International Seminar on Determining Cultural Continuity since Vedic and Epic Eras, New Delhi, 23-24 February, 2014

Astronomical Dating from Rigveda to Mahabharat

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Astronomical dating

- A reliable calendar was an urgent need of the earliest societies for
  - *Prediction of seasons & Moon's phases*
    - *to regulate civic, social and agricultural activities*
- Numerous astronomical references are found in ancient scriptures that hold clues to their time of composition
  - *Natural cycles that affect human life*
    - *alternation of daylight and night*
    - *recurrence of the phases of the moon* and
    - *recurrence of the seasons*

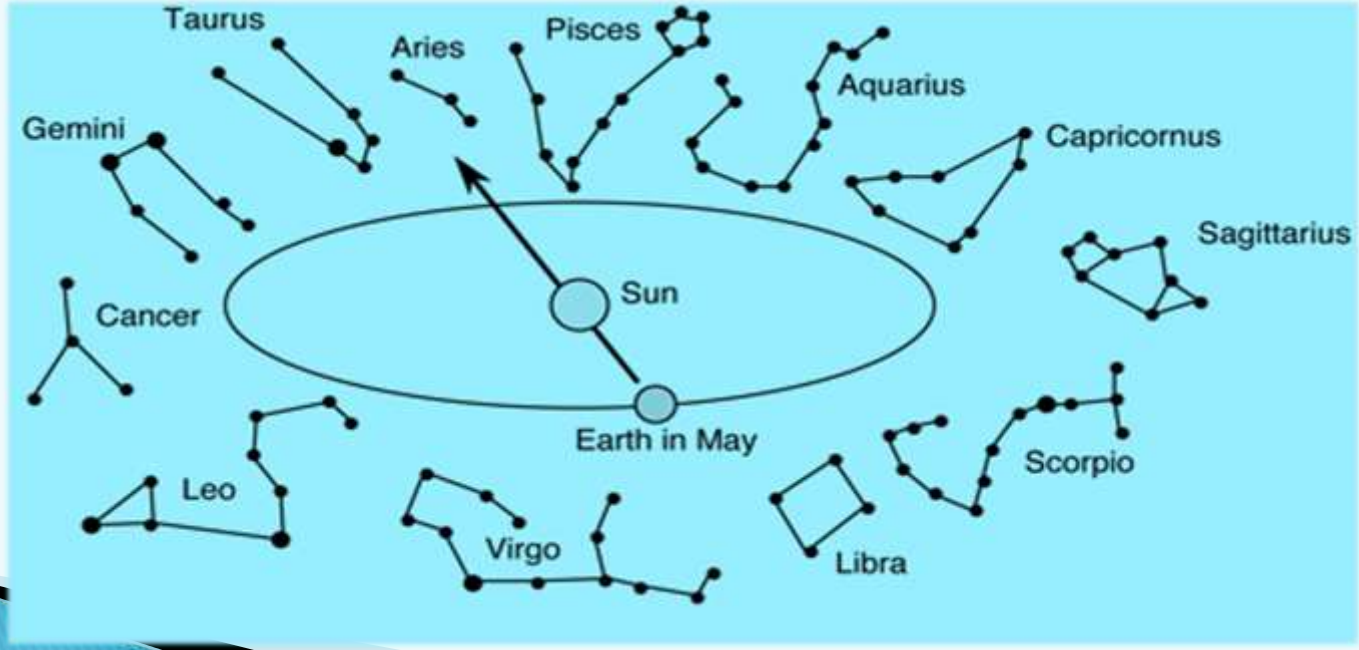
Astronomical dating…

- Useful references
  - Location of equinox and solstices among stars
  - Mention of month,Tithi, Nakshatra, Ascdt Rasi (Lagna) with season/solstices/equinox
  - Eclipses
  - Conjunctions of Moon, planets and stars
  - Reference to heliacal rising/setting of stars
  - Location of Pole of earth's rotation axis etc

- Pioneering work
  - *to trace development of astronomy in ancient India*
    - S. B. Dikshit, *'Bharatiya Jyotisa Sastra'* (1896), *(Marathi);* Eng Translation by R.V.Vaidya, IMD (1968)
    - K. D. Abhyankar *(Bull. Astron. Soc. of India,* **26,** 61-66, 1998).

Sun's path among stars- ecliptic

- Observe stars near horizon just before Sunrise or after Sunset
- Each day these stars seen to rise about 4 minutes earlier; slowly moving away from Sun
- Trace Sun's path among stars. This is called **Ecliptic** and known from the most ancient times
- Interval between two successive returns of the Sun to same stars- Sidereal Year.



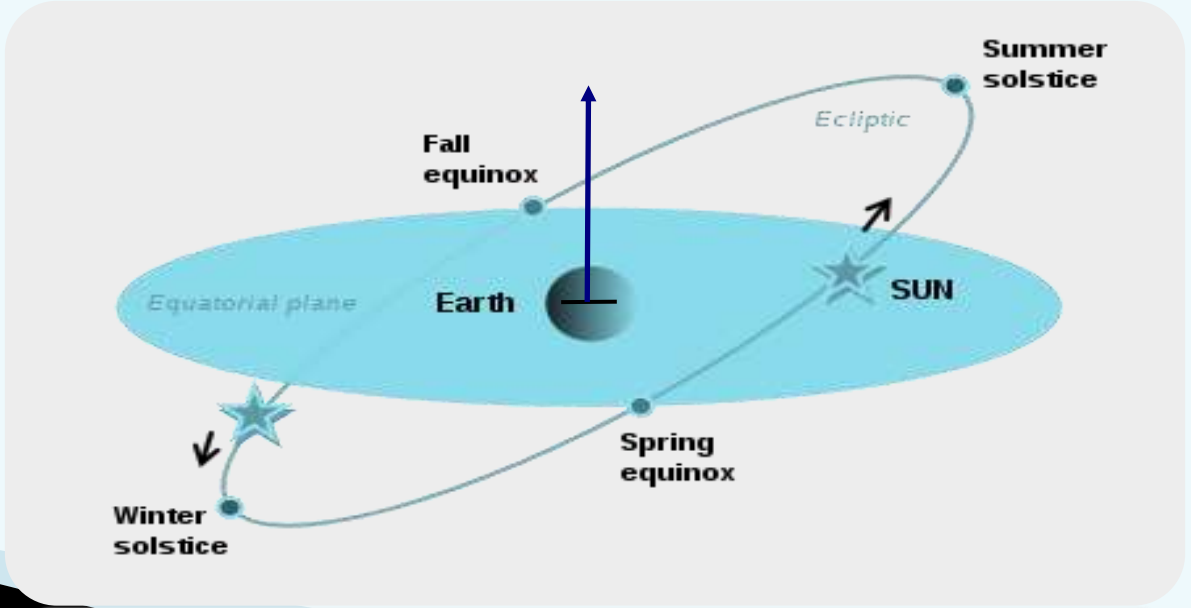
Equinoxes –are the two intersection points of ecliptic and equator. Sun crosses them twice in a year- Vernal Equinox around 20 March & Autumnal Equinox around 23 Sept (Gregorian) .

Solstices- when sun is maximum north of equator, around 21 June is summer solstice, and when maximum south around 21 Dec, is called Winter Solstice as shown below.

Season (astronomical) - the span of time from an equinox to the following solstice or from a solstice to the following equinox. *Beginning and duration may differ for different geographic regions.*

Tropical/seasonal Year-

Interval between two successive returns of the Sun to same equinox or solstice. Shorter by 20m than sidereal year.



Ancient Observations

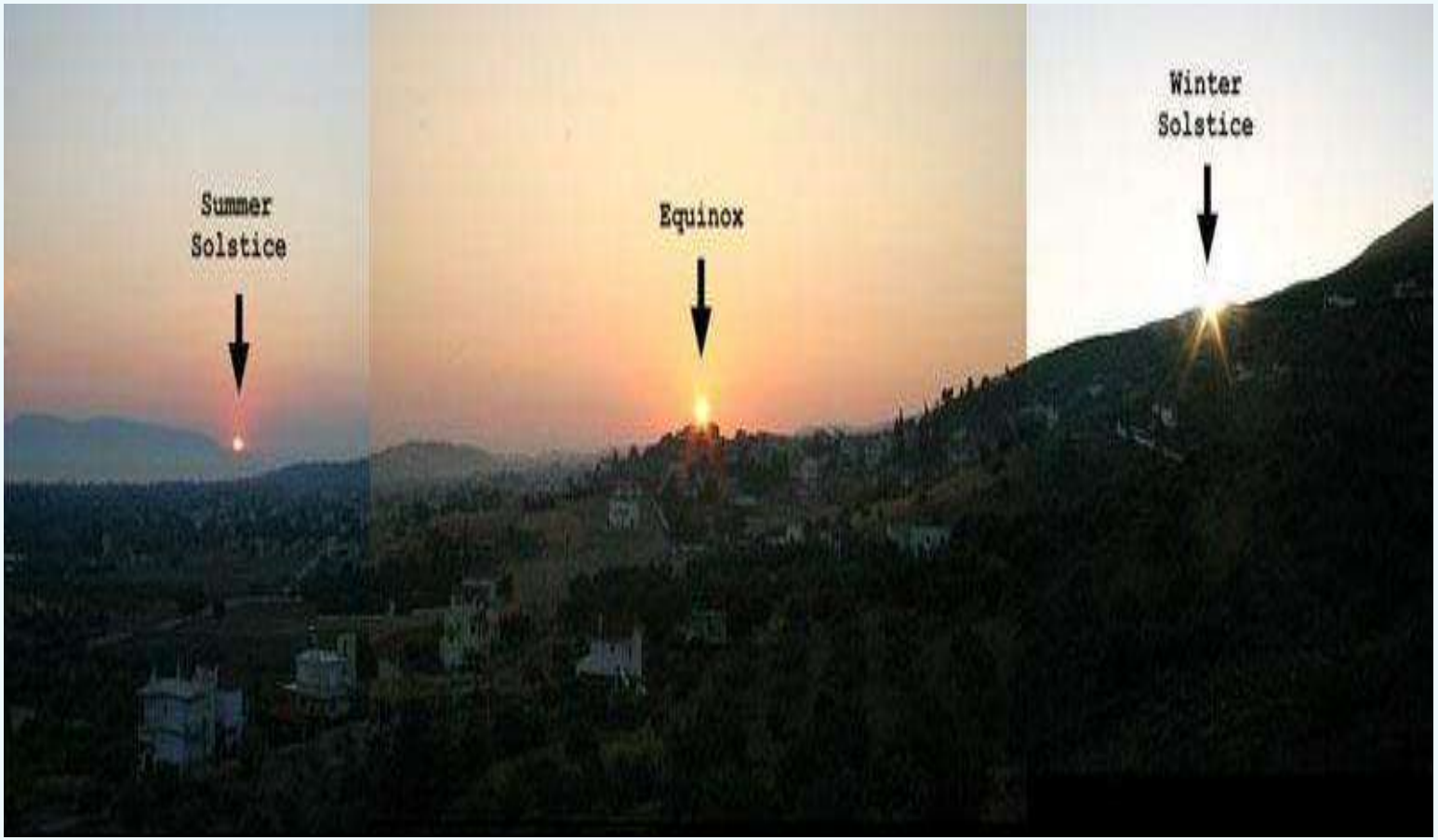
- Sunrise Point served as indicator of
  - Seasons, Solstices/ Equinoxes
  - Year beginning (Uttarayana and Dakshinayana)
  - Sun's position among stars
    - Heliacal rising of given stars used as time markers
- Moon's Motion among stars
  - Indian Nakshatra system
  - Sidereal system of Indian Astronomy and Calendar

