------------|
| 1 | 01.04.1190 BC | S(3) | <i>Samvatsara</i> | 04.10.1190 BC | S(12) |
| 2 | 01.04.1189 BC | S(14) | <i>Anuvatsara</i> | 04.10.1189 BC | K(9) |
| 3 | 01.04.1188 BC | K(9) | <i>Idvatsara</i> | 04.10.1188 BC | S(4) |
| 4 | 01.04.1187 BC | S(6) | <i>Samvatsara</i> | 04.10.1187 BC | S(15) |
| 5 | 01.04.1186 BC | K(2) | <i>Parivatsara</i> | 04.10.1186 BC | K(12) |

The above date renders validity for the technical meaning ascribed by Holay to the year names and the mechanism of calendar – *saṃvatsara* cycles forming 19 years.

ṚK-JYOTIṢA, VERSE 34

*caturdaśīmupavasathastathā bhaved yathodito dinamupaiti candramāh|
māghasūklanikoyukte śraviṣṭhāyāṃ ca vārṣ ikim ||34||*

For this verse TSK Sastry gives the meaning: “The *caturdaśī tithi* on which the moon rises just after the Sun has risen ...”

This is not correct. Actually the reference is to the observation of Moon rising before the sunrise on K (14) during which day the Sun and Moon can be assumed to be together (new moon) and the next day the bright fortnight and yuga begins with Sun and Moon on *Śraviṣṭhā*.

As we have noted earlier the verse rejects the possibility of 5-year yuga as the Sun and Moon cannot return to the above sidereal positions at the expiry of five years and thus any such observational criteria to ascertain the beginning of yuga was meaningless.

ṚK-JYOTIṢA, VERSE 19

*śraviṣṭhābhyāṃ guṇābhyasthān prāgvilagnān vinirdiśet|
sūryanmāsān śalabhyasthān vidyāccandramansān ṛtūn ||19||*

Interpretation:

“Using the rising of *Śraviṣṭhā* in the yuga (viz., 1835) which are also the number of its Orient Ecliptic points (*prāg-lagna*), and multiplying it by the number in the group (here, of asterisms, viz. 27), we get the total number of *lagnas* in the yuga (viz. 1835 x 27 = 49,545). Multiplying the sidereal revolutions of the Moon in the yuga by 6, we get the total number of lunar

rtus (viz. $67 \times 6 = 402$). [Considering the mandatory verb in the first half of the verse, one can translate it also as “Using the distance of *Śraviṣṭhā* from the rising point (i.e. its hour angle), and multiplying it by 27, we get the *lagna*, in asterisms and parts).] (R-Vj 19)” – TSK Sastry⁶

In what is presented in the 36 verses as the *kālavidhāna śāstra* of Lagadha – Lagadha’s science of ascertaining time or the Science of Calendar – all that has been mentioned above by TSK Sastry has little relevance.

What is the use of “the total number of *lagnas* in Yuga” computed as $1835 \times 27 = 49545$? What is the meaning of lunar *rtu* ?

In what way are the above two factors useful in deciding the time of sacrifice? *Lagna* had no relevance as the sacrificial calendar depended on *muhūrtas*, which had an independent definition. How could they have reconciled between the 30 *muhūrtas* of a day and 27 *lagnas* of a day for their auspiciousness/inauspiciousness? *Lagna* of many stars like *Mūla* whose deity in *nirṛti* would have been taken as inauspicious and at the same time the *muhūrta* of the day must have been good – in fact no Vedic text speaks of any alternate consideration of *lagna* instead of *muhūrta*. Further, in the above rendering, the parameters like 27 have been brought in by emendations made for the specific purpose. *Guṇa* has been changed to *Gaṇa* and a meaning of 27 has been imposed to serve the computation of *lagna* imagined.

On the contrary, *Ṛk-Jyotiṣa*, verse 19 however as interpreted by Holay runs, “If we break the (chain of) *nakṣatras*, (a *nakṣatra*) before *Śraviṣṭhā* and repeat (jāvādi) multiplications, we observe a *ṛtuseṣa* in lunar *nakṣatra* at the intervals of six solar months”

Even though there can be criticism of the wordings employed by Holay the explanation is more logical and scientific when examined in relation to other verses the meaning of which we have already verified by the appropriate astronomical data. In the words of Holay: “The text is thousands of years old.

