# [Title] Manual

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## [Section] Introduction

There were **two forms of epoch in the Indian canons**, one located in midnight (*ardharātrika*) and the other 6 hours later (*audayika*), both for 18 February 3102 B.C. The three canons that are used by HIC differ in these regards. For comparative purposes we therefore recalculate the *ardharātrika* (Sūryasiddhānta) canon to the *audayika* system.

An Indian **solar month** starts when the sun enters a zodiacal sign, *rāśi*, i.e. has a longitude that is a multiple of 30˚. The mean months have all the same length, 1/12 of the sidereal year. Because the true sun has a non-uniform motion in the zodiac, the true months have unequal lengths, varying roughly between 31.6 and 29.3 days. The solar day is counted from sunrise to sunrise.

The numbers generated by the application are very precise because of the arithmetic involved (see the Examples below) in contrast to the data of inscriptions which is almost always vague. The application's results might therefore appear to be imputing an undue accuracy to the originals. Consider though, that if item A is at X, item B at Y and item C at Z *all at the same time* in a text, they could not be in their declared positions unless the original calculations were close to those that the application returns.

A **lunar month** starts when the moon has the same longitude as the sun. The mean lunar month has a length of about 29.53 days. The length of the true lunar month varies around this value; it is normally shorter but can occasionally be longer than a true solar month. The name of a lunar month (Caitra, Vaiśākha, etc.) is determined by the *nakṣatra* the moon normally occupies at full moon.

Caution may be needed here because there are "solar" months that nonetheless bear the same names as the lunar months. Thus, in our application's default year (KY 4600 **/** Śaka 1421 in the Sūryasiddhānta Old canon), the readout shows the sun entering Taurus (Vr̥ṣabha) at 39'45" on April 27. Since this is after sunset, *solar* Jyeṣṭha will begin at sunrise on the following day, 28 April, whereas *lunar* Jyeṣṭha begins on 11 May. Had the sun changed sign before sunset, solar Jyeṣṭha would have begun at sunrise on the same day. (There are other rules used, but this seems to be the prevalent one.)

There is no convincing evidence that Southeast Asia reckoned by "solar" months. Instead, their function is to provide a check on whether or not a lunar month requires to be doubled or suppressed, as follows:

Kaliyuga 4598 | Vikrama 1554 | Śaka 1419 | Western AD 1497

True / Mean — Julian / Gregorian — Sexagesimal / Decimal

| | | | | | |
|---|---|---|---|---|---|
| Meṣa (0) | 1497 Mar 27 | 14'32'' | VAIŚĀKHA | Apr 2 | 48'27'' |
| Vṛṣabha (1) | 1497 Apr 27 | 8'42'' | JYEṢṬHA | May 2 | 22'32'' |
| Mithuna (2) | 1497 May 28 | 33'23'' | ĀṢĀḌHA | May 31 | 49'50'' |
| Karka (3) | 1497 Jun 29 | 12'19'' | ADHIKA ŚRAVAṆA | Jun 30 | 12'12'' |
| Siṁha (4) | 1497 Jul 30 | 43'58'' | NIJA ŚRAVAṆA | Jul 29 | 31'59'' |
| Kanyā (5) | 1497 Aug 30 | 49'32'' | BHĀDRAPADA | Aug 27 | 51'30'' |

Here the sun enters Leo (Siṁha) on July 30, but there is a new moon on July 29 after the one on June 30. At this second new moon the sun is still in Cancer (Karka), and the lunar month therefore becomes Nija Śravaṇa instead of moving on. The "extra" one comes first in Indian convention.

Since a true lunar month can occasionally be longer than a true solar month (about twice a century), the reverse then happens, and the corresponding lunar month will be expunged (*kṣaya*).

1/30 of a lunar month is a **lunar day or *tithi***. The mean *tithi* is slightly shorter than a solar day, while the true *tithi* can be either longer or shorter than a solar day.

In theory the *tithi* determining a calendar day is the one that is current at sunrise. Thus, it can happen that a certain *tithi* starts after sunrise and ends before the next sunrise. That *tithi* will then be expunged (*kṣaya*). On the other hand, a true *tithi* may be current on two consecutive days and these two days will have the same *tithi*, making it *adhika*. The *tithi* essentially represents a way of counting the interval between the longitudes of the moon and the sun. While the "sunrise" rule is often stated by the pundits to determine the calendars' numerical day, it is sometimes the case that a *tithi* which begins after sunrise will be chosen, because operative at the time of a particular event or ceremony. A *tithi* is divided into two *karaṇa*s of equal length. A table of the correspondence between *tithi*s and *karaṇa*s is given among the Tables.