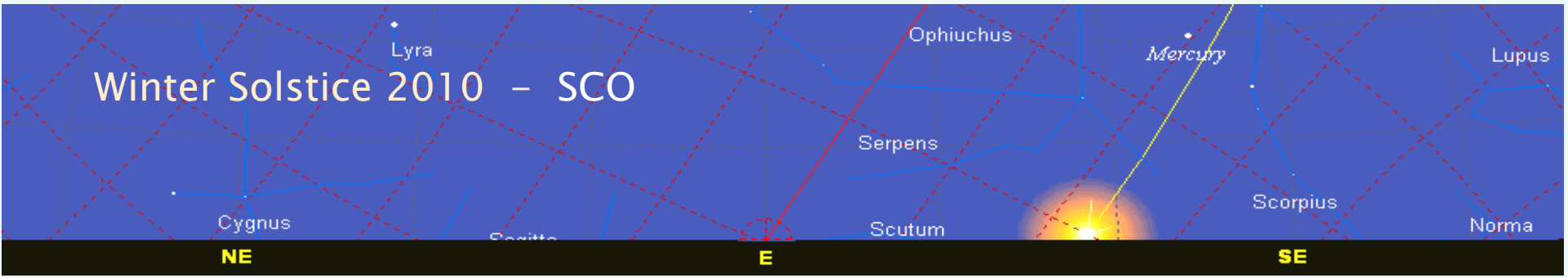
Sunrise point

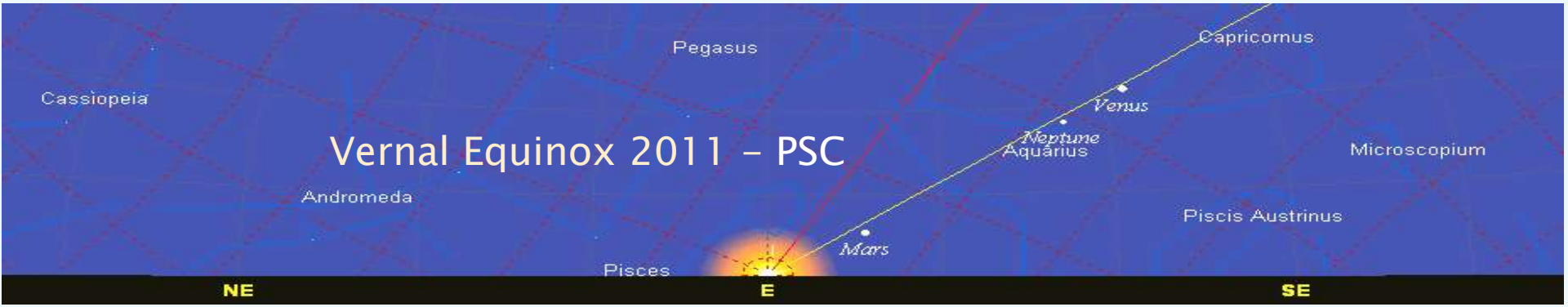
Summer Solstice

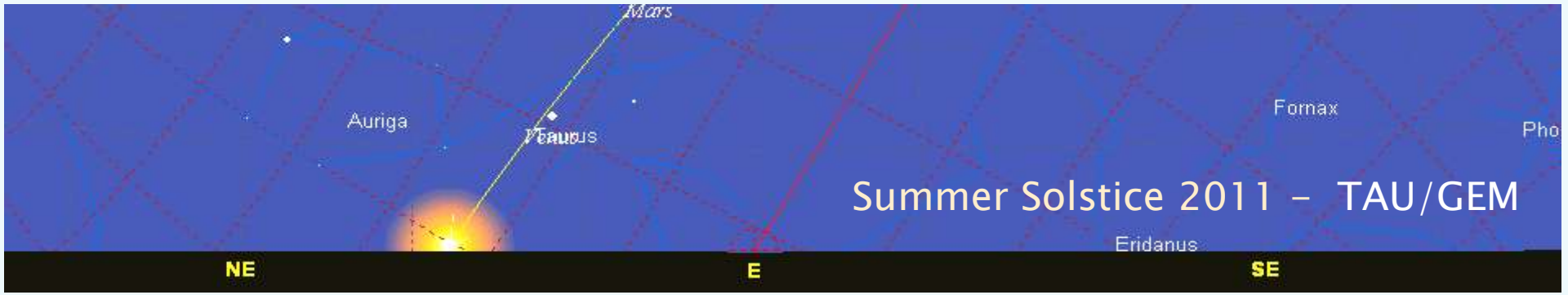
Vernal Equinox

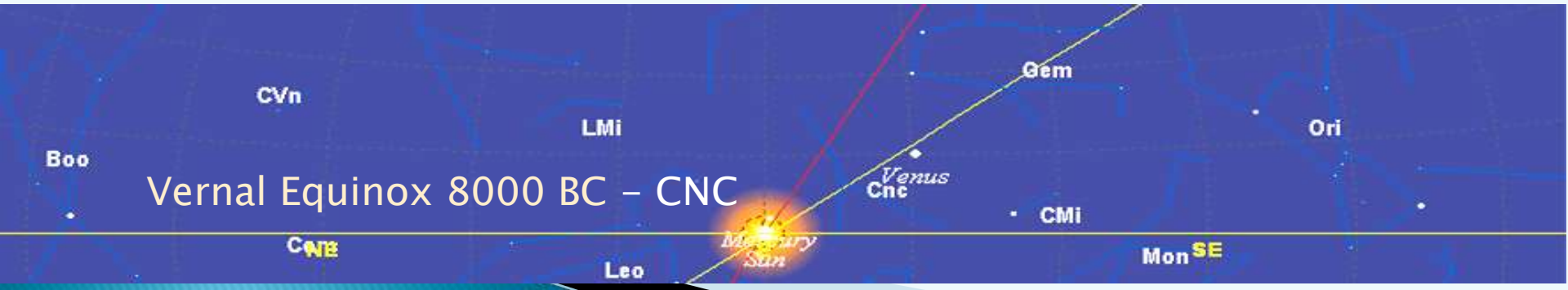
Winter Solstice



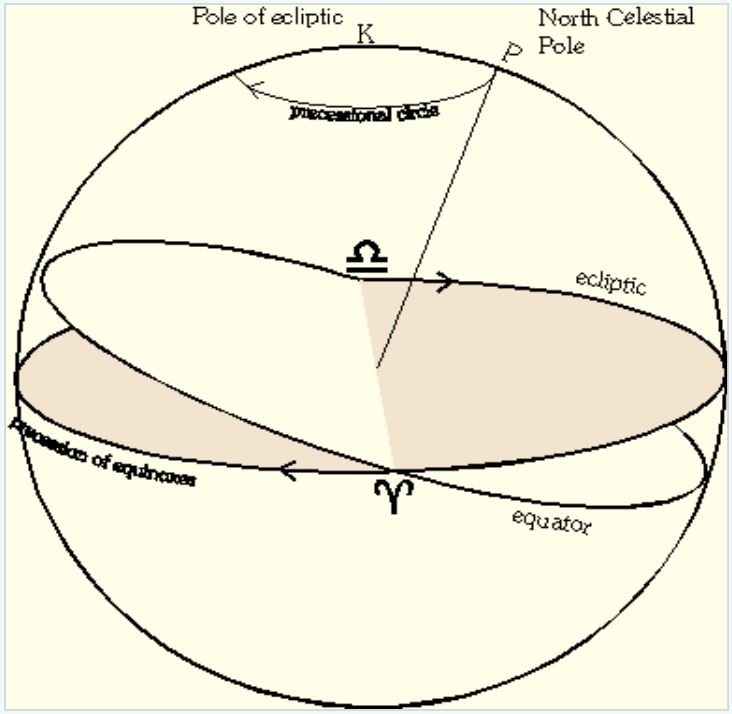

Winter Solstice 2010 – SCO
Lyra
Ophiuchus
Mercury
Lupus
Serpens
Cygnus
Scutum
Scorpius
Norma
NE
E
SE

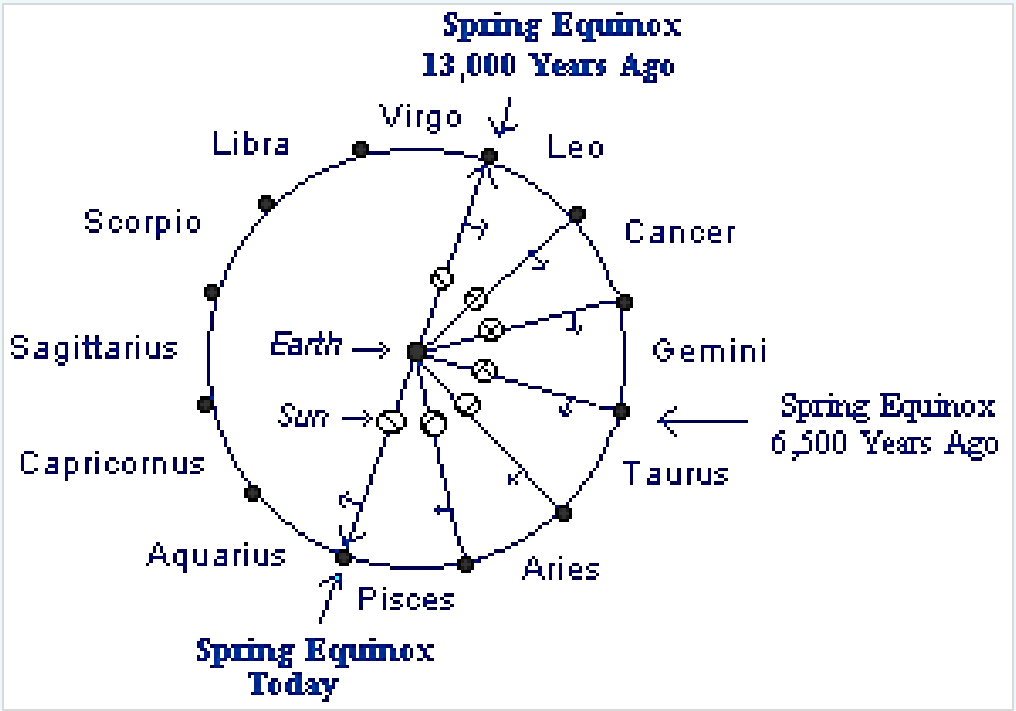

Vernal Equinox 2011 – PSC
Pegasus
Capricornus
Cassiopeia
Venus
Neptune
Aquarius
Microscopium
Andromeda
Piscis Austrinus
Mars
Pisces
NE
E
SE


Mars
Auriga
Fornax
Summer Solstice 2011 – TAU/GEM
Eridanus
NE
E
SE


Gem
CVn
LMi
Ori
Boo
Vernal Equinox 8000 BC – CNC
Venus
Cnc
CMi
Leo
Mon
SE

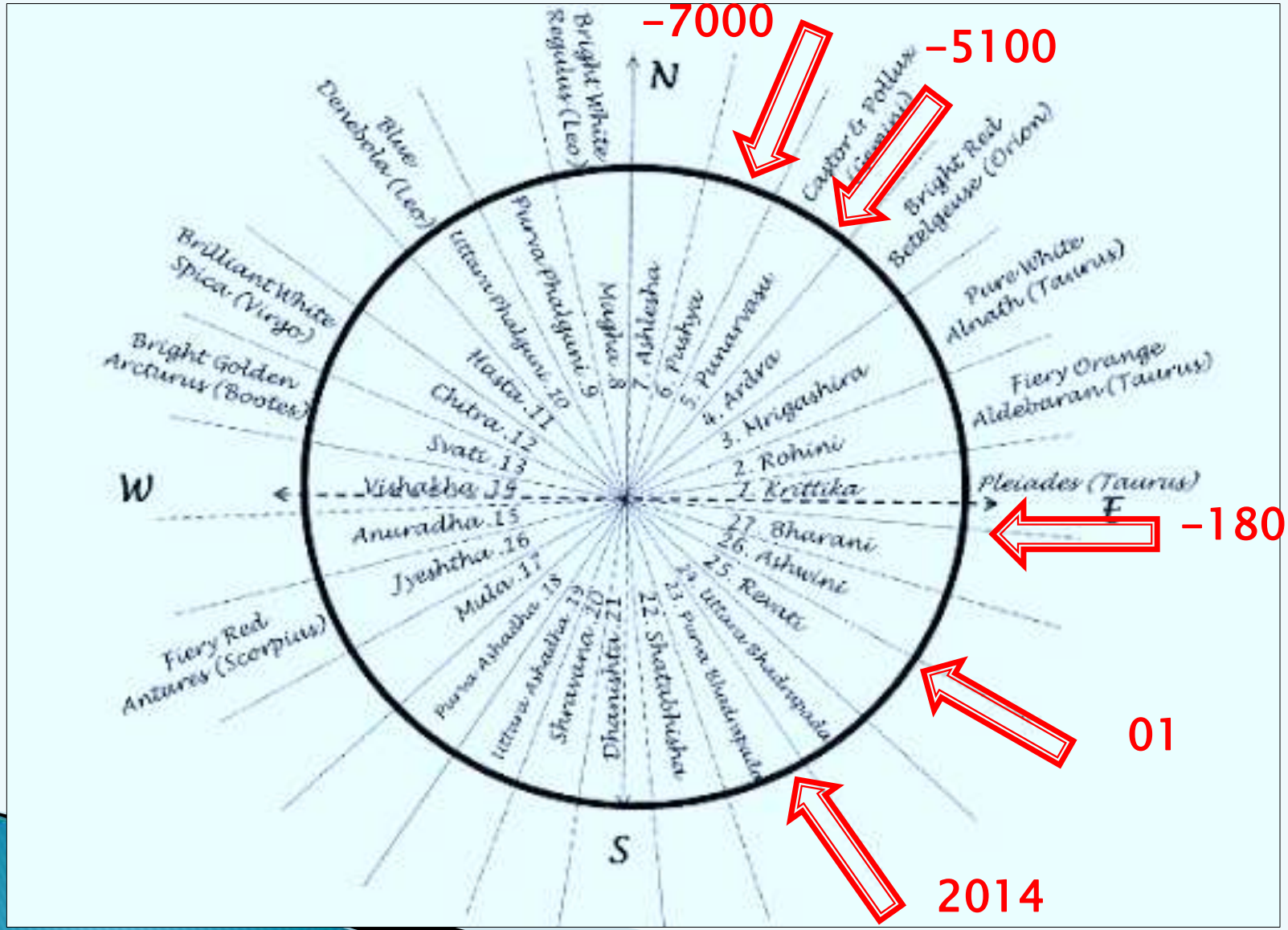
Precession- Vernal Equinox through ages





Equinoxes move westward along the ecliptic relative to the fixed stars, at the rate of about 50.3 seconds of arc per year. Past observations of Equinox/Solstice can help determine their date using precession rate.

Movement of Vernal Equinox through Nakshatras (Full cycle 25,772 years)



Indian Nakshatras

S. No.	Nakṣatra**	Star group yogatārā		λ (1950)	
1.	Aśvinī	α, β Ari	β Ari	33°	16′
2.	Bharaṇī	35, 39, 41 Ari	41 Ari	47°	30′
3.	Kṛttikā	Pleiades	η Tau	59°	17′
4.	Rohiṇī	Aldebaran	α Tau	69°	05′
5.	Mṛgaśīrṣa	λ, ϕ^1, ϕ^2 Ori	λ Ori	83°	01′
6.	Ardrā	Betelgeuse	α Ori	88°	03′
7.	Punarvasu	α, β Gem, α, β CMi	β Gem	112°	31′
8.	Puṣyā	Praescepe	δ Cnc	128°	01′
9.	Āśleṣā	η,σ,δ,ε,ζ,θ Hya	ζ Hya	133°	53′
10.	Maghā	ε,μ,ρ,γ,η,α Leo	α Leo	149°	08′
11.	P. Phālgunī	δ,θ Leo	δ Leo	160°	37′
12.	U. Phālgunī	β, 93 Leo	β Leo	170°	55′
13.	Hasta	α, β, γ, δ, ε Crv	δ Crv	192°	48′
14.	Citrā	Spica	α Vir	203°	08′

S. No.	Nakṣatra**	Star group yogatārā		λ (1950)	
15.	Svātī	Arcturus	α Boo	203°	32′
16.	Viśākhā	α, β Lib	α Lib	224°	23′
17.	Anurādhā	Dzuba	δ Sco	241°	52′
18.	Jyeṣṭhā	Antares	α Sco	249°	04′
19.	Mūla	ξ,μ,ζ,η,Θ, i,K,λ Sco	λ Sco	263°	53′
20.	Pūrvaāṣāḍā	δ, ε Sgr	δ Sgr	273°	53′
21*	Uttaraāṣāḍā	ζ, σ Sgr	σ Sgr	281°	41′
22*	Śravaṇā	α, β, γ Aql	α Aql	301°	04′
23.	Dhaniṣṭhā	α,β,γ,δ,ε,ζ Del	β Del	315°	38′
24.	Śatabhiṣaj	Aquarius	λ Aqr	340°	52′
25.	P. Bhādrapadā	α, β Peg	β Peg	352°	47′
26.	U. Bhādrapadā	γ Peg, α And	γ Peg	8°	28′
27.	Revatī		ζ Pis	19°	10′

Sky simulation software

- Sky simulation software for public use on PCs

  Planetarium Gold, Stellarium, Starry Night, Celestia, SkyMap Pro, Cartes du Ciel, Voyager, Digital Universe Atlas, RedShift, TheSky, Universe Sandbox, XEphem etc.

  - High precision data on positions of stars (HIPPARCOS)
  - Ephemeris (DE200/HORIZONS of JPL, NASA, USA and VSOP87 of France)
- Time can be set to generate views of sky in future or past
- Planetary accuracy of 1s to 1m, over yr −3000 to +3000
- **Calendar**: Gregorian in *Planetarium Gold*

  –Fixed wrt Vernal Equinox and seasons (20–23 March)

  - keeps drifting in *Stellarium* from 21 March during 2014–1582 to 2 May in 5000 BC and so on.
- These can be used to simulate the phenomena described in ancient texts to help determine their dates. We used *Planetarium Gold* software for this research.