This portion of the text is in the then current Sanskrit language. We can only guess and tell the meaning...”.

ANTIQUITY OF THE 19-YEAR YUGA

*svarākameke somārkau yadā sārkāḥ savāsavaḥ |
syāttadādi yugaṁmāghaḥ tapah śuklodinaṁ tyajah ||5||*

Rk-Jyotiṣa, verse 5

As amended and interpreted by Holay, the verse means: “Yuga and the month of *tapah* begin when the Sun and Moon are on either side of the sky at the end of *śuklapakṣa* when the Sun has covered *Śraviṣṭhā*”.

This verse in fact suggests a *pūrṇimānta* system of reckoning when the winter solstice coincided with Māgha S (15) – the full moon on Regulus with Sun at the east end of *Śraviṣṭhā*. To cite a specific epoch: UT 2424 BC January 08, 11:03.JD =836064.96042, Sunday: On the evening of 7th January at the Indian longitude of Ujjain, Moon rose in rapt conjunction with Regulus and marked the beginning of the yuga next day, *kṛṣṇa* 1. The *Śraviṣṭhādi amānta* calendar on the other hand represents an epoch such as BC 1448 (January 01) – 1000 years later.

It is apparent therefore that the 19-year yuga and calendar of Lagadha had prevailed with the Vedic civilization for millenniums with appropriate correction in the matter of year beginning to account for the changes caused by precession.

CONCLUDING REMARKS

When contrasted against the background of more than a hundred years of variant interpretations and emendations, it is quite natural that an entirely new interpretation may arise especially on the following aspects:

1. There is no mention of a 19-year cycle in *Vedāṅga Jyotiṣa*. It is to note here that Holay has brought in the 19-year cycle with a technical interpretation of the verses beginning with 1, 8 etc. which were not yielding an astronomically correct interpretation earlier. Proposed cycles of 15, 30 and 95 years by other scholars are based on external references and not by any indication from the *Ṛk-Jyotiṣa*.
2. There's no classification of years in the *Ṛk-Jyotiṣa* verses. Holay gave the classification of years, which in turn enabled him to correctly interpret the verse “*pāñcasamvatsaramayam yugādhyakṣam*” with the right technical meaning of ‘*Samvatsara*’. Mechanism of *samvatsara* year’ cycle introduced by Holay served to gain a new consistency among the verses without emendations. Holay contradicts neither any verse nor any astronomical implications of the verses of *Ṛk-Jyotiṣa*.
3. We must note that Holay has shown the verses to be consistent with a 19-year yuga, and years of 371 *tithis* and 3339 *bhāṃśas*. Whether 5 years, 372 *tithis*, 3348 *bhāṃśas* were a better choice is ably answered by the astronomical phenomena in favour of Holay's scheme.
4. It may be concluded that the 19-year calendar, known at present as Metonic cycle and considered to have originated in Greek around 400 BC, was known among Vedic Indians almost two millenniums before when the winter solstice coincided Māgha *purnamī* and the new year as per *pūrnimānta* reckoning was from Magha-*kṛṣṇa* (16).

REFERENCES

1. Holay, P. V., *Vedic Astronomy*, Shri Babasaheb Apte Smarak Samitee, Nagpur, 1994
2. Dikshit, S. B., *Bharatīya Jyotiḥśāstra*, Vol. 1, Controller of Publications, Civil Lines, New Delhi.
3. Sastry, TSK, *Vedāṅga Jyotiṣa* of Lagadha, *IJHS*, 19.3 (1984), 19.4 (1984), 33-74
4. *Dviguṇam* has been emended as *prathamam* by all scholars except Holay. The right interpretation of the verse given by Holay is valid irrespective of the validity of the term *dviguṇam*
5. Sastry, TSK, *Vedāṅga Jyotiṣa* of Lagadha, With the translation and notes of TSK Sastry, Critically edited by KV Sarma, Supplement Part-II, *IJHS*, 19.4 (1984) 46.
6. *Ibid*, p.42.