The business of ***tithi*s versus civil days** often requires attention. In the early Cambodian record (until SurS reckoning was replaced by f.638 reckoning) and in the Campā record, for instance, it is impossible to say whether *tithi* or civil reckoning was the norm. There will be a time in almost every month when the *tithi* and the civil days are at odds, as is readily seen by comparing the numbers in the top row and in the bottom left of the day boxes in the Month window.

| | |
|---|---|
| 24 | 25 |
| Sep 16 | Sep 17 |
| 25 8 20 | 26 9 21 |

The commonest form of difference between a record's data and a computer return for the date will be a one-day difference, usually in the form "3 waxing, Tuesday" when 3 waxing will be returned as a Wednesday, both as regards the *tithi* and the civil day;

there is some consistency in the form of this discrepancy.

Another problem comes with how the “day” is measured. When working out planetary position for the purposes of verifying an inscription’s data editors have generally used intervals from sunrise, not time from 6 a.m. The “time” in the sources is usually measured by the distance between the degree of the zodiac occupied by the sun and the *lagna*, the degree of the zodiac on the eastern horizon (or the start of the sign). That value is then converted by editors to a “clock” time or interval by allowing 4 minutes to one degree. It is supposed in some studies that every sign rises in two hours, but this is not true even at the equator. Difference in geographic latitude creates a difference in Oblique Ascension, the amount of the celestial equator that rises with the thirty degrees of a sign.

There is occasional mention in the sources of time by a **water clock**, but no indication whether the size of the container or the rate of flow was seasonally adjusted. The *Sūryasiddhānta* says that the hole of the bowl has to be of a size to cause the bowl to sink in 1 *ghaṭikā* (60 to a day and night) and we have heard it said that the Burmese varied the size of the bowl with the time of the year. (A source for this would be very gratefully received.)

The ***nakṣatra***, as indicated, is essentially a way of representing the moon’s longitude. The Moon’s sidereal period is about 27 days. Each *nakṣatra* covers 1/27 of 360˚ or 13˚20' and starts as the moon enters one of these partitions. It is common to find the word rendered as “asterism” or “constellation” but these misnomers arise because the partitions take their names from prominent star clusters nearby. The plane of the *nakṣatra* belt lies on the ecliptic, meaning that the moon is treated as not having latitude. “Lunar mansion” is a less unsatisfactory rendition of the term if one is needed.

The ***yoga*** represents the sum of the longitudes of the sun and the moon and follows the same rules as *tithi*s and *nakṣatra*s, sometimes being doubled or expunged. As with the *nakṣatra*, the *yoga* longitude is divided in 27 equal partitions. Note here the inbuilt check in which this element is merely the sum of two other elements.

The *tithi*, *nakṣatra*, and *yoga* are not independent. Denoting *tithi* by $t$, *nakṣatra* by $n$, and *yoga* by $y$, and the longitudes of the sun and moon by $\lambda_S$ and $\lambda_M$, respectively, we have the following relations

$$t = \lambda_M - \lambda_S$$
$$n = \lambda_M$$
$$y = \lambda_S + \lambda_M$$

from which we easily derive relations like

$$t + y = 2n$$
$$\lambda_S = n - t = (y - t)/2$$

which are useful when checking the internal consistency of a document.

The solar year starts when the sun enters the first sign of the zodiac. The lunar year starts in many systems with the lunar month (Caitra) in which the sun has longitude 0˚. In some parts of India, however, the year starts with the lunar month Kārttika. Further, sometimes the lunar months start at full moon instead of at new moon. The HIC application uses *caitrādi* and New Moon reckoning, not least because these two were the prevailing, if not the sole, methods in Southeast Asia.

The HIC application implements calendars based on **three famous Indian astronomical canons**:

1) The Sūryasiddhānta described by Varāhamihira and Brahmagupta. The canon dates from about AD 500.
2) The Āryabhaṭīya by Āryabhaṭa dating from about the same time
3) The modern Sūryasiddhānta from about AD 1000–1200 described in great detail by E. Burgess (we refer to the 1935 edition of his work)

## [Section] Handling the application

The default **canon** is Sūryasiddhānta (Old). At the top of the main window are Kaliyuga, Vikrama, Śaka and Western years. The first three modes differ only in their zero point and use completed years, i.e. the first year is year 0, the next 1 ... This is in contrast to normal Western reckoning where the first year is year 1, i.e. current year reckoning.

Some Indian documents use current years, but there is no clear evidence that Southeast Asia used other than years completed.

The Kaliyuga, Vikrama and Śaka years can be set in the respective text slots. These years can also be stepped up or down by one year by using the arrow up/down keys in the interface.

To the right of the year panels are pairs of radio buttons enabling the user to switch

1) between True and Mean reckoning,
2) between using Julian or Gregorian for the Western calendar and
3) between Sexagesimal and Decimal read-out for the times.

Mean and True describe stages in the calculation process: first (Mean) position as determined by positing an even and average rate of progress, and then actual (True) calculated position by applying a table or formula of correction.

On the left hand of this window are the solar months and the date and time of their start, counted from mean sunrise (6 a.m.). The times are (for the sexagesimal mode) given in *ghaṭikā*s and *pala*s, a *ghaṭikā* (as stated above) being 1/60 of the time from sunrise to sunrise and a *pala* being 1/60 of a *ghaṭikā*.