Astronomical dating by I-SERVE

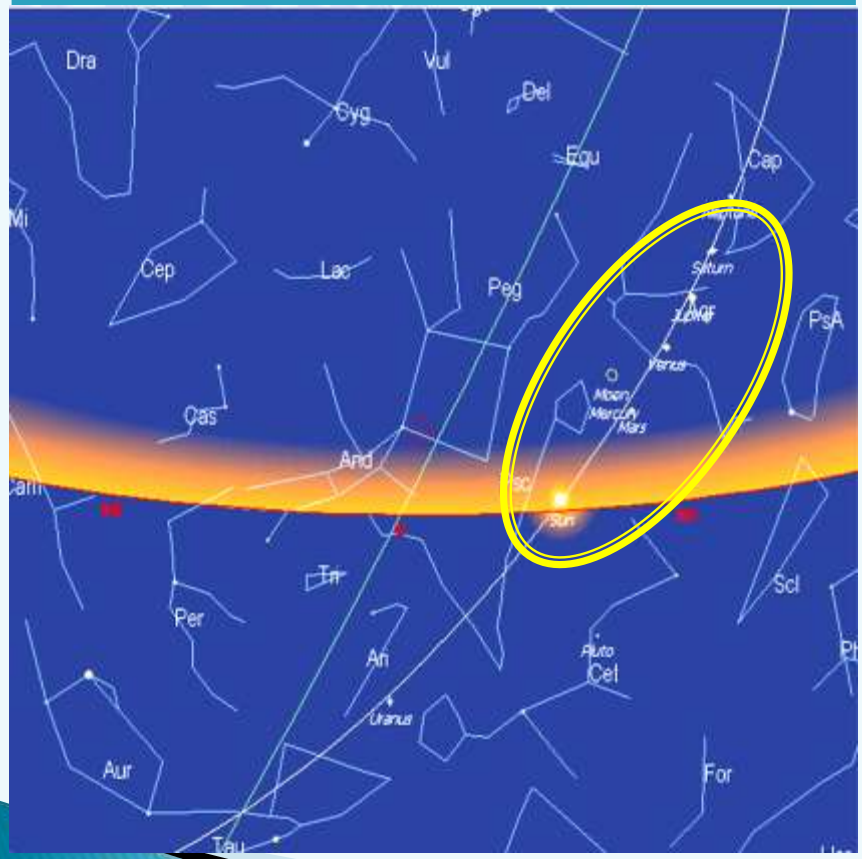
- Simulated location of solstices and equinoxes
- ***Rigveda*** : Year beginning (WS) by using heliacal rising of *Aśvini Nakshatra* (Aries) dates back to -7000.
- Second stage: year beginning with full moon in *Citrā* (α Vir) on WS, from around -6000 (***Taittiriya Samhita***)
- *Agastya Muni's* time around 5100 BC, matches with time of *Ramayana. (*through visibility of *Canopus* from *Vindhyas),*
- Vernal Equinox was at *Rohini* (α Tauri) about -3100. Some researchers showed *Kali Era* and *Mohenjo-Daro* connection by interpreting the symbols on seals found from that time.
- *Satapatha Brahamana* , 2174 BC, based on VE in *Krittika.*

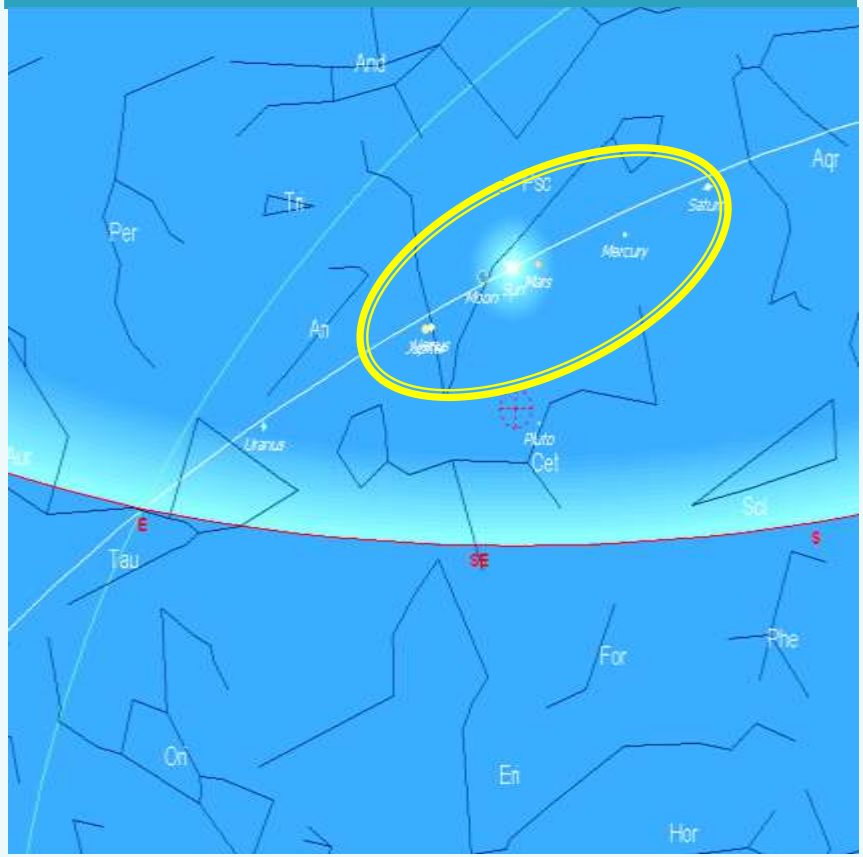
Time of Mahabharata war

- Various dates: 8th to 56th century BCE
- Aryabhata (Dasagitika): *Bharat* war fought 36 years before *Kali Era* commenced in -3101, latter marked by conjunction of 5 planets, Sun and Moon in Aries.
- Simulations
  - **Spectacular assemblage:** Occurred in Cap/Psc region on 13th January, -3103, 25 days after the Winter Solstice and again on 22 January -3101 in Psc/Ari.
  - **Seasons:** Simulations for the years -3101 to-3137 show serious contradictions with internal description of corresponding seasons in *Mahabharata*.
- Prompted in-depth analysis of astronomical references in *Mahabharata* to date it accurately.

Legendary assemblage of Sun, Moon & Planets at Kali beginning?

13 Jan -3103; 25d after WS	22 Jan -3101; 31d after WS





Parv	Title of Parva	Contents of Parvas in Mahabharata (MB Calcutta Edition))
1	Adi- Parva	Introduction, birth and upbringing of the princes.
2	Sabha	Dice game, exile of Pandavas. Palace/court at Indraprastha.
3	Vana	The twelve years in exile in the forest (aranya).
4	Virata	The year in exile spent at the court of Virata.
5	Udyoga	Preparations for war.
6	Bhishma	Great battle, first part. Bhishma commander for Kauravas.
7	Drona	The battle continues, with Drona as commander.
8	Karna	The battle again, with Karna as commander.
9	Shalya	Last part of the battle: Shalya as commander.
10	Sauptika	Ashvattama and party kill Pandava army in their sleep
11	Stri	Gandhari and the other women lament the dead
12	Shanti	Crowning of Yudhisthira, and his instructions from Bhishma
13	Anusasana	The final anusasana from Bhishma.
14	Ashvamedhika	The royal ashvamedha by Yudhisthira.
15	Ashramavasika	Dhritarashtra, Gandhari, Kunti go to ashram, death in forest
16	Mausala	The infighting between the Yadavas with maces
17	Mahaprasthanika	The first part of mahaprasthan of Yudhisthira and brothers
18	Svargarohana	The Pandavas return to svarga

Seasons and Indian Luni-solar calendar dates

- Search for description of
  - seasons/equinox/solstices occurring in specific months/date (*tithis/Nakshatras*) of the sidereal luni-solar Indian Calendar.
- Very important clues
  - Verses on Pandavas' *Vanavasa* (exile) period:
    - highlight vividly the connection between autumn and *Kartik* month.
  - Verse on Krishna's peace mission describes:
    - *Sarat Ritu* (autumn) during *Kartik* month with the Moon in *Revati Nakshatra*.

Seasons and Indian Luni-solar calendar dates

तथा बहुविधाकारा प्रावृष्मेंघानुनादिता / अभ्यतीता शिवा तेषां चरतां मरुधन्वसु //
क्रौंचहंससमाकीर्णा शरत् प्रमुदिताभवत् / रूढकक्षवनप्रस्था प्रसन्नजलनिम्नगा //
विमलाकाशनक्षत्रा शरत् तेषां शिवाभवत / मृगद्विजसमाकीर्णा पाण्डवानां महात्मनाम//

tathā bahuvidhākārā prāvṛṣ meghānunāditā |abhyatītā śivā teṣāṃ caratāṃ marudhanvasu ||
krauñca haṃsagaṇākīrṇā śarat praṇihitābhavat |rūḍdha kakṣavanaprasthā prasannajalanimnagā ||
vimalākāśa nakṣatrā śarat teṣāṃ śivābhavat |mṛgadvijasamākīrṇā pāṇḍavānāṃ mahātmanām ||

MB/3.182/9,10,12 (Cr Ed 3.179/9,10,11)

'Thus while the Pandavas were roaming about in the deserts and sandy tracts, the happy season of rain, so various in aspect and resounding with clouds passed away. Then set in the season of autumn, thronged with ganders and cranes and full of joy; then the forest tracts were overrun with grass; the river turned limpid; the firmament and stars shone brightly, and the autumn, thronged with beasts and birds, was joyous and pleasant for the magnanimous sons of Pandu'.

Seasons and Indian Luni-solar calendar dates

द्रश्यन्ते शान्तरजसः क्षपा जलदशीतलाः|
ग्रहनक्षत्रसंघैश्च सॊमेन च विराजिताः ||
तेषां पुण्यतमा रात्रिः पर्व संधौ स्म शारदी|
तत्रैव वसतामासीत कार्तिकी जनमेजय ||

Drishyante śāntarajasaḥ kṣapā jaladaśītalāḥ| grahanakṣatrasaṃghaiś ca somena ca virājitāḥ ||
teṣāṃ puṇyatamā rātriḥ parva saṃdhau sma śāradī|tatraiva vasatām āsīt kārtikī janamejaya||

MB/3.182/12,16 (Cr Ed 3.179/12,16)

'Then were seen nights, that were free from dust and cool with clouds and beautified by myriads of planets and stars and the moon.

And, O Janamejaya, the holiest night that of the full moon in the month of Kartika in the season of autumn, was spent by them while dwelling there!'

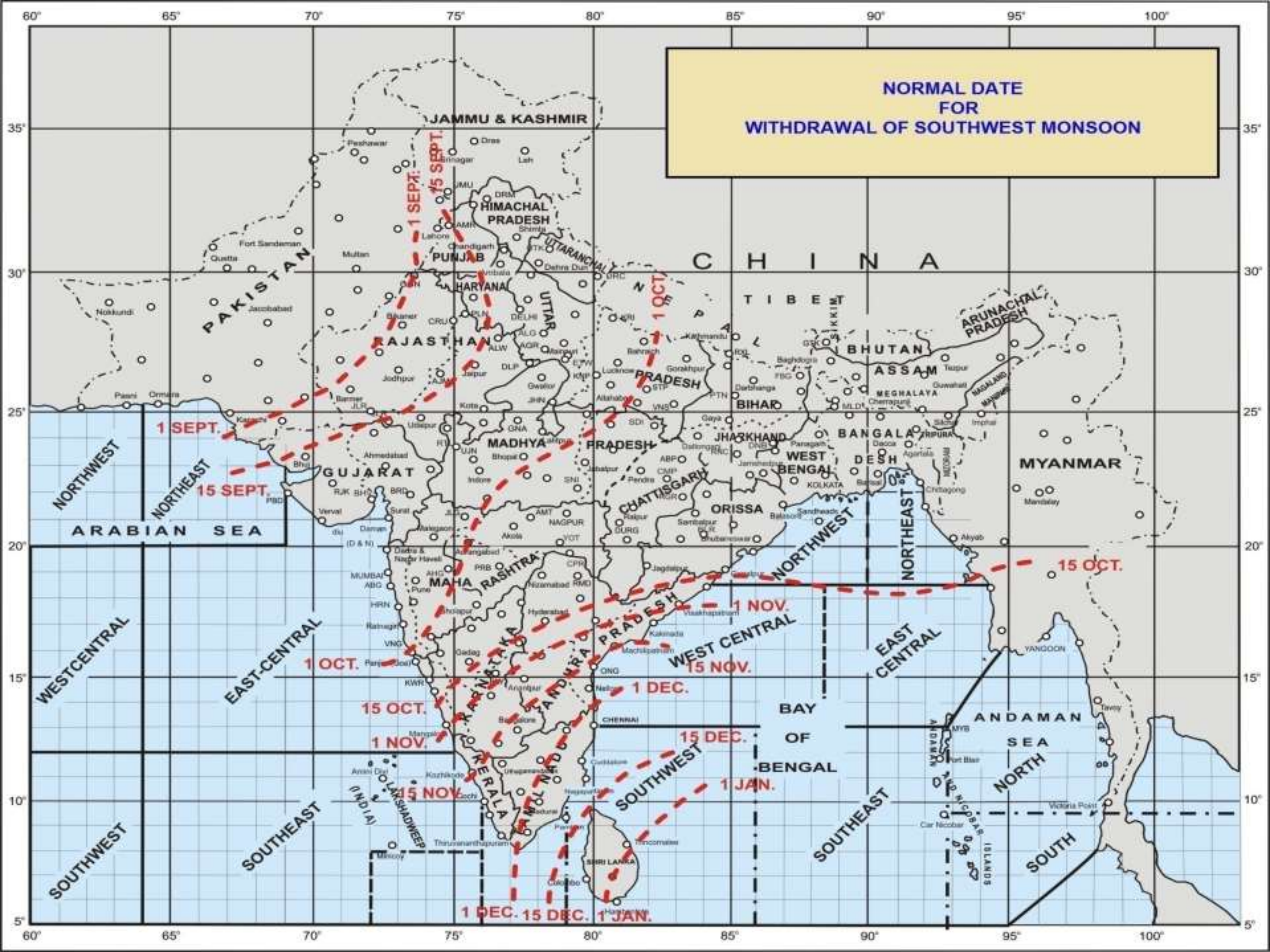
Seasons and Indian Luni-solar calendar dates

कौमुदे मासि रेवत्यां शरदन्ते हिमागमे|
स्फीतसस्यसुखे काले कल्पः सत्त्ववतां वरः||7

kaumude māsi revatyāṃ śarad ante himāgame |
sphītasasyasukhe kāle kalpaḥ sattvavatāṃ varaḥ ||

MB 5.83/7 (Cr Ed 5.81/7)

'In the month of Kaumuda (Kartika), under the Revati constellation, after the passing away of autumn, and in the dewy season, and at a time when the earth had an abundance of crops on it, that foremost of men of prowess…'



NORMAL DATE
FOR
WITHDRAWAL OF SOUTHWEST MONSOON
1 SEPT.
15 SEPT.
1 OCT.
15 OCT.
1 NOV.
15 NOV.
1 DEC.
15 DEC.
1 JAN.
JAMMU & KASHMIR
HIMACHAL PRADESH
PUNJAB
HARYANA
RAJASTHAN
UTTAR PRADESH
GUJARAT
MADHYA PRADESH
MAHARASHTRA
KARNATAKA
ANDHRA PRADESH
KERALA
TAMIL NADU
CHATTISGARH
ORISSA
JHARKHAND
BIHAR
WEST BENGAL
ASSAM
MEGHALAYA
ARUNACHAL PRADESH
SIKKIM
TRIPURA
PAKISTAN
CHINA
TIBET
NEPAL
BHUTAN
BANGALA DESH
MYANMAR
SHRI LANKA
ARABIAN SEA
BAY OF BENGAL
ANDAMAN SEA
LAKSHADWEEP
ANDAMAN AND NICOBAR ISLANDS
NORTHWEST
NORTHEAST
WESTCENTRAL
EAST-CENTRAL
SOUTHWEST
SOUTHEAST
WEST CENTRAL
EAST CENTRAL
NORTH
SOUTH

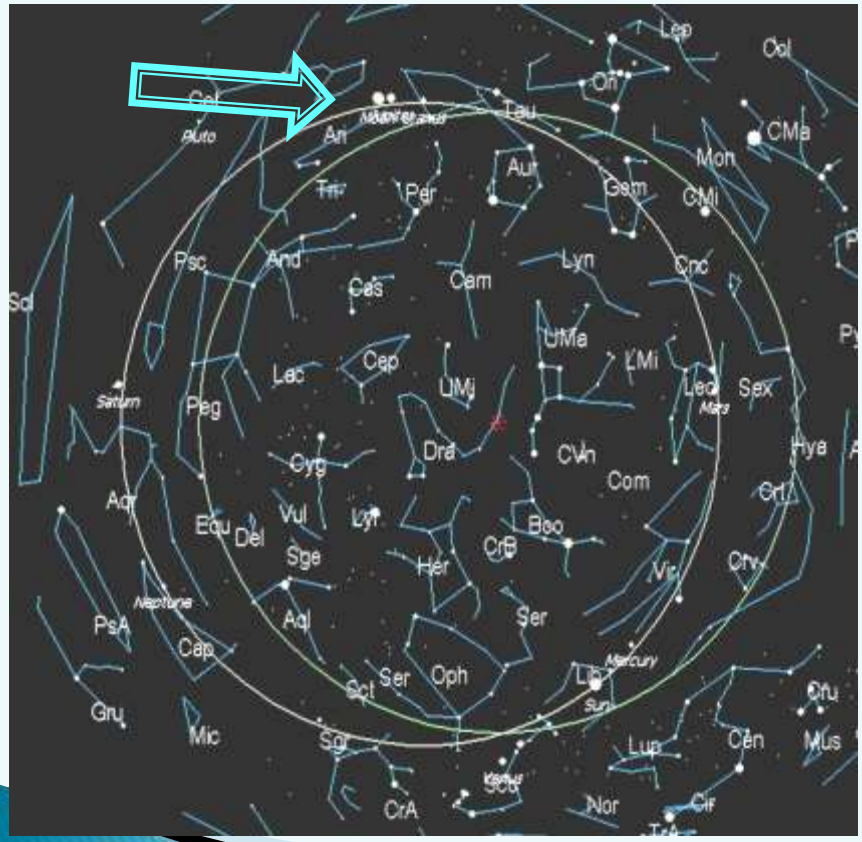
Connection with Kali Era

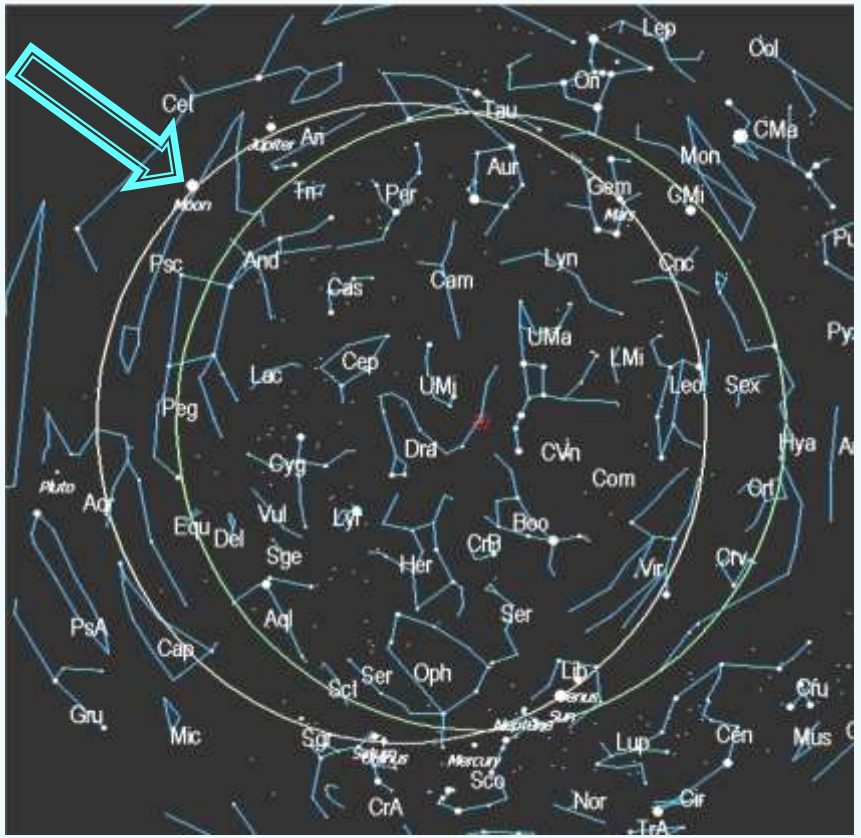
- Simulations for the year −3101 show
  - *Revati Nakshatra* on 29 August.
  - *Kartik Purnima* on 31 August,
    both in the rainy season, not in autumn.

  - In the year −3137, *Revati Nakshatra* occurred on 5 September, when the Sun was 20° away from the Autumnal Equinox (AE). This again goes against the description of the prevailing season.

Year of *Kali* beginning
Kartik Purnima : 31 Aug -3101
Rainy season

Yr. -36, *Kali* Era
Kartik mth, Revati Nakshtr
5 Sep -3137 Sun 20° from AE



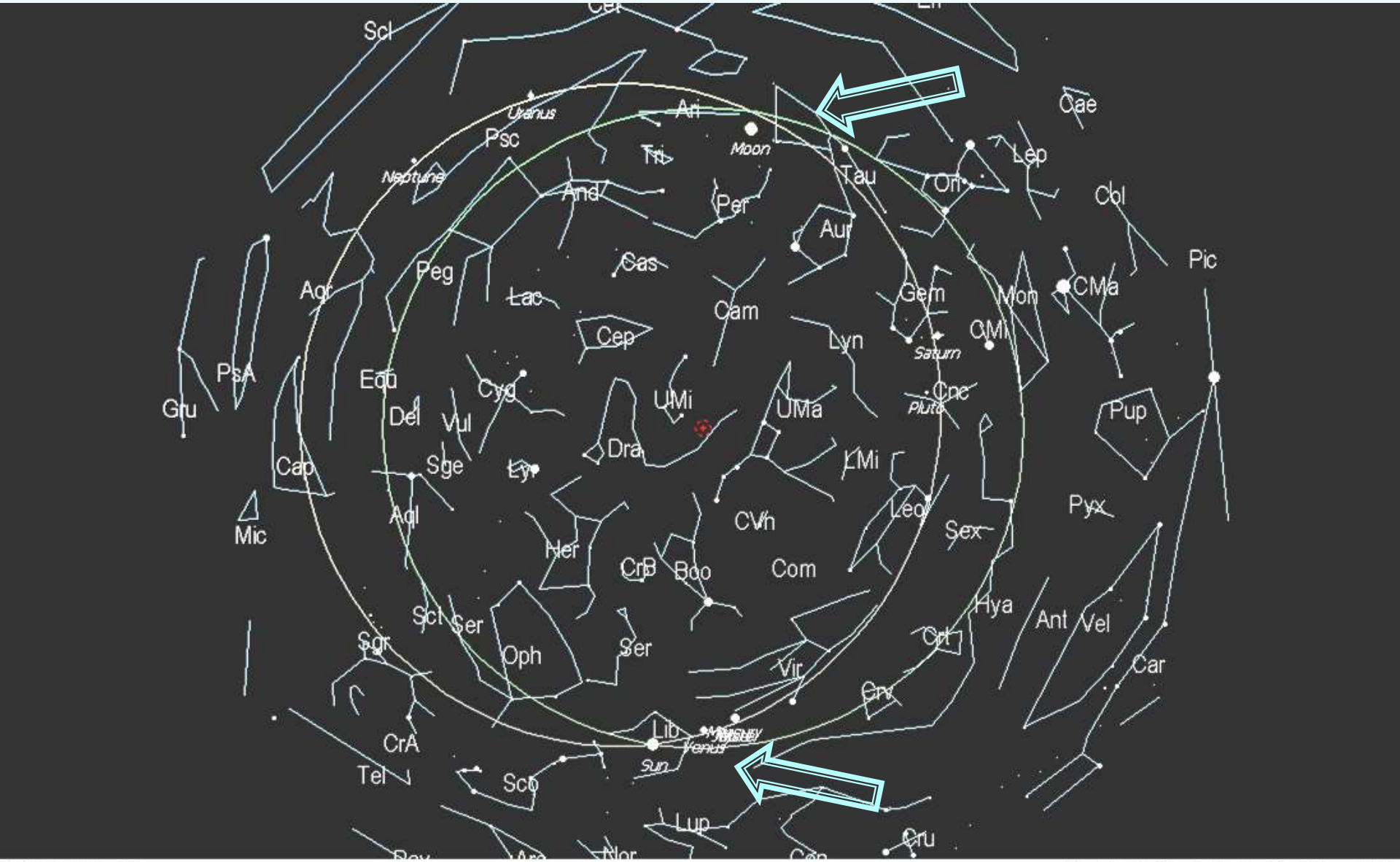


Season, equinox, tithi and nakshatra

Coming back to foregoing references to seasons in MB text, we must remember that:

- On *Kartik Purnima*, the Sun must be located between *Anuradha* (δ Sco) Nakshatra and *Visakha* (α Lib) opposite *Krittika* (η Tauri).
- Autumn season implies that the Sun was located in or close to Autumnal Equinox (AE). This fixes the position of the Autumnal Equinox between *Visakha* and *Anuradha,* which occurred on 22 September -1767.
- AE remains in one Nakshatra for about 960 yrs. **This limits our search from yr -2150 to -1280**. Beyond these limits *Kartik* month of sidereal luni-solar Indian calendar begins to lose its connection with autumn season and the corresponding tropical calendar dates.

22 Sep -1767; Kartik Purnima on Autumnal Equinox Day



29°N 77°E GMT+5:30 Mag 4.0 11h23m 90.0° Sep 22, -1767 10:50

Bhishma's demise on Winter Solstice

- Next important clue comes from the verses on Bhishma's demise.

आगन्तव्यं च भवता समये मम पार्थिव |
विनिवृत्ते दिनकरे प्रावृत्ते चोत्तरायणे|| 14

āgantavyaṃ ca bhavatā samaye mama pārthiva|
vinivṛtte dinakare pravṛtte cottarāyaṇe||

MB 13.166.14 (Cr Ed 3.152/10)

'When the hour comes for my departure from this world, do thou come here, O king. The time when I shall take leave of my body is that period when the sun, stopping in his south-ward course, will begin to return northwards!' …

Bhishma's demise...

उषित्वा शर्वरीः श्रीमान पञ्चाशन्नगरोत्तमे|
समयं कौरवाग्र्यस्य सस्मार पुरुषर्षभः||

uṣitvā śarvarīḥ śrīmān pañcāśan nagarottame| samayaṃ kauravāgryasya sasmāra puruṣarṣabhaḥ||

स निर्ययौ गजपुराद् याजकैः परिवारितः|
दृष्ट्वा निवृत्तमादित्यं प्रवृत्तंचोत्तरायणम्||

sa niryayau gajapurād yājakaiḥ parivāritaḥ| dṛṣṭvā nivṛttam ādityaṃ pravṛttaṃ cottarāyaṇam||

MB 13.167/5,6 (Cr Ed 13.153/5,6)

'The blessed monarch (Yudhishthir) having passed fifty nights in the capital recollected the time indicated by his grandsire as the hour of his departure from this world. Accompanied by a number of priests he then set out of the city named after the elephant, having seen that the sun ceasing to go southwards had begun to proceed in his northward course.'

Bhishma's demise...

दिष्ट्या प्राप्तोऽसि कौन्तेय सहामात्यो युधिष्ठिर|परिवृत्तो हि भगवान्हस्रांशुर्दिवाकरः||

diṣṭyā prāpto 'si kaunteya sahāmātyo yudhiṣṭhira| parivṛtto hi bhagavān sahasrāṃśur divākaraḥ||

माघोऽयं समनुप्राप्तो मासः सौम्यो युधिष्ठिर|त्रिभागशेषः पक्षोऽयं शुक्लोभवितुमर्हति||

māgho 'yaṃ samanuprāpto māsaḥ saumsaumyo yudhiṣṭhira|
tribhāgaśeṣaḥ pakṣo 'yaṃ śuklo bhavitumarhati||

MB 13.167 /26 ,28 (Cr Ed 13.153/26,28)

'That thorough master of words (Bhishma) said, 'By good luck, O son of Kunti, thou hast come here with all thy counsellors, O Yudhishthira! The thousand-rayed maker of day, the holy Surya has begun his northward course.'

'O Yudhishthira, the lunar month of Magha has come. This is, again, the lighted fortnight and a fourth part of it ought by this (according to my calculations) be over'

Bhishma's demise...

निवृत्तमात्रे तव अयन उत्तरे वै दिवाकरे|
समावेशयद आत्मानम आत्मन्य एव समाहितः||

nivṛttamātre tv ayana uttare vai divākare| samāveśayad ātmānam ātmany eva samāhitaḥ||

MB 12.47/3 (Cr Ed 12.47/3)

...the high-souled Bhishma cast off his body. 'As soon as the Sun, passing the solstitial point, entered in his northerly course, Bhishma, with concentrated attention, caused his soul (as connected with and independent of the body) to enter his soul (in its independent and absolute state).'

Winter Sostice and Precession of Magha

- At WS, Longitude of Sun = 270°
  - Moon's Long (on S8, 84° to 96° ahead of Sun) =354° to 6°
- Long of Sun on *Purnima Magha S 15* (7d later) =277°
- Long of Full Moon in *Magha (*αLeonis*)*=277°+180° = 97°
- Long(1950.0) of α Leonis (*Magha)* =149°
  - Long(1950.0) of α Tau*(Rohini)*= 69°
  - Difference in Long (1950.0) of two stars (constant)=80°
  - Long of α Tau (*Rohini)* on Bhishma's death= 97°−80°=17°
  - VE would be between *Bharani* (41 Ari) and *Krittika* (η Tauri)
- Change in longitude of α Leonis 149 °– 97 °= 52°
- Arises due to precession @ 50".3 per year or 52 ° in about 3722 years).

Thus we arrive approximately at the year 1950–3722= –1772.

Eclipses

Let us now examine the following description of eclipses in MB:

चतुर्दशीं पञ्चदशीं भूतपूर्वां च षॊडशीम|
इमां तु नाभिजानामि अमावास्यां त्रयॊदशीम|
चन्द्रसूर्याव उभौ ग्रस्ताव एकमासे त्रयॊदशीम|| 32

caturdaśīṃ pañcadaśīṃ bhūtapūrvāṃ ca ṣoḍaśīm | imāṃ tu nābhijānāmi amāvāsyāṃ trayodaśīm| candrasūryāv ubhau grastāv ekamāse trayodaśīm ||

MB 6.3/32 (Cr Ed 6.3/28,29)

'A lunar fortnight had hitherto consisted of fourteen days, or fifteen days (as usual), or sixteen days. This, however, I never knew that the day of new-moon would be on the thirteenth day from the first lunation, or the day of full-moon on the thirteenth day from the same. And yet in course of the same month both the Moon and the Sun have undergone eclipses on the thirteenth days from the day of the first lunation.'

Eclipses…

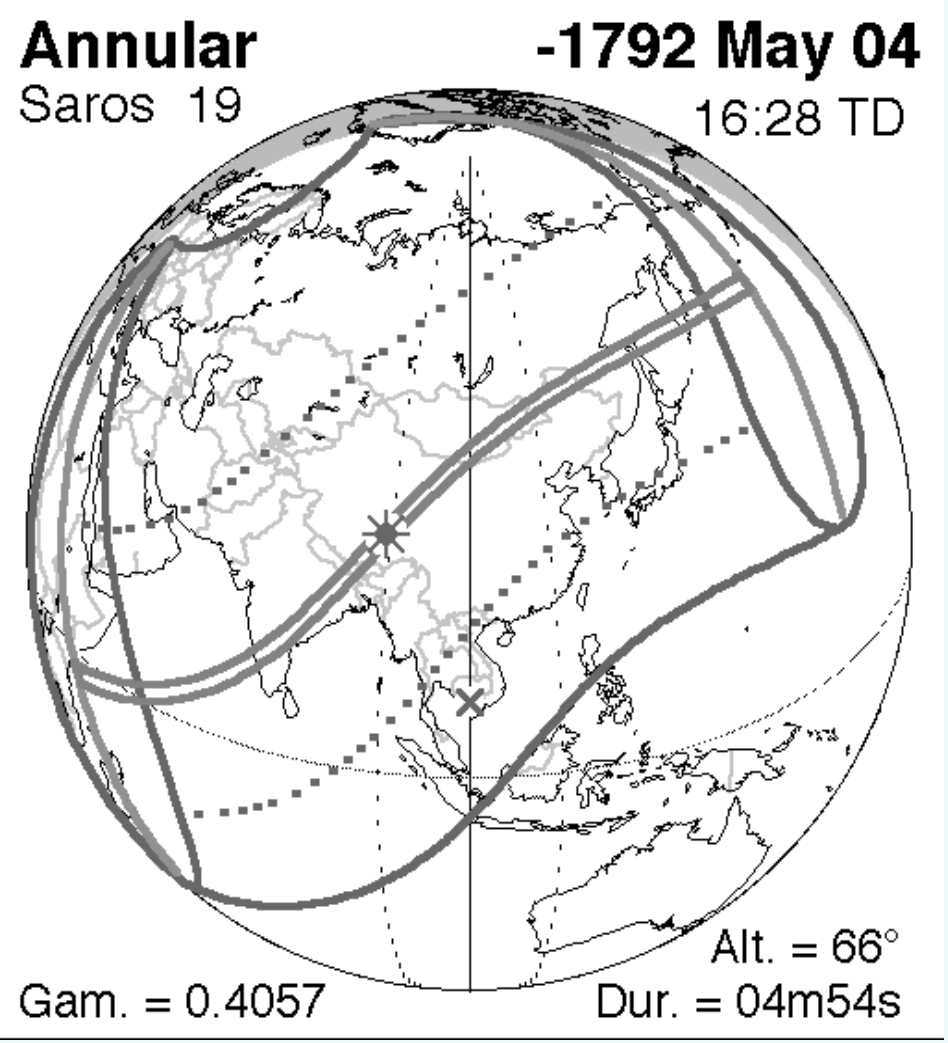
- Pair of solar and lunar eclipses occured in the same month at an interval of 13 days.
- We searched in 'Five Millennium Canons of Solar Eclipses/ Lunar Eclipses : **-1999 to +3000 (2000 BCE to 3000 CE)** NASA/TP-2006-214141, October 2006' and NASA/TP-2009-214172 January 2009 by **Espenak, Fred and Meus, Jean. (2006)**
  - Predictions based on the best available ephemerides
  - Improvement on the previous eclipse canons.
  - Uncertainties in the predictions due to
    - Variations in the rotation of the Earth and
    - Moon's distance due to its secular acceleration
- Predicted times, magnitude and area of visibility may differ from the observed ones within the specified limits.