In the middle are the lunar months with corresponding starting dates and times. The text of the bottom Caitra month is in red to indicate that this month belongs to the year following. This arrangement is necessary because by convention solar Meṣa pairs with lunar Vaiśākha. Clicking on Caitra will cause the appropriate year number to increase by 1.

Information on Jupiter years is displayed at the bottom of the window.

Clicking the name of the lunar month accesses its details by bringing up the **Month window** where the arrangement of the days of the month is displayed. Each day square has a sequential number at the top; the middle line shows the Western date; the bottom line displays the *tithi*, *nakṣatra* and *yoga* in force at the sunrise of the given calendar day. Further information of a given day can be obtained by clicking a day square. This brings up the Day window.

In the lower half we have the lunar date and the Western date. The number to the left and below is the number of completed days in the Kaliyuga epoch, its *ahargaṇa*. To the right are the cyclic names of the day used on Java and Bali. The next line indicates the longitude that the user has set. It will also give the time difference from Ujjain (the Hindu Greenwich) or if that option has been used in the Settings, a note that the longitude difference is included in the calculations.

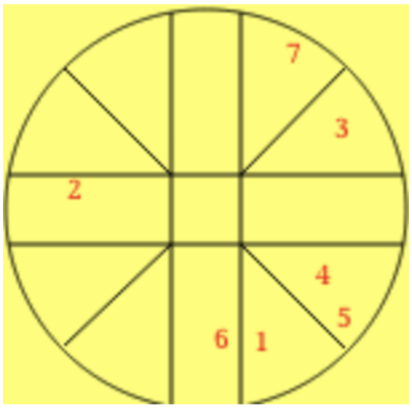
In the top half of the **Day window**, the *tithi*s, *nakṣatra*s and *yoga*s are displayed graphically and numerically. Night and day are represented by respectively white and grey strips. The red part of the base line represents the time interval from mean sunrise to sunrise (from 6 a.m. to 6 a.m.).

The top line shows the two *karaṇa*s of the current *tithi* and the time overlap between current *tithi*, *nakṣatra* and *yoga* for the given *karaṇa*.

Ticking the Search Wuku button will bring up a search tool for Indonesian 5, 6, and 7-day cyclic day combination. See Wuku Search.

Ticking the Planets button brings up the **Planets window** displaying the *true* longitudes of the planets at 6 a.m. at Ujjain or the location optionally chosen in Settings. The window also displays a schematic picture of the zodiac with its twelve 30˚ partitions, 0–30˚ being at the top, the others following in the anti-clockwise direction. The digits 1–7 in the circle indicate the location of the corresponding planets.

**Planets**




| | | |
|---|---|---|
| Sun | (1) | 7:14:58 |
| Moon | (2) | 3:02:53 |
| Mars | (3) | 10:13:23 |
| Mercury | (4) | 8:05:39 |
| Jupiter | (5) | 8:06:53 |
| Venus | (6) | 6:01:54 |
| Saturn | (7) | 11:22:41 |

Ticking the Time button brings up the **Time window**. The Time window computes the longitudes of the sun, the moon and the *lagna* (the rising sign) as well as intermediate values for the *tithi*, *nakṣatra* and *yoga*.

There are two sliders, for the *ghaṭikā*s and the *pala*s. These set the required times of day. The values are from true sunrise to true sunrise, as opposed to the Day window, which runs from 6 a.m. to 6 a.m.

The numbering in the Time window of the zodiacal signs, *nakṣatra*s, *tithi*s, and *yoga*s may at first sight appear to be inconsistent, but the convention is that a value, say, of 7:30 specifies thirty parts into number 8 of the element involved, with number 7 complete. For the longitudes (upper row) the format is sign:degree:minute.

By ticking these buttons a second time the respective window will close again.

The Time readout will automatically adapt to the True/Mean setting in the main window in order to conform with the Day window. The sliders can be operated either by clicking or dragging. The time set by the sliders is displayed as hours and minutes after true sunrise to the right, just above the upper slider. This can be used for converting between ghaṭikās:palas and hours:minutes.

## [Section] The Menus

At the top right of the screen there are three menus: Settings, Tables and About.

The menu **Settings** allows you to specify six parameters for the computation.

1. The item **Canons** makes it possible to switch between Sūryasiddhānta (old), Sūryasiddhānta and Āryasiddhānta.
2. The inclusion of the **correction for longitude difference** can be switched on or off.
3. The preferred year readout can be set according to three **eras**, Kaliyuga, Virama or Śaka.
4. The breakpoint year can be set after which the ***bīja*** (a correction to the movement of the lunar apogee and the longitudes of several of the planets introduced about KY 4500) should be applied. For Kaliyuga years occurring after the *bīja* breakpoint in the *Sūryasiddhānta* canon, a correction is applied to the mean motion of the planets and to the motion of the lunar apogee.
5. The preferred reckoning for the **Jupiter year** (Northern/Southern) can be set.
6. Under **Location**, the user can set the latitude and the longitude of a given document. The latitude setting will affect true sunrise, the longitude setting will give an overall shift of all times which can have an effect on the *tithi*s, *nakṣatra*s and yogas current at the given location, and hence vary the astrological significance of the configuration.

Clicking the Set button will save the settings, which will then be used until changed. The other button allows the restoring default settings, which are as follows:

| | |
|---|---|
| Canon | Sūryasiddhānta. |

| | |
|---|---|
| Longitude correction | On |
| Era | Śaka |
| Apply bīja from KY | 4500 |
| Jupiter Years | Northern |
| Location | 23.2 N, 75.8 E (i.e. Ujjain) |

The **Tables** menu gives access to tables of the names of *tithi*s, *karaṇa*s, *nakṣatra*s, *yoga*s and Jupiter years.

Finally, the **About** menu brings up a window stating the Java and Javascript version history and a copyright note, and gives access to this manual.

## [Section] Examples

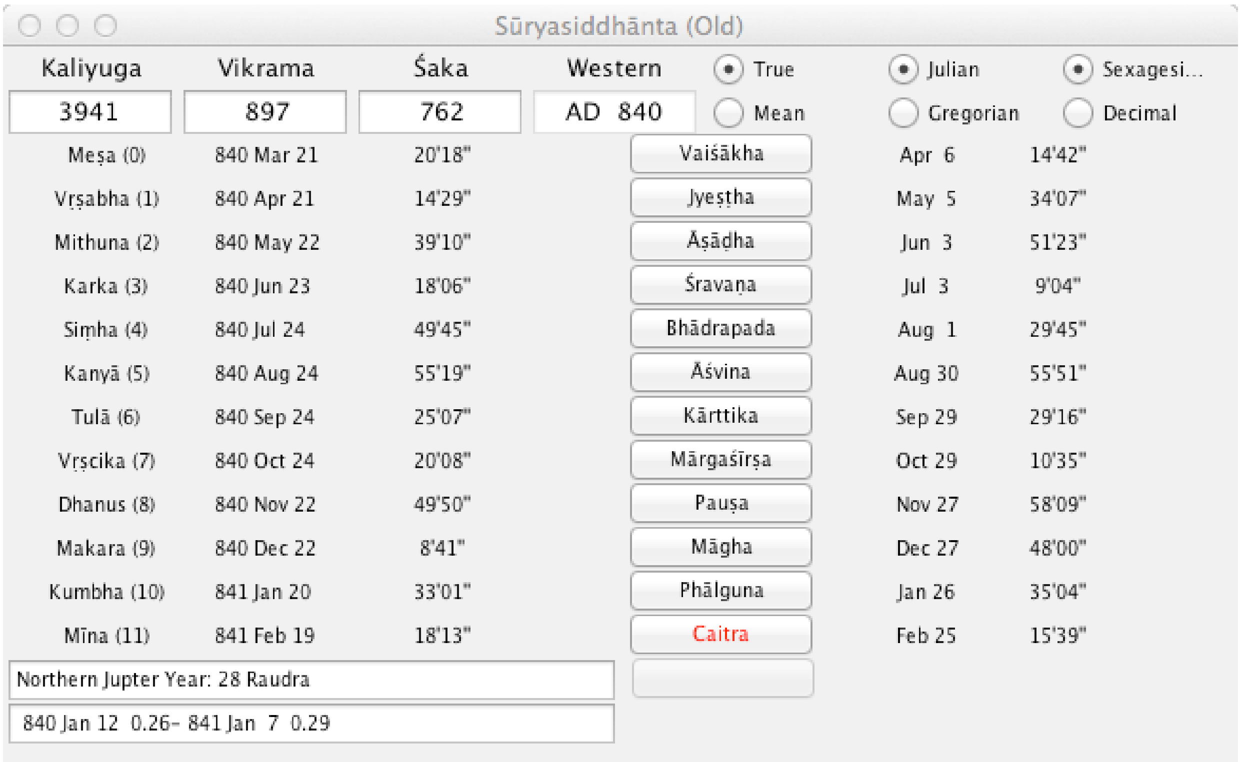
### [Subsection] 1

We try to replicate the data in the Javanese inscription, A12, in Louis-Charles Damais' study (*Bulletin de l'Ecole française d'Extrême-Orient*, 47.19):