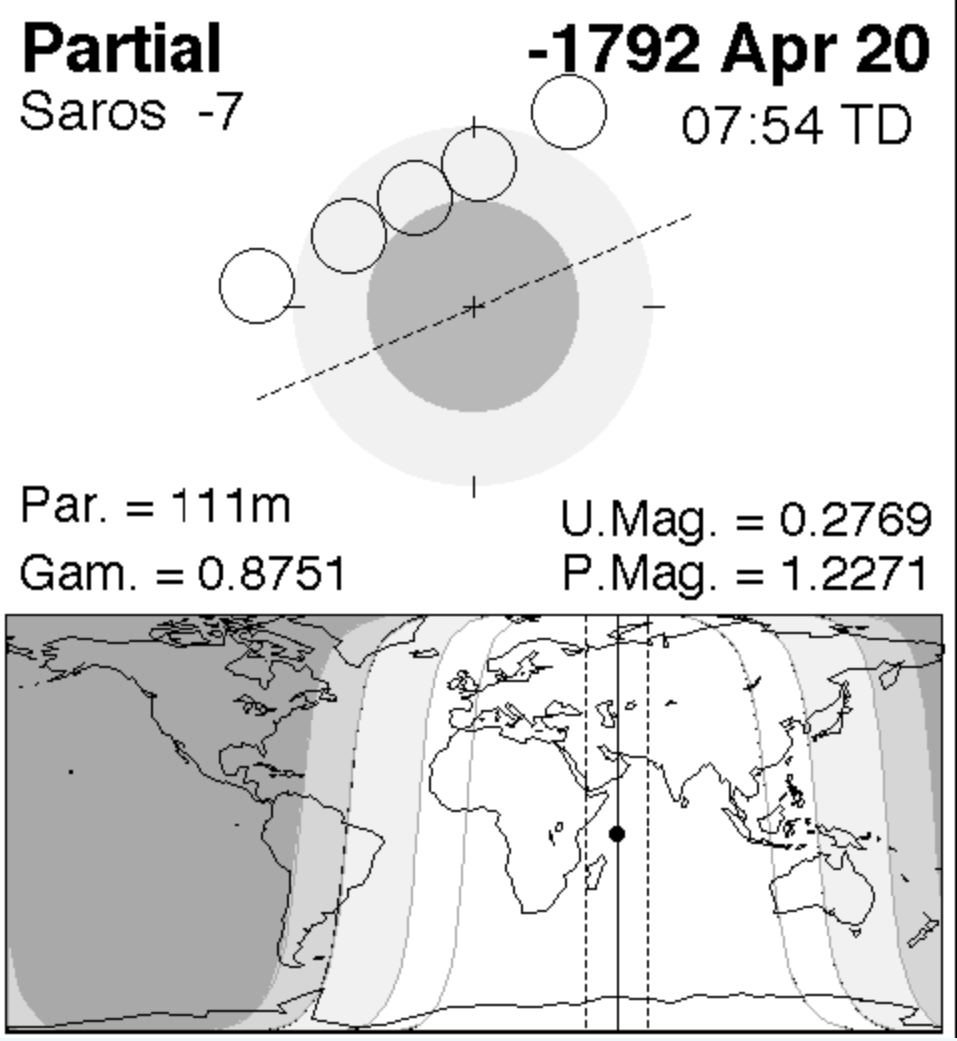
Eclipses…

- Search period -1999 to -740

  (Canon does not go before -1999)
- 75 pairs of eclipses shortlisted
- Most likely events visible over Kurukshetra/Indraprastha:

Calendar Date	Total Solar Eclipse	Lunar Eclipse
Julian	May 4, -1792	Apr 20, -1792
Gregorian	Apr 19, -1792	Apr 05, -1792





Solar Eclipse

[Apr 19, -1792 (Greg); May 4, -1792 (Juln)]

Lunar Eclipse

[Apr 05, -1792 (Greg); Apr 20, -1792 (Juln)]

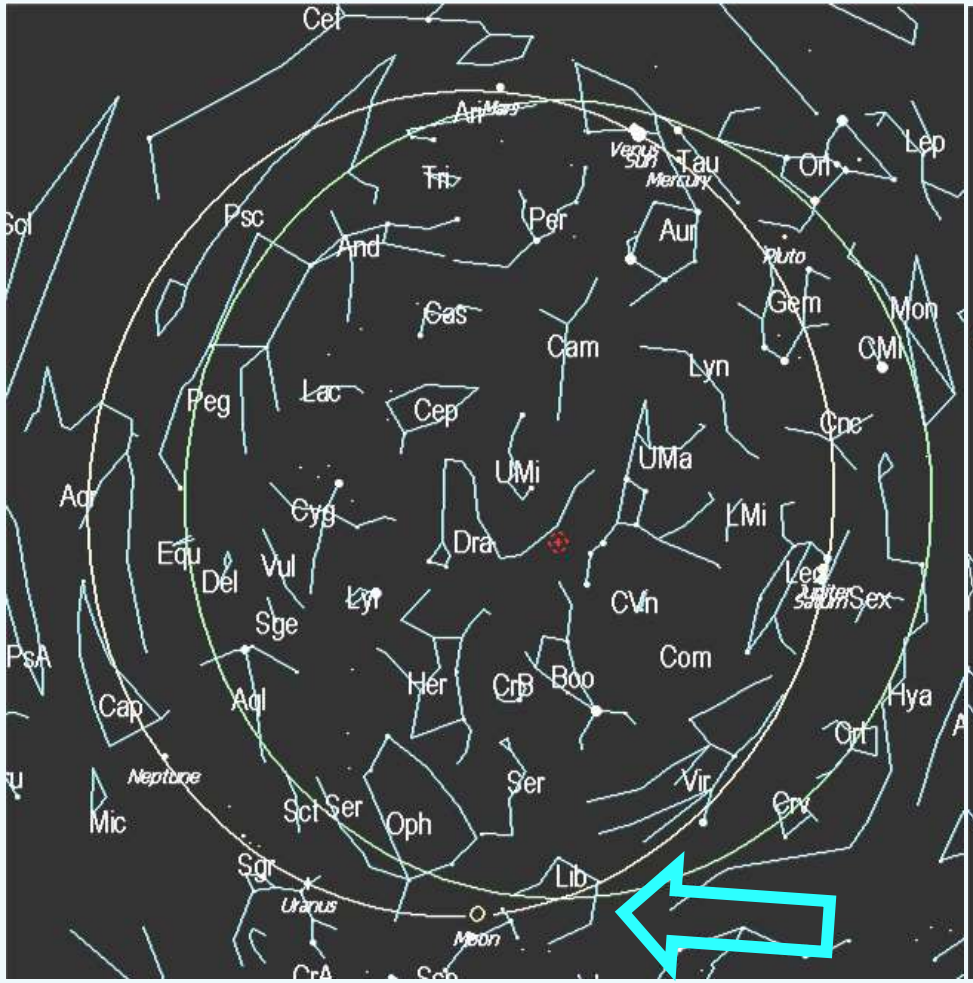
Five Millennium Canon of Solar Eclipses: –1999 to +3000 (2000 BCE to 3000 CE)

NASA/TP–2006–214141, October 2006

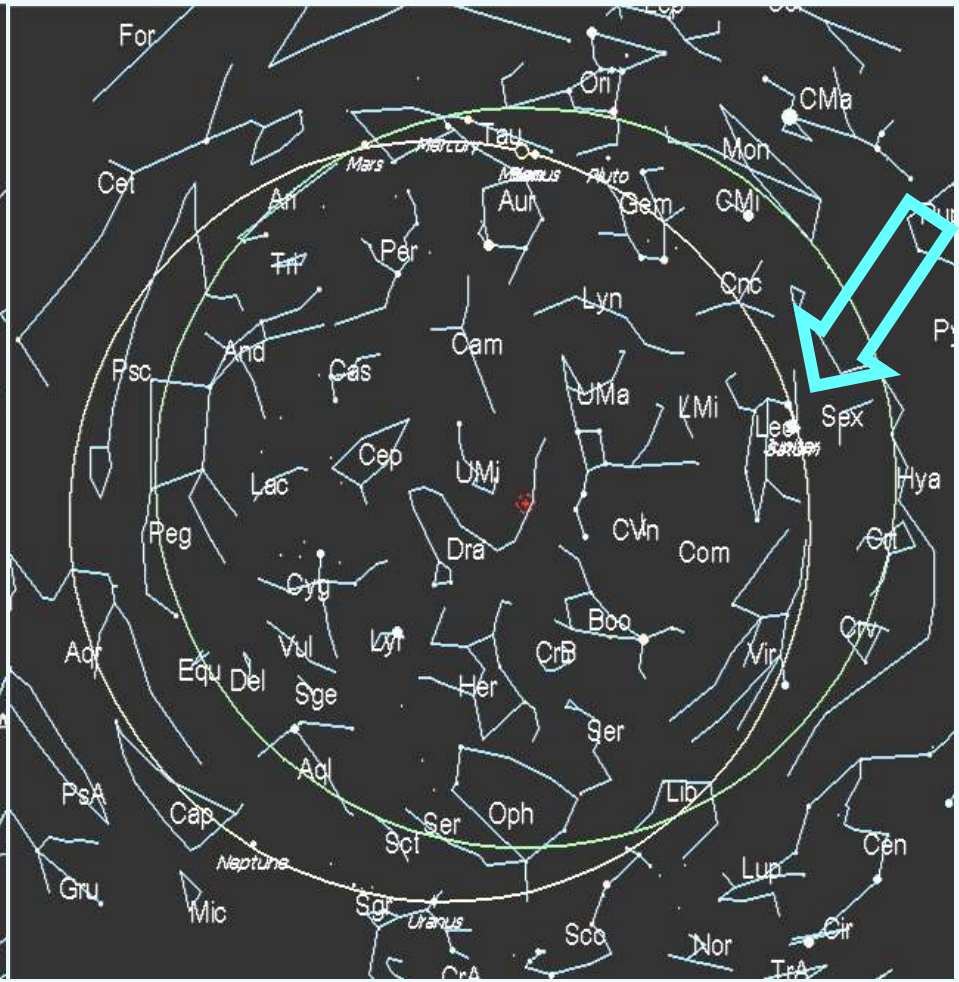
Fred Espenak and Jean Meeus

Eclipse Pair

Lunar Eclipse Apr 05 (G) Apr 20 -1792 (J)



Solar Eclipse Apr 19 (G) May 4 -1792 (J)



Eclipses…

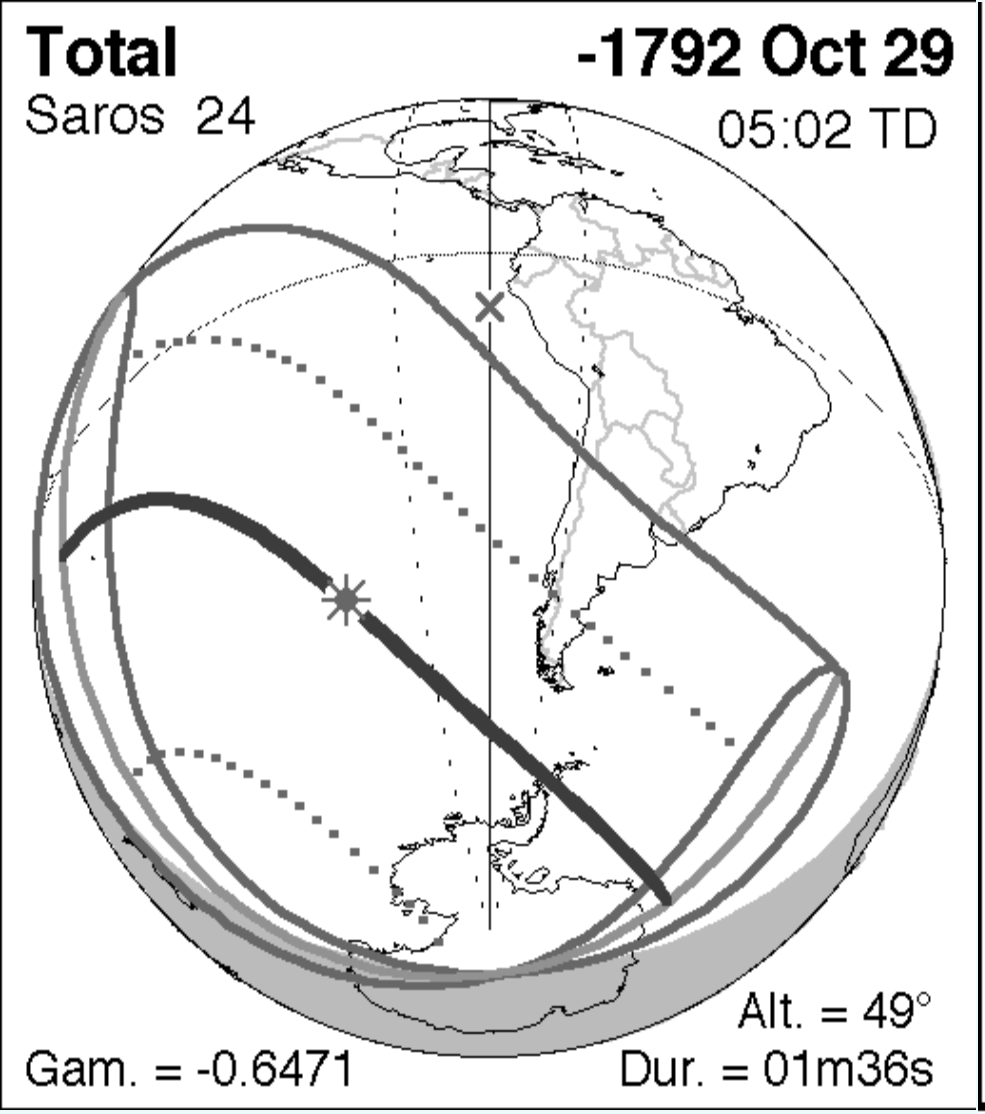
Further, Vyasa observes, in the following verse, that the *Kartik* full moon was lusterless.