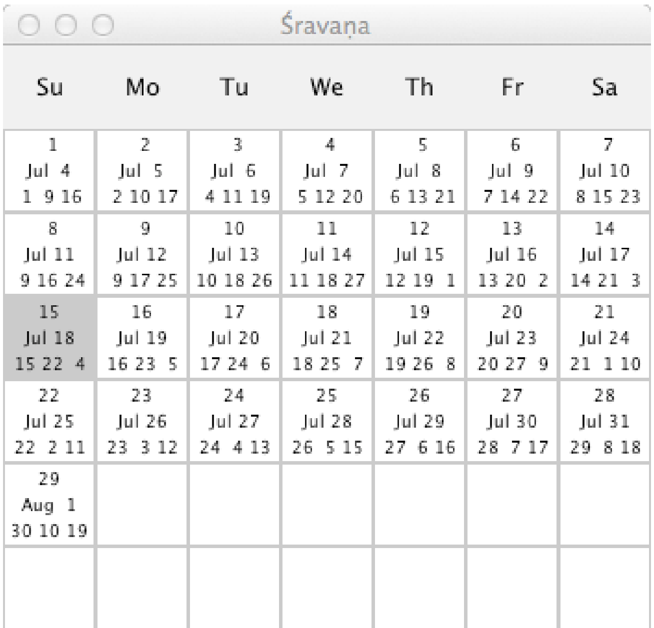
> 762 śrawaṇamāsa tīthi pañcadaśī śuklapakṣa ma po ra wāra manahil grahacāra neritistha daniṣṭanakṣatra piwāsyādewatā mahendramaṇḍala śobhāgaṇayoga balawakarāṇa śaśiparwwoṣa bagomūhūrttā kumbaraśi.

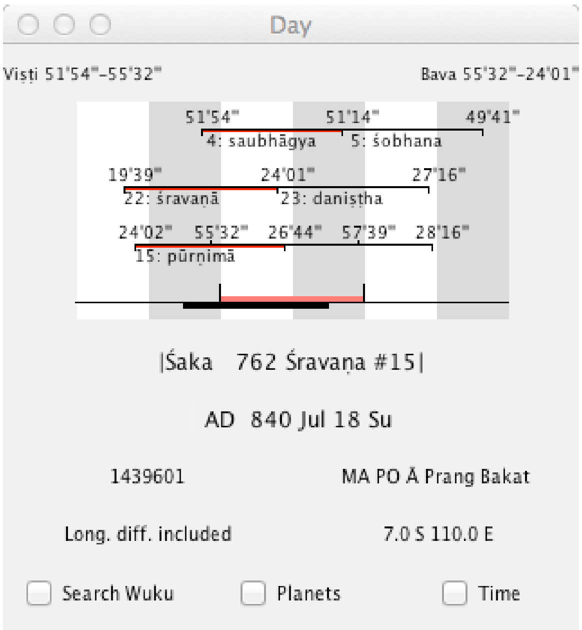
We assume SurS(Old)/True (defaults) and set latitude to 7˚ S, and longitude 110˚ E. in the **Options**/**Locations** dialog.

The first items of the inscription tell us that the target is Śaka 762 Śravaṇa 15. We edit the Śaka year slot in the main window to read 762 and set it by ENTER or Carriage Return.




We then click the month Śravaṇa and finally day #15 in the Month window.




Now we match the information in the Day window with the

inscription: (1) Śaka 762 = AD 840,

(2) śrawaṇamāsa tīthi pañcadaśī = Śravaṇa 15 = July 18 Sunday,

(3) ma po ra wāra manahil, the last item is wrong, should be Prang Bakat.

For Manahil the 6-5-7 combination is ma-po-so, number 23 in sequence, not 24.

(4) daniṣṭanakṣatra is an alternative name for śravistha, which comes into effect at 24'01" (ghaṭikas:palas).

(5) śobhāgaṇayoga looks like a hybrid of 4: saubhāgya and 5: śobhana,

more can be determined about this anomaly by bringing item 7 into play.

(6) balawakaraṇa is number 16:1 vālava, and another indication that the time of the inscription is not the start of the day.

The readings at the top of the day window are Viṣṭi 51'54" to 55'32", i.e. the start of yoga 4: saubhāgya to the end of the karaṇa; and bava 55'32" to 24'01", i.e. the start of the karaṇa to the end of nakṣatra 22.

Karaṇa 16.1 vālava lies by definition in the next tithi, so the intended time must be at least after 24' and may or may not be before 51'14"when yoga 5: śobhana starts.

(7) kumbarāśi, this is the *lagna*, the time in the day when in this case Aquarius comes to the eastern horizon. Using the sliders in the Time window one would find that lagna rāśi 10: kumbha, begins at 30'11" and is completed by 35'21" (Operate the sliders until the top right, lagna, value in the Time window passes from 10:00 to 11:00.) This indicates that, if the data is consistent, 5: śobhana is not intended, since the time of the specified lagna is complete before the time of śobhana begins.

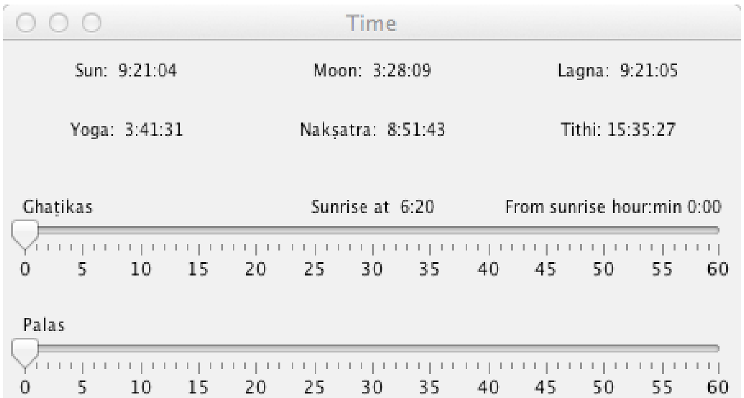
(8) bagomūhūrta, one of the times of day (15 to the day and 15 to the night). According to standard lists bhaga is the last muhurta of day at 28'-30'. (=17:12hrs to 18hrs).