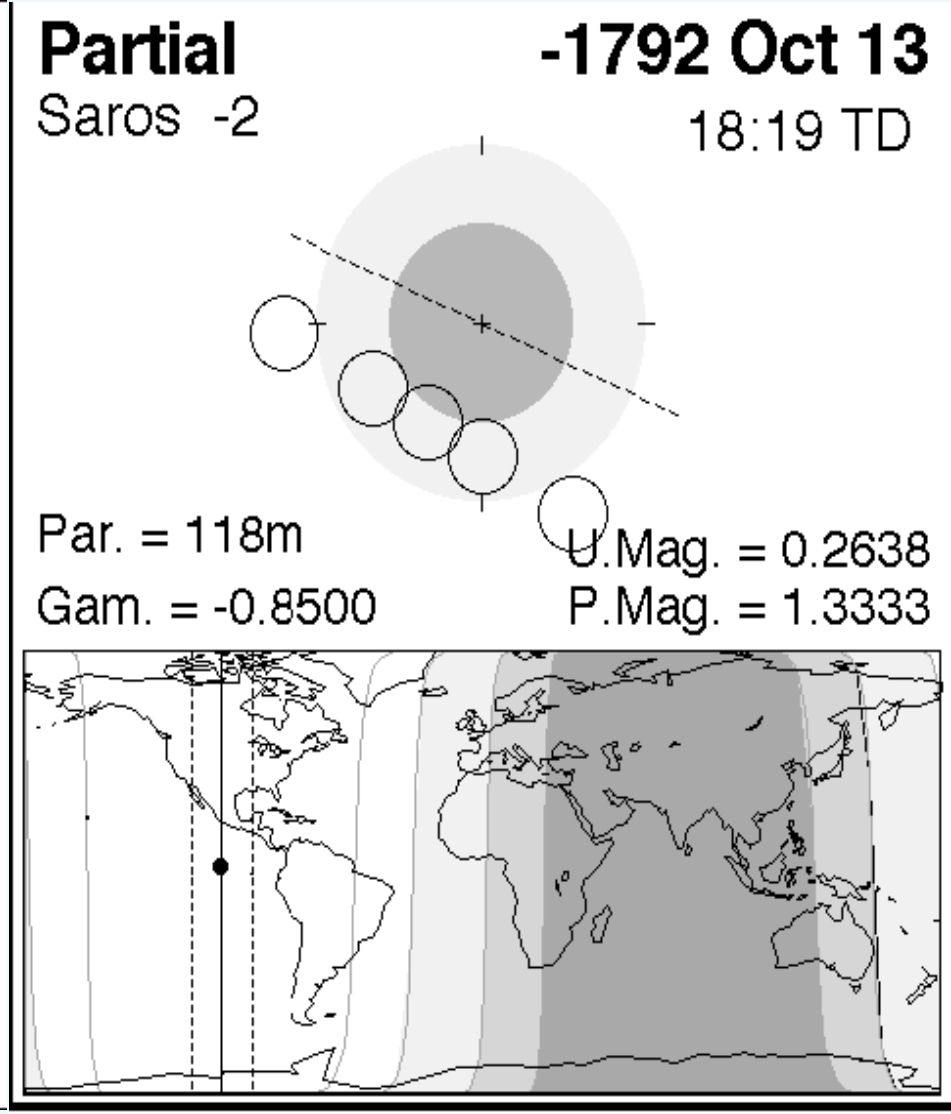
अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम|
चन्द्रो ऽभूद अग्निवर्णश च समवर्णे नभस्तले|| 23

alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm |
candro 'bhūd agnivarṇaś ca samavarṇe nabhastale||

MB 6.2/23 (Cr Ed 6.2/23)

'On even the fifteenth night of the lighted-fortnight in Kartika, the Moon, divested of splendour, became invisible, or of the hue of fire, the firmament being of the hue of the lotus'





Solar Eclipse (14 Oct -1792 Grego) **Lunar Eclipse(28 Sep -1792 Grego)**

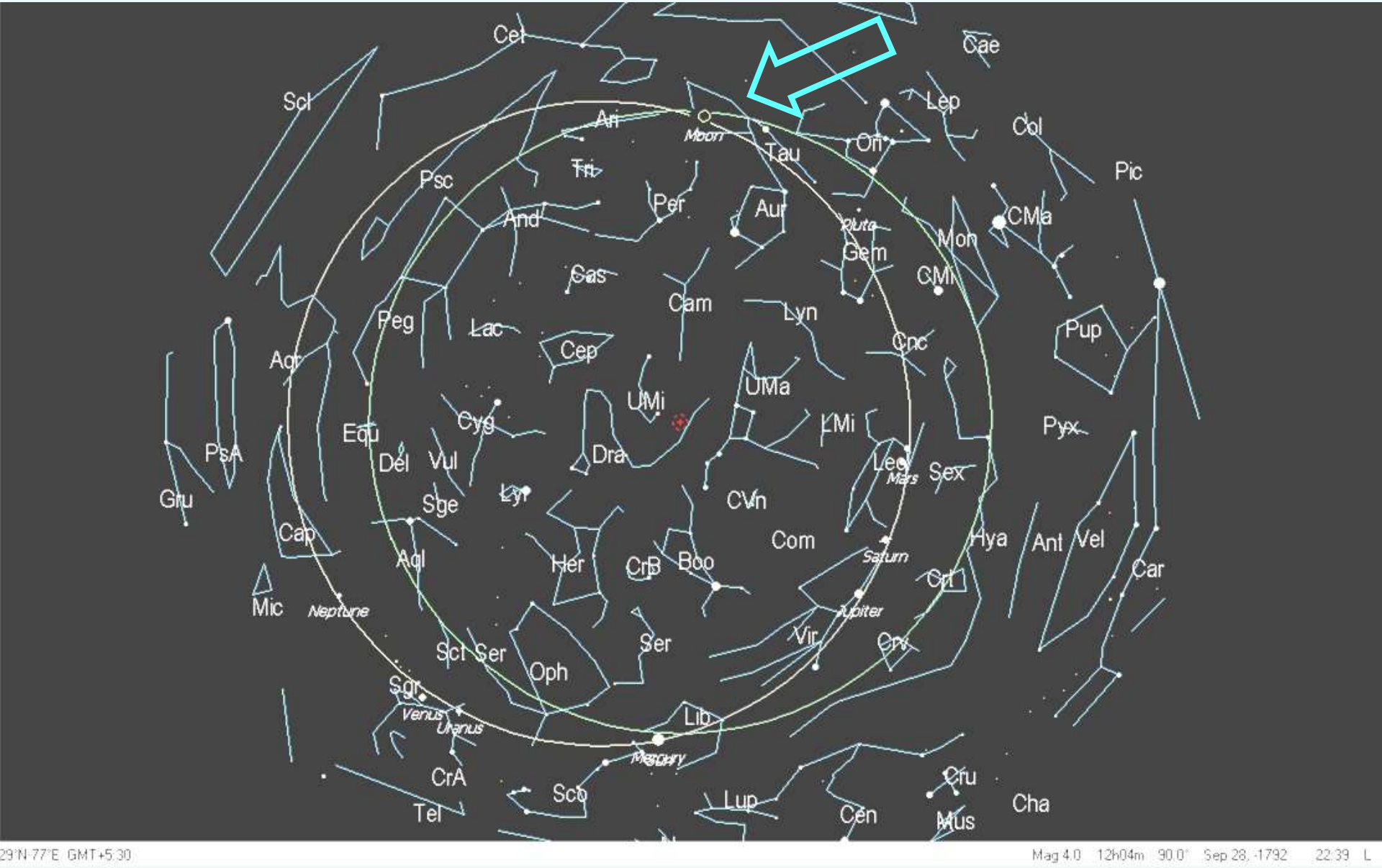
Five Millennium Canon of Lunar Eclipses: –1999 to +3000 (2000 BCE to 3000 CE)

NASA/TP–2009–214172

January 2009

Fred Espenak and Jean Meeus

28 Sep -1792; Lunar Eclipse on Kartik Purnima

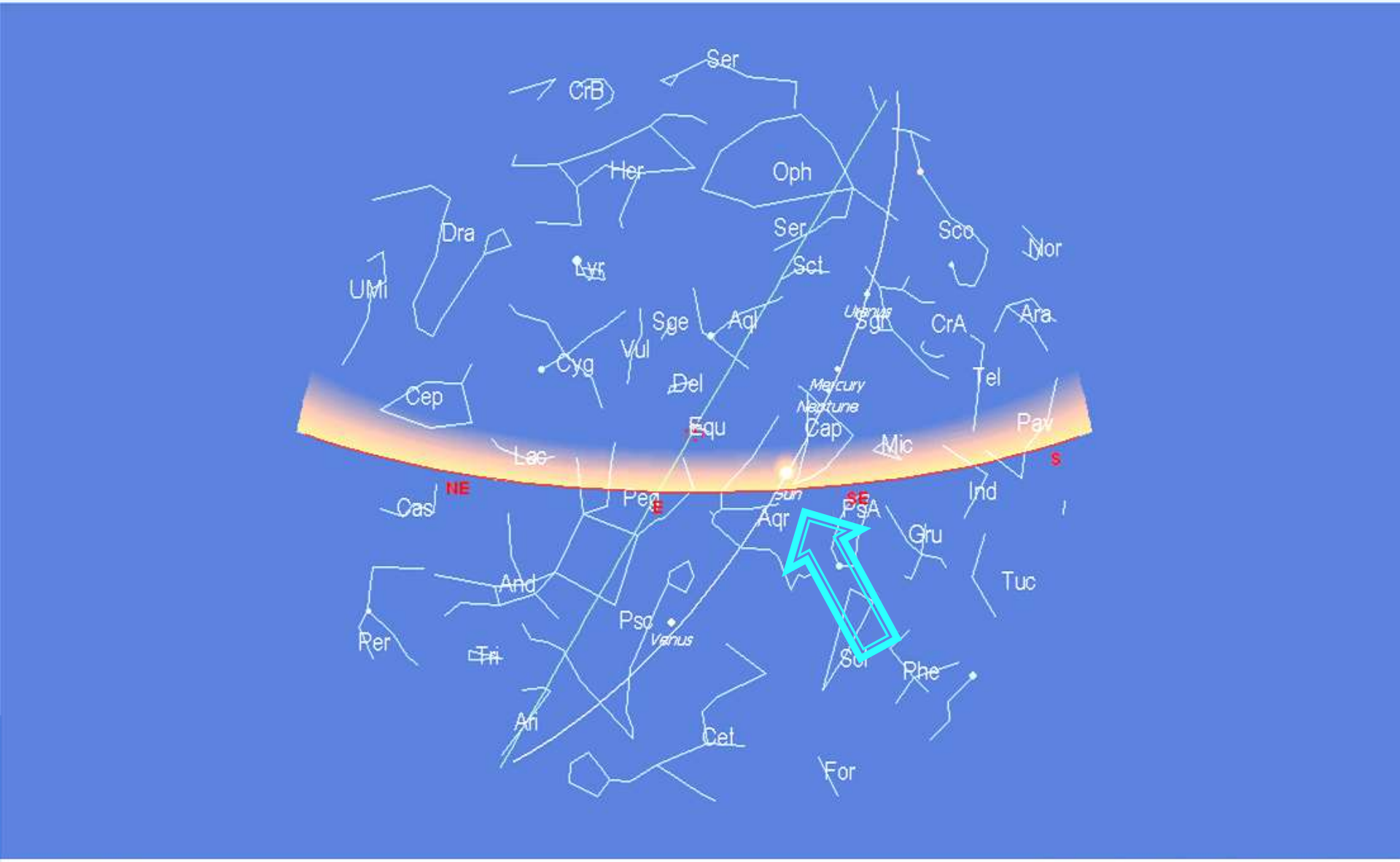


29°N 77°E GMT+5:30 Mag 4.0 12h04m 90.0° Sep 28, -1792 22:39 L

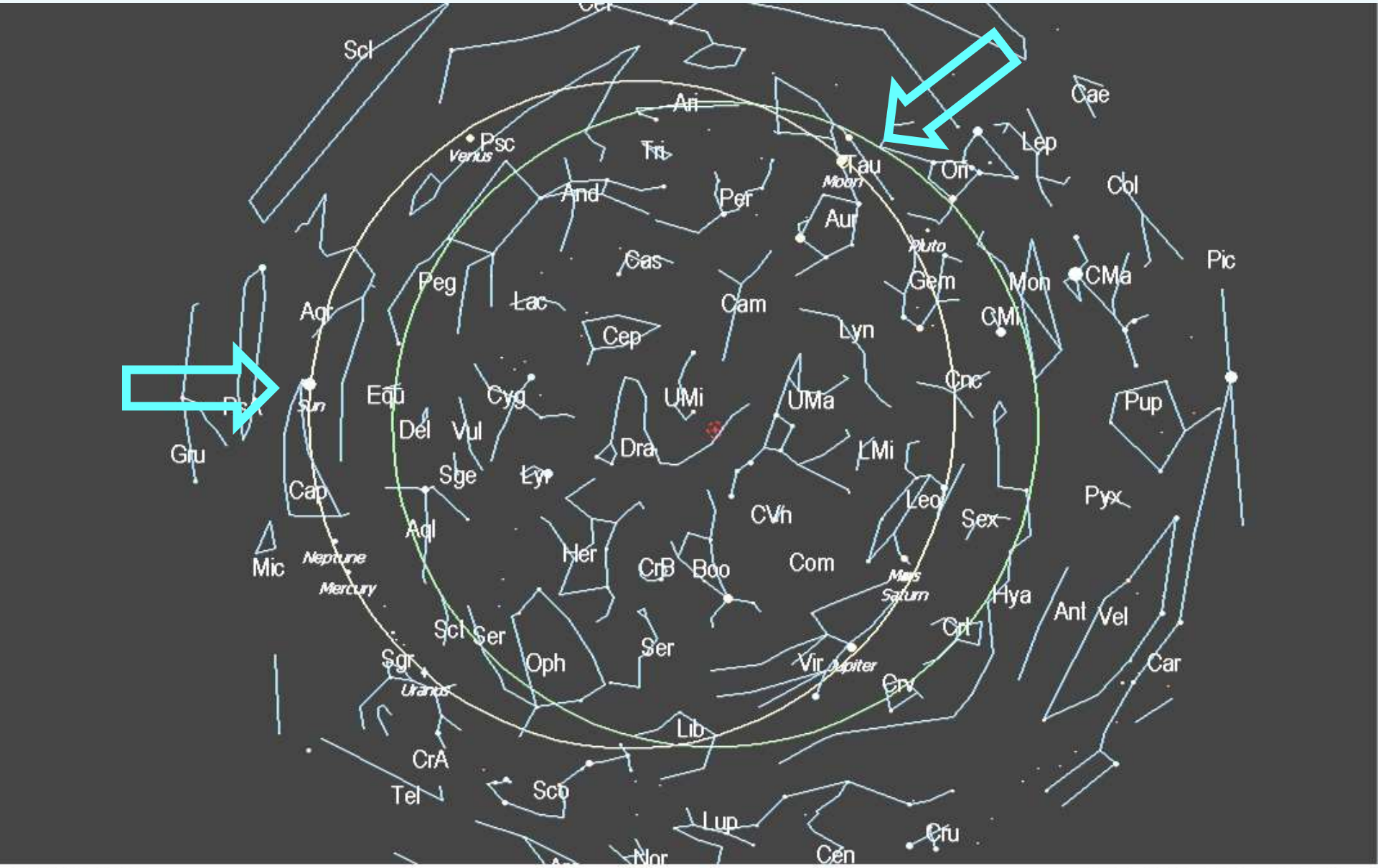
Eclipses…

- The above is a clear description of a lunar eclipse
- Above canons list a lunar eclipse in the same year on **Sep 28 -1792** (Greg) {October 13, -1792 Juln}. In fact, it is another pair in that year.
- Seen on *Kartik Purnima* in simulation (28 Sep)
- **This fixes the year of our search as -1792**
- Simulation shows WS on Magha S 8 *accurately on* 20 December -1792 in *Rohini Nakshatra* (Bhishma's demise)
- The year -1792 is the only one among 75 years shortlisted that satisfies above condition, i.e., WS on *Magha Sukla 8 (*in *Rohini)*

20 Dec -1792; Winter Solstice



20 Dec -1792; Winter Solstice on Magha S 8; Rohini Nakshtr: Bhisma's demise



29°N 77°E GMT+5:30 Mag 4.0 11h31m 88.5° Dec 20, -1792

Other events: war beginning on Kartik Amavasya

अहानि युयुधे भीष्मो दशैव परमास्त्रवित्|
अहानि पञ्च दरोणस तु ररक्ष कुरु वाहिनीम|| 30

ahāni yuyudhe bhīṣmo daśaiva paramāstravit|
ahāni pañca droṇas tu rarakṣa kuru vāhinīm||

MB 1.2/30 (Cr Ed 1.2/26)

' Bhishma acquainted with choice of weapons, fought for ten days. Drona protected the Kaurava Vahinis for five days'.

अष्टपञ्चाशतं रात्र्यः शयानस्यादय मे गताः|
शरेषु निशिताग्रेषु यथा वर्षशतं तथा|| 27

aṣṭa pañcāśataṃ rātryaḥ śayānasyādya me gatāḥ |
śareṣu niśitāgreṣu yathā varṣaśataṃ tathā||

MB 13.167 / 27 (Cr Ed 13.153/27)

'I have been lying on my bed here for eight and fifty nights. Stretched on these sharp-pointed arrows I have felt this period to be as long as if it was a century.'

Other events…

- The above lines show that
  - Bhishma fell in the battle on the 10th day.
  - He lay there for 58 days before breathing his last on WS day.
- Therefore, the battle began 68 days before WS
- Counting 68 days from 20 Dec -1792 (WS) we arrive at **14 Oct -1792** as the date when war began.
- Let us see the following verse now:

Krishna suggests war to begin on ensuing Amavasya

सर्वौषधिवनस्फीतः फलवानल्पमक्षिकः |
निष्पङ्को रसवत्तोयो नात्युष्णशिशिरः सुखः|| 17
सप्तमाच चापि दिवसाद अमावास्या भविष्यति |
संग्रामं योजयेत तत्र तां हय आहुः शक्र देवताम|| 18

sarvauṣadhi vanasphītaḥ phalavān alpamakṣikaḥ |
niṣpaṅko rasavat toyo nātyuṣṇa śiśiraḥ sukhaḥ||
saptamāc cāpi divasād amāvāsyā bhaviṣyati |
saṃgrāmaṃ yojayet tatra tāṃ hy āhuḥ śakra devatām||

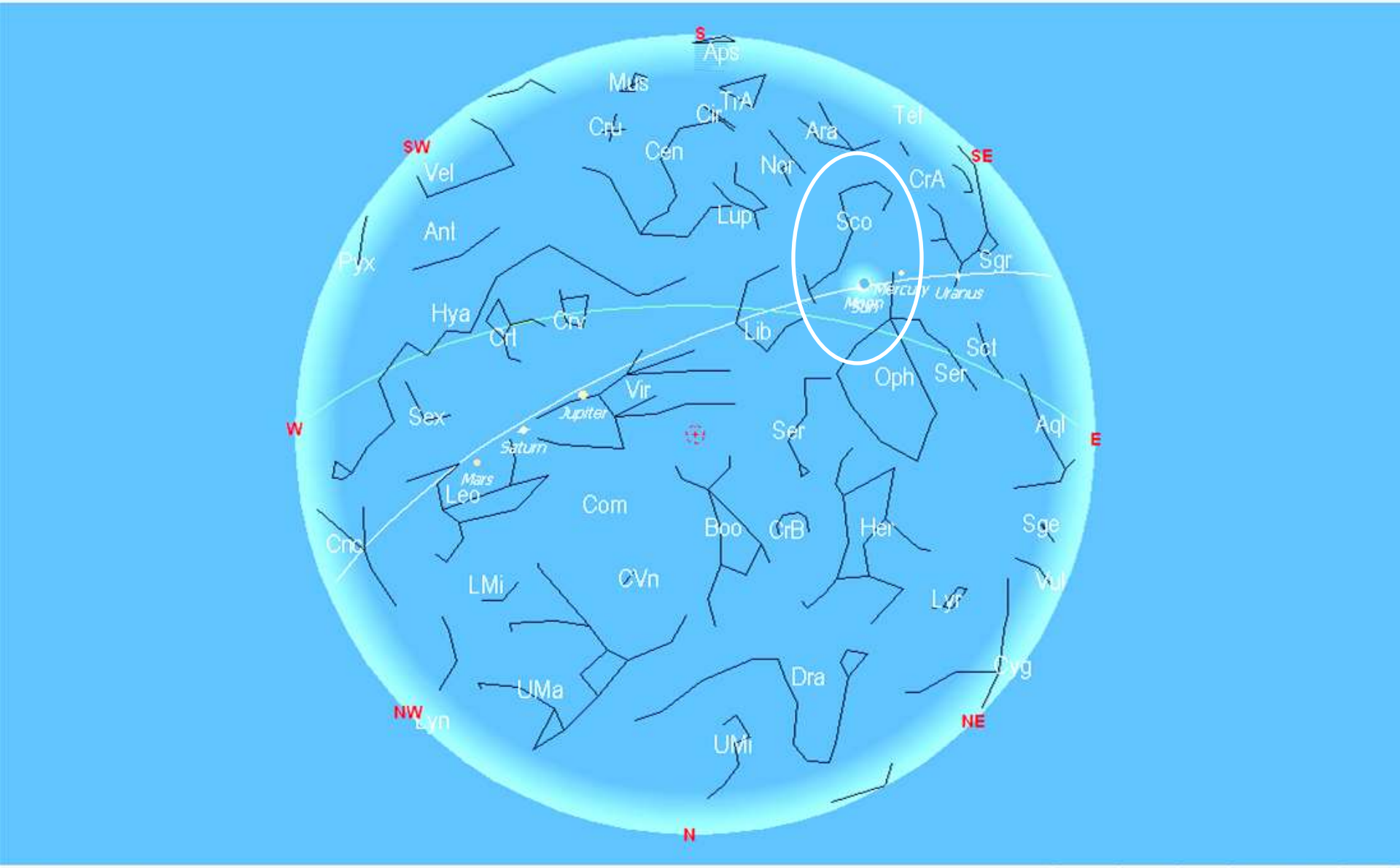
MB 5.142/17,18 (Cr Ed 5.140/17,18)

…O Karna, say unto Drona …'that all plants and herbs are vigorous now, all trees full of fruits, and flies there are none… The weather is neither very hot nor very cold and is, therefore, highly pleasant'.

'Seven days after, will be the day of the new moon. Let the battle commence then, for that day, it hath been said, is presided over by Indra'.

Simulation accurately reproduces Kartika Amavasya on 14 Oct -1792.

14 Oct -1792; War to Begin on Amavasya (in Jyeshtha)



29°N 77°E GMT+5:30 ---------- 180.9° 90.0° Oct 14, -1792 09:50

Other events: Pandavas' Departure for Varnavat

अष्टमे ऽहनि रौहिण्यां प्रयाताः फल्गुनस्य ते|
वारणावतम आसाद्य ददृशुर नागरं जनम||34

aṣṭame 'hani rohiṇyāṃ prayātāḥ phalgunasya te|
vāraṇāvatam āsādya dadṛśur nāgaraṃ janam||

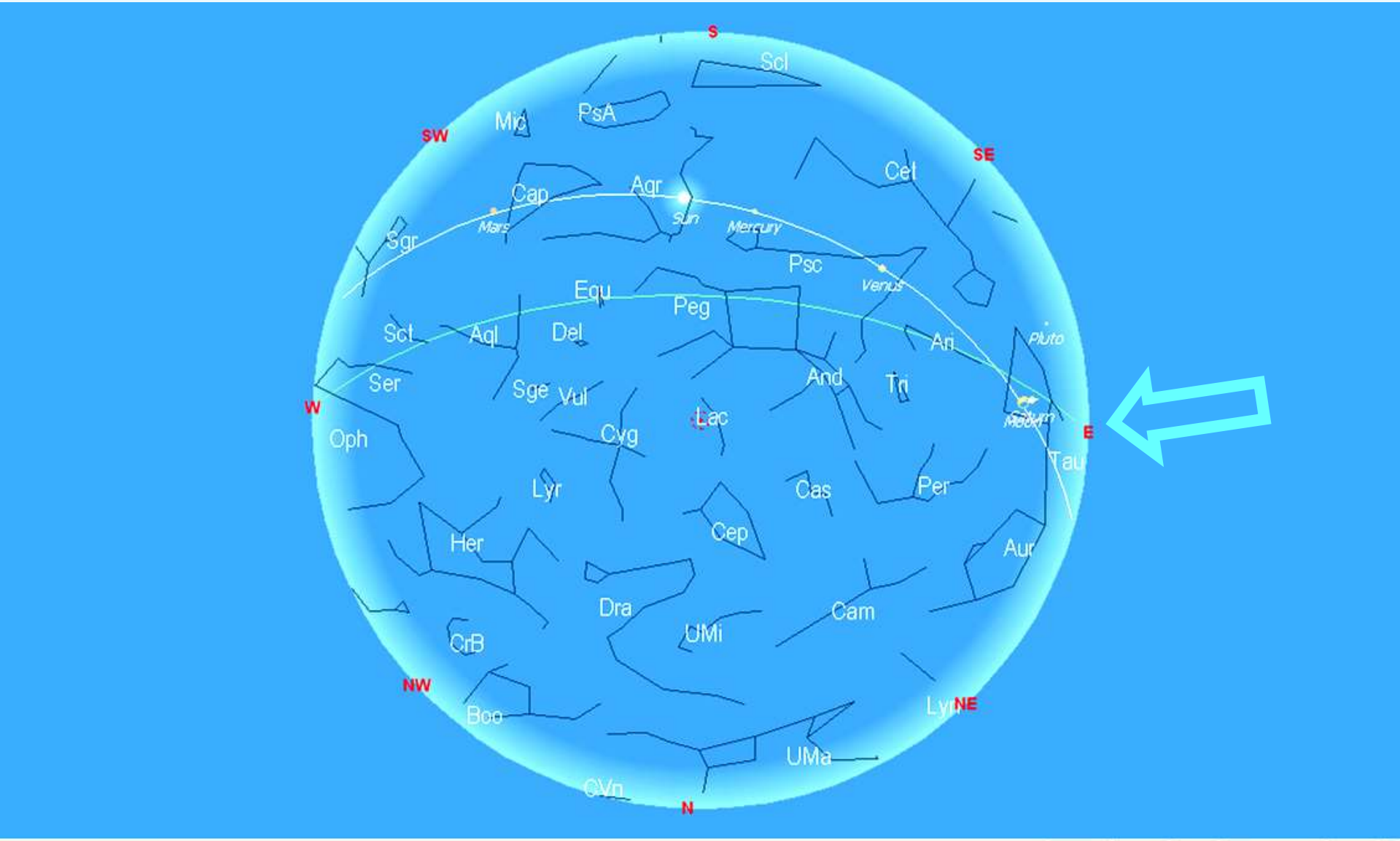
MB 1.145/34 (Cr Ed 1.133/30)

*…Vaisampayana continued, 'The Pandavas set out on the **eighth** day of the month of **Phalguna** when the star **Rohini was in the ascendant**, and arriving at Varanavata they beheld the town and the people'.*

- This configuration is accurately reproduced on 5 January -1828 i.e. nearly 36 years before Bhishma died on 20 December -1792.

05 Jan -1828 ; Departure to Varanavat; Phalgun S8

Rohini Nakshtr Ascendant



dia 29°N·77°E GMT+5:30 ····· 181.9° 90.0° Jan 05, -1828 12:55 L

Other events contd… Arjun's exile for 12 years

सो ऽभयनुज्ञाप्य राजानं ब्रह्मचर्याय दीक्षितः|
वने दवादॅश वर्षाणि वासायॊपजगाम ह||35

so 'bhyanujñāpya rājānaṃ brahmacaryāya dīkṣitaḥ|
vane dvādaśa varṣāṇi vāsāyopajagāma ha||

MB 1.213/35 (Cr Ed 1.205/30)

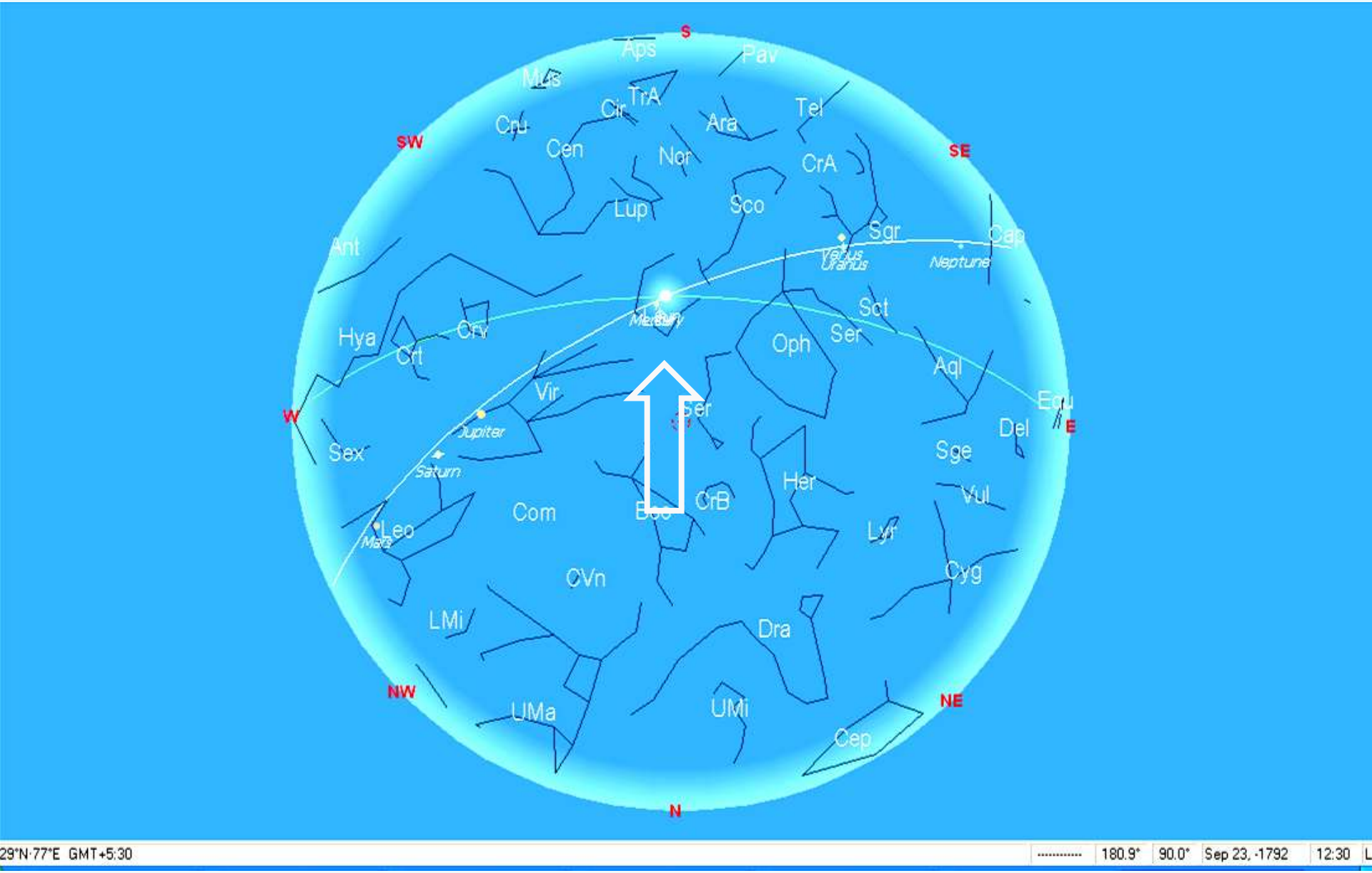
*'Vaisampayana continued, 'Obtaining then the king's permission, Arjuna prepared himself for a forest-life; and he went to the forest to live there for **twelve years**'.*

- This happened after the Pandavas succeeded in surviving the 'Lakshya Griha' episode and spent a year or two in secrecy. During that period, they married Draupadi and finally returned to Indraprastha.