Checking these elements and their integration with one another the user will find there is an acceptable amount of agreement. Small differences might be put down to minor variations in calculation; with major ones the constraints imposed by all the elements needing to be *simultaneously* valid the Application will indicate what is in error. (Many of the yogas in this Corpus do not fall as expected even when the positions of the sun and moon clearly indicate what the yoga value should be.)

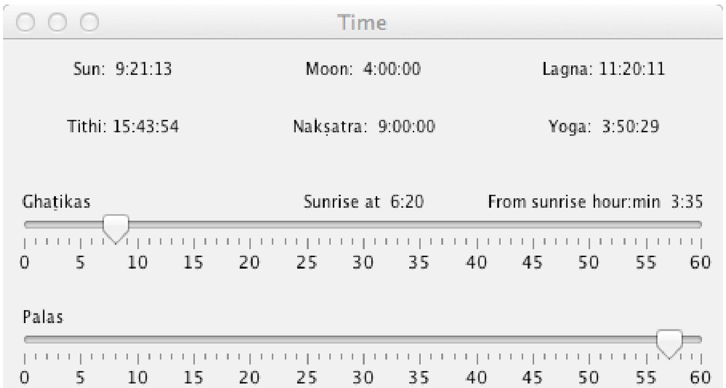
## [Subsection] 2

Suppose the **Location** has been set to 13 N, 103 E and the date to 16 Māgha śaka 678 (1 waning, ＝11 Jan AD 757). We use the SurS(Old) canon.

The Day window will then show for nakṣatra 10: Māgha a time of 9'52", but the Time window (with its sliders zeroed) will then read a nakṣatra of 8:51:43, the nakṣatra being still in 9: Āśleṣā at true sunrise.




To obtain 9:00:00 as the value for the nakṣatra in the Time window, it will be necessary to move the two sliders to 8 ghaṭikas and to 57 palas (3 hours 35 minutes), generating a difference from the Day window's value of 0'55'' (9'52'' minus 8'57'').

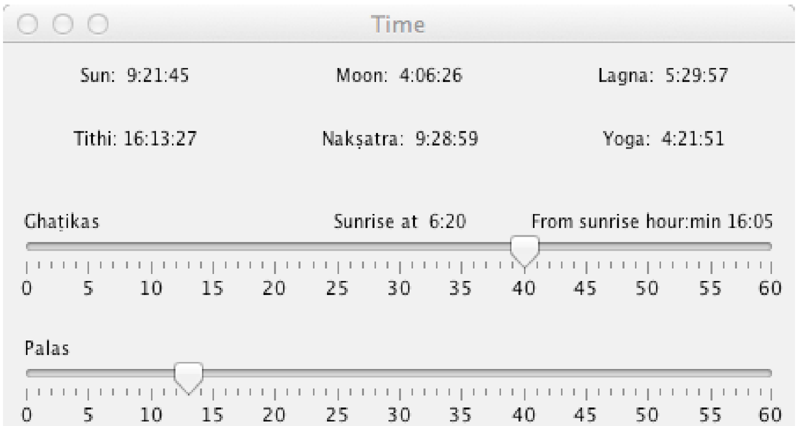



Setting the sliders to 0'55'' shows that this time difference corresponds to 22 minutes.

This difference in the values is between an interval based on sunrise and an interval based on 6 a.m. (for *audayika* reckoning); and since the time of year is January, sunrise will obviously be after 6 a.m., from which it follows that the smaller interval (8'57'') is the one from true sunrise and the larger interval (9'52'') is the one reaching back further, to 6 a.m. The difference between the two intervals of course itself indicates that on this day, by calculation, sunrise was at 0'55'' = 6:22 a.m.

The planets move too slowly to require tabulating in the Time window (fine adjustment for the planets can be made, at need, by interpolating in the values given by the Planets window for two successive days), but for the moon, moving at 13 degrees a day, and with the nakṣatra and the lagna being the two important elements in the fixing of ceremonial time, it is useful to be able to modify the relevant times and locations by means of the sliders.

The slider device is also useful, inter alia, for finding a position for the moon when the lagna is set to the start of a *rāśi*, (a multiple of 30°). Suppose it is required to know which nakṣatra the moon was in when the lagna entered Libra (6 signs 0). When the sliders are set to read 5:29:57 for the lagna, the time will be 40'13", the nakṣatra will read 9:28:59 (10: Māgha).




To check that against the moon's longitude, be aware that 9:28:59 means 28:59 parts of 60 into nakṣatra 10, therefore you multiply 9:28:59 (9.484056) by 13°20' to get 4s 06°26', the moon's value in the window.

Be aware, too, that redundancy in the information is not a detriment: the point indicated by the Indonesian example is that all the data in an inscription has to be *simultaneously* valid, so the more elements that hold good by individual inspection, the better.

## [Section] Technical Appendix

The mean motion of the sun in Indian astronomy is given in terms of the number of days used for 4 320 000 sidereal revolutions of the sun (a *mahāyuga*). The mean motion of the moon and the moon's apogee are in the same way given as revolutions in a mahāyuga. The table gives the number of days in a mahāyuga for the three canons.

| | *Mahayuga(days)* |
|---|---|
| *SurS(Old)* | 1577917800 |
| *SurS* | 1577917828 |
| *Arya* | 1577917500 |

The moon makes 57 753 336 revolutions in a mahāyuga in all the canons. The moon's apogee makes 488 219 revolutions in SurS(Old) and Arya, and 488

203 in SurS. The latter value was corrected (bija) to 488 199 around KY 4500 (AD 1400).

The epoch of all the canons is Thursday 18 February 3102 BC, the start of the Kaliyuga era. For SurS(Old) and SurS the epoch starts at midnight, for Arya at mean sunrise. At the Kaliyuga epoch the sun, moon and the other planets all have mean zero longitude and the moon's apogee has longitude 90˚.

The number of revolutions in a mahāyuga is given for the different canons in the following table:

| *Planet* | *SurS(Old)* | *Arya* | *SurS* | *SurSwithbija* |
|---|---|---|---|---|
| *Sun* | 4320000 | 4320000 | 4320000 | 4320000 |
| *Mercury* | 17937000 | 17937020 | 17937060 | 17937044 |
| *Venus* | 7022388 | 7022388 | 7022376 | 7022364 |
| *Mars* | 2296824 | 2296824 | 2296832 | 2296832 |
| *Jupiter* | 364220 | 364224 | 364220 | 364212 |
| *Saturn* | 146564 | 146564 | 146568 | 146580 |

For SurS(Old) and Arya the longitudes of the sun's apogee and the other planets except the moon is fixed. For SurS the value for the sun at epoch is 77˚ 7' 48" and its apogee makes 387 revolutions in 1000 mahāyugas. In SurS also the apogees of the planets are moving very slowly. For the calculation of the true longitudes of the planets we have used the following values for the apogee positions, the SurS values for epoch KY 4500.

| *Planet* | *SurS(Old)* | *Arya* | *SurS* |
|---|---|---|---|
| *Sun* | 80 | 78 | 77.28 |
| *Mercury* | 220 | 210 | 220.45 |
| *Venus* | 80 | 90 | 79.85 |
| *Mars* | 110 | 118 | 130.04 |
| *Jupiter* | 160 | 180 | 171.34 |
| *Saturn* | 240 | 236 | 236.61 |

The true longitude, $\lambda_{true}$, for the sun is computed from mean longitude, $\lambda_{mean}$, according to

$$\lambda_{true} = \lambda_{mean} - \arcsin\left(\sin(\lambda_{mean} - \lambda_0)\left(e_S - e_S' \left|\sin(\lambda_{mean} - \lambda_0)\right|\right)\right)$$

where $\lambda_0$ is the position of the apogee.

| | $e_S$ | $e_S'$ |
|---|---|---|
| $SurS(Old)$ | $\frac{14}{360}$ | 0 |
| $SurS$ | $\frac{14}{360}$ | $\frac{20}{360(60}$ |
| $Arya$ | $\frac{3}{80}$ | 0 |

The eccentricity values $e_S$ for $e_S'$ in the different canons are and given in the table to the right.

As can be seen the sun's epicycle has for SurS a small contraction being largest at 90° from the apogee.

| | $e_M$ | $e'_M$ |
|---|---|---|
| $SurS(Old)$ | $\frac{31}{360}$ | 0 |
| $SurS$ | $\frac{32}{360}$ | $\frac{20}{360(60}$ |
| $Arya$ | $\frac{7}{80}$ | 0 |

The true longitude $\lambda_{true}$ for the moon is computed in the same way

$$\lambda_{true} = \lambda_{mean} - \arcsin\left(\sin(\lambda_{mean} - \lambda_0)\left(e_M - e'_M \left|\sin(\lambda_{mean} - \lambda_0)\right|\right)\right)$$

| *Angle / arcmins* | *HinduSine* |
|---|---|
| 0 | 0 |
| 225 | 225 |
| 450 | 449 |
| 675 | 671 |
| 900 | 890 |
| 1125 | 1105 |
| 1350 | 1315 |
| 1575 | 1520 |
| 1800 | 1719 |
| 2025 | 1910 |
| 2250 | 2093 |
| 2475 | 2267 |
| 2700 | 2431 |
| 2925 | 2585 |
| 3150 | 2728 |
| 3375 | 2859 |
| 3600 | 2978 |
| 3825 | 3084 |
| 4050 | 3177 |
| 4275 | 3256 |
| 4500 | 3331 |
| 4725 | 3372 |
| 4950 | 3409 |
| 5175 | 3431 |

but with other values for the eccentricities and with a moving lunar apogee as explained above.

The sine function in Indian astronomy is implemented by a table giving the value for every 3.25˚ (225'). The maximum value at 90˚ is 3438. Intermediate values are found by linear interpolation. Using a value for $\pi = 3.1414$, a circle with radius 3438 has a circumference of 21600, the number of arc minutes in 360˚.

The mean solar months have all the same length, i. e. 1/12 of the sidereal year. A solar month starts when the sun enters a zodiacal sign, i.e. has longitude 0˚, 30˚, 60˚,…, 330˚.

As the true sun moves with non-uniform speed in the ecliptic, the true months will have different lengths. For SurS(Old) and Arya, that both have a fixed apogee, these lengths are invariable. However, for SurS, having an apogee that moves, the length of the true months will change slowly with time.

The table below shows the lengths of the true solar months in the three calendars:

| *Solar Month* | *SurS(Old)* 2.2403991 | *SurS* 2.1697222 | *Change* 2.2242 | *AryaS* 2.1481170 |
|---|---|---|---|---|
| *Mesha* | 30.9030 | 30.9378 | -6.0233 | 30.9251 |
| *Vrshabha* | 31.4114 | 31.4221 | -4.1131 | 31.4010 |
| *Mithuna* | 31.6489 | 31.6449 | -0.3521 | 31.6072 |
| *Karka* | 31.5275 | 31.4735 | 3.6690 | 31.4679 |
| *Simha* | 31.0928 | 31.0162 | 5.8468 | 31.0347 |
| *Kanya* | 30.4966 | 30.4388 | 6.2909 | 30.4564 |
| *Tula* | 29.9170 | 29.8911 | 5.2879 | 29.9033 |
| *Vrcika* | 29.4950 | 29.4890 | 3.2345 | 29.5087 |
| *Dhanus* | 29.3142 | 29.3177 | 0.2653 | 29.3506 |
| *Makara* | 29.4055 | 29.4488 | -2.8516 | 29.4566 |
| *Kumbha* | 29.7535 | 29.8229 | -5.0328 | 29.8084 |

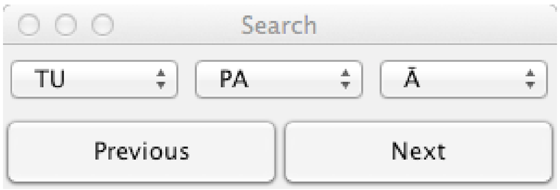
| | | | |
|---|---|---|---|
| *Mina* | 30.2934 | 30.3561 -6.2213 | 30.3388 |

The change of the SurS parameters is in days per 10 000 000 years.

The numbers at the head of the table are the *sodhyas*, the interval in days between the times when the true and the mean sun has longitude 0˚.

## [Section] Wuku search

The Search Wuku button in the Day window brings up a dialog with three fold-down menus for, respectively, the 6-, the 5-, and 7-day cycles. The target cyclic combination can be set with these menus. For each menu there is also a wildcard option (**). Then by clicking on the previous or next button, the previous/next day in the calendar, fitting the cyclic combination will be found.




### Tables of Terms

These tables can be brought up from the **Tables** menu.


Jupiter Years

| | | | |
|---|---|---|---|
| I: Vijaya | 16: Kilaka | **31: Rudhirodg.irin** | 46: Bahudhanya |
| 2: Jaya | **17: Saumya** | 32: Raktakia | **47: PralllJthin** |
| **3: Manmatha** | **18: S.idh.irar:,a** | 33: Krodhana | **48: Vikrama** |
| **4: Durmukha** | 19: Virodhikrt | 34: Kiaya | **49: V( a** |
| S: Hemalamba | **20: Paridh.ivin** | 35: Prabhava | **SO: Citrabh.inu** |
| 6: Vilamba | **21: PralllJdin** | 36: Vibhava | SI: Subhanu |
| **7: Vikarin** | 22: Ananda | 37: Sukla | **52: T.iraQa** |
| **8: S.irvarin** | 23: **R.ik asa** | **38: Pramoda** | **53: P.irthiva** |
| 9: Plava | 24: Anala | **39: Praj.ipati** | 54: Viyaya |
| 10: Subhakrt | 25: Pingala | **40: Aflgiras** | **55: Sarvajit** |
| 11: Sobhana | 26: Kalayukta | 41: Srimukha | **56: Sarvadh.irin** |
| 12: Krodhin | 27: Siddharthin | 42: Bhava | **S7: Virodhin** |
| **13: ViSv.ivasu** | **28: Raudra** | **43: Yuvan** | 58: Vikrta |
| **14: Par.ibhava** | **29: Durmati** | **44: Dh.itr** | 59: Khara |
| IS: Plavanga | 30: Dundubhi | **45: Isvara** | **60: Nandana** |

## [Section] References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