Other events contd… Krishna's peace mission MB/5/83/7 (Cr Ed)5.81/7

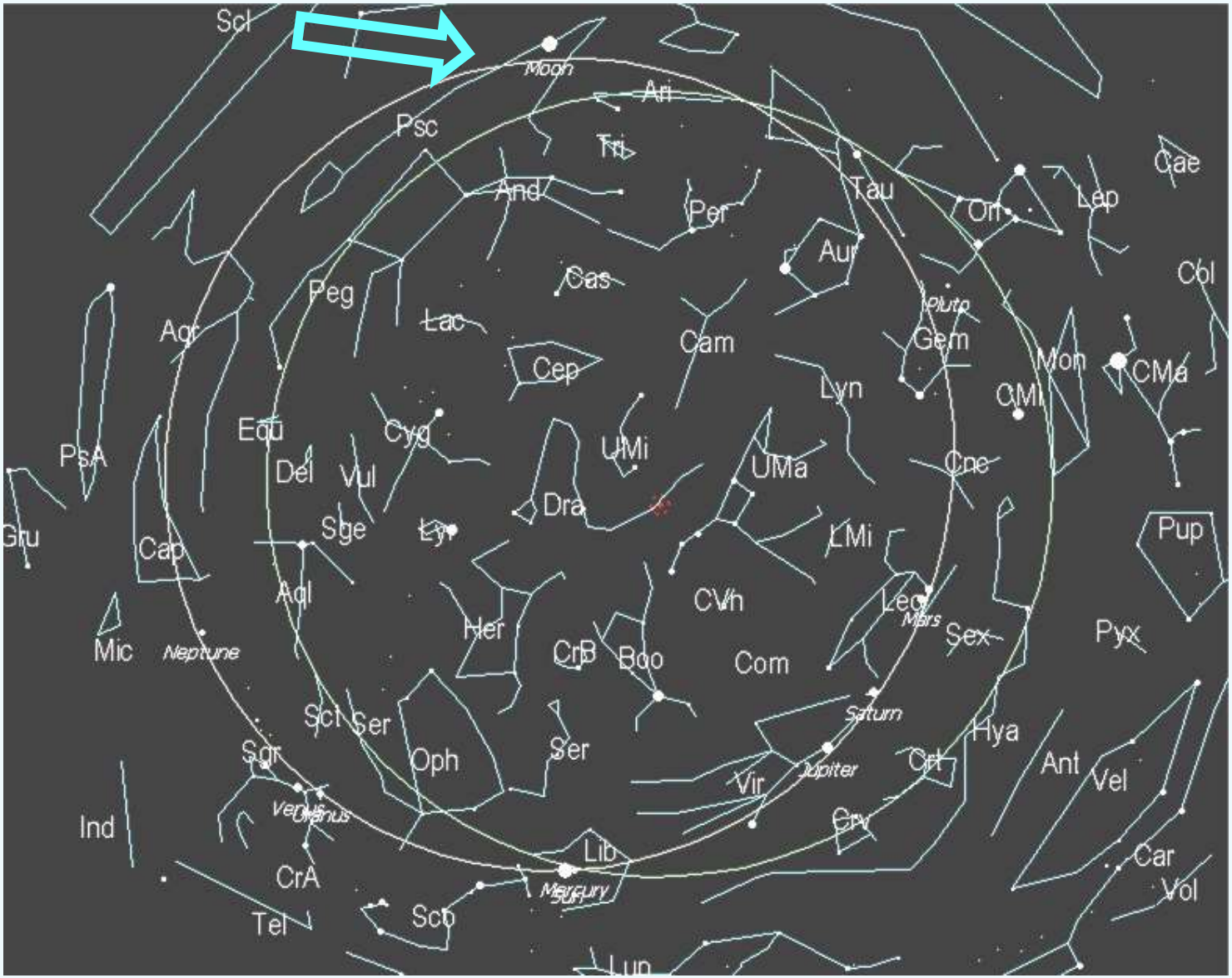
- Month: *Kaumuda (Kartika)* under *Revati*
- Season: *Sharad* to *Hemanta;* Autumnal equinox on 23 Sep -1792
- The date is well after 15 Sept., the normal date of withdrawal of monsoon from Delhi region
- The scenario is accurately reproduced on 26 Sep -1792

23 Sep -1792; Autumn Equinox in Visakha (β Lib);
Mars in Magha, Saturn P/UPhalguni, Jupiter Hasta, Venus P. Ashadha



29°N·77°E GMT+5:30 ····· 180.9° 90.0° Sep 23, -1792 12:30

26 Sep -1792; Krishna's Peace Mission
Kartik month, Revati Nakshtr (ζ Psc)



Issues resolved- Planets before and during war

- Most references to planets in *MB* : astrological
- Identity of celestial objects not straightforward
- Often a planet seen associated with two or more *Nakshatras* at the same time
- Planetary positions given in astrological terms like '*afflicting'* or *'aspecting'* a constellation
- The time is the eve of the war around the month of *Kartik* of -1792
- We tried clues to their position from the astrological usage in the following verses.

Planets

प्रजापत्यं हि नक्षत्रं ग्रहस्तीक्ष्णो महाद्युतिः |
शनैश्चरः पीडयति पीडयन् प्राणिनो ऽधिकम् ||8
कृत्वा चाङ्गारको वक्रं जयेष्ठायां मधुसूदन |
अनुराधां प्रार्थयते मैत्रं संशमयन्निव ||9

prājāpatyaṃ hi nakṣatraṃ grahas tīkṣṇo mahādyutiḥ| śanaiścaraḥ pīḍayati pīḍayan prāṇino 'dhikam||
kṛtvā cāṅgārako vakraṃ jyeṣṭhāyāṃ madhusūdana| anurādhāṃ prārthayate maitraṃ saṃśamayann iva ||

MB 5.143/8,9 (Cr Ed 5.141/8,9)

'That fierce planet of great effulgence, Sanaischara (Saturn), is afflicting the constellation called Rohini, in order to afflict greatly the creatures of the earth'.

'The planet Angaraka (Mars), wheeling, O slayer of Madhu, towards the constellation Jeshthya, approacheth towards Anuradhas, indicating a great slaughter of friends'.

Planets...

मघास्व अङ्गारको वक्रः श्रवणे च बृहस्पतिः|
भगम् नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते ||

maghāsv aṅgārako vakraḥ śravaṇe ca bṛhaspatiḥ|
Bhāgaṃ nakṣatram ākramya sūryaputreṇa pīḍyate ||

शुक्रः प्रोष्ठपदे पूर्वे समारुह्य विरोचते /
उत्तरे तु परिक्रम्य सहितः समुदीक्षते ||

śukraḥ proṣṭhapade pūrve samāruhya virochate |
uttare tu parikramya sahitaḥ samudīkṣate ||

MB 6.3/14,15 (Cr Ed 6.3/13,14)

'Mars wheeleth towards Magha and Vrihaspati (Jupiter) towards Sravana. The Sun's offspring (Sani) approaching towards the constellation Bhaga, afflicteth it'.

'The planet Sukra, ascending towards Purva Bhadra, shineth brilliantly, and wheeling towards the Uttara Bhadra, looketh towards it, having effected a junction (with a smaller planet)'.

Planets...

ध्रुवः प्रज्वलितो घोरमपसव्यं प्रावर्तते |
रौहिणीम पीडयत्येवमुभौ च शाशिभास्करौ |
चित्रास्वात्यन्तरे चैवंविष्ठितः परुषग्रहः ||17

dhruvaḥ prajvalito ghoram apasavyaṃ pravartate|
Rohinim Pidayatyevamubhau ch sasibhaskarau| (This line not in critical edition)
citrā svāty antare caiva dhiṣṭhitaḥ paruṣo grahaḥ ||

MB 6.3/17,18 (Cr Ed 6.3/16)

'The constellation Dhruva, blazing fiercely, wheeleth towards the right. ***Both the Moon and the Sun are afflicting Rohini.*** *The fierce planet (Rahu) hath taken up its position between the constellations Chitra and Swati'.*

Planets...

वक्रानुवक्रं कृत्वा च श्रवणे पावकप्रभः|
ब्रह्मराशिं समावृत्य लोहिताङ्गो व्यवस्थितः||18

vakrānuvakraṃ kṛtvā ca śravaṇe pāvakaprabhaḥ|

brahmarāśiṃ samāvṛtya lohitāṅgo vyavasthitaḥ ||

MB 6.3/18 (Cr Ed 6.3/17)

'The red-bodied (Mars) possessed of the effulgence of fire, wheeling circuitously, stayeth in a line with the constellation Sravana over-ridden by Vrihaspati'.

Planets

संवत्सरस्थायिनौ च ग्रहौ प्रज्वलितावुभौ | विशाखायाः समीपस्थौ बृहस्पतिशनैश्चरौ || 27

saṃvatsarasthāyinau ca grahau prajvalitāv ubhau |viśākhayoḥ samīpasthau bṛhaspatiśanaiścarau ||

MB 6.3/27 (Cr Ed 6.3/25)

'Those two blazing planets, viz., Vrihaspati and Sani, having approached the constellation called Visakha, have become stationary there for a whole year'.

Again, Jupiter's position here is different from *Sravana* as shown under MB/6/3/13 above and *Sani's* is different from *Bhaga* as shown in MB/6/3/14.

मघा विषयगः सोमस तद दिनं प्रत्यपद्यत| दीप्यमानाश च संपेतुर दिवि सप्त महाग्रहाः||2

maghā viṣayagaḥ somas tad dinaṃ pratyapadyata | dīpyamānāś ca saṃpetur divi sapta mahāgrahāḥ ||

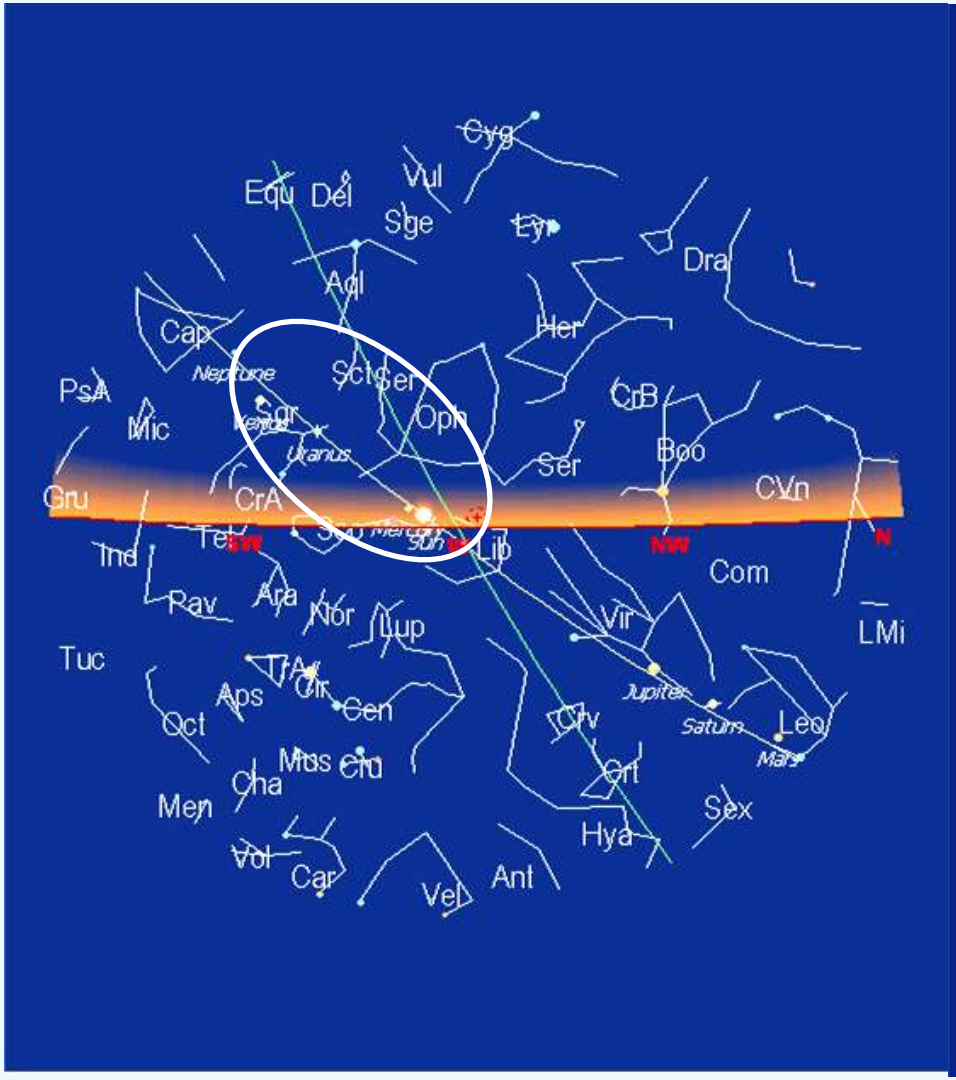
MB 6.17/2 (Cr Ed 6.17/2)

'On that day on which the battle commenced Soma approached the region Magha. The seven large planets (Grahas), as they appeared in the firmament, all looked blazing like fire'.

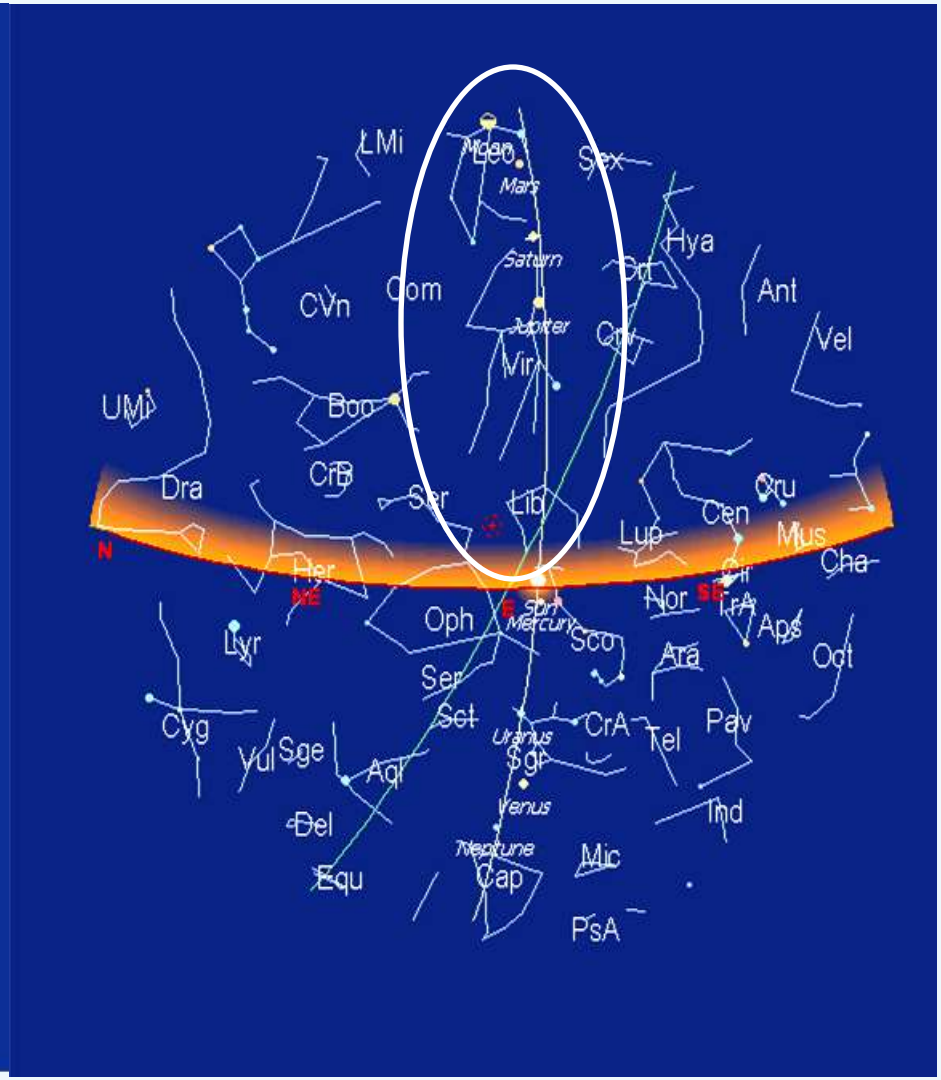
5/6 Oct -1792; Sun Moon and 5 Planets 'blazing in night sky'

MB 6.17/2

Evening (after sunset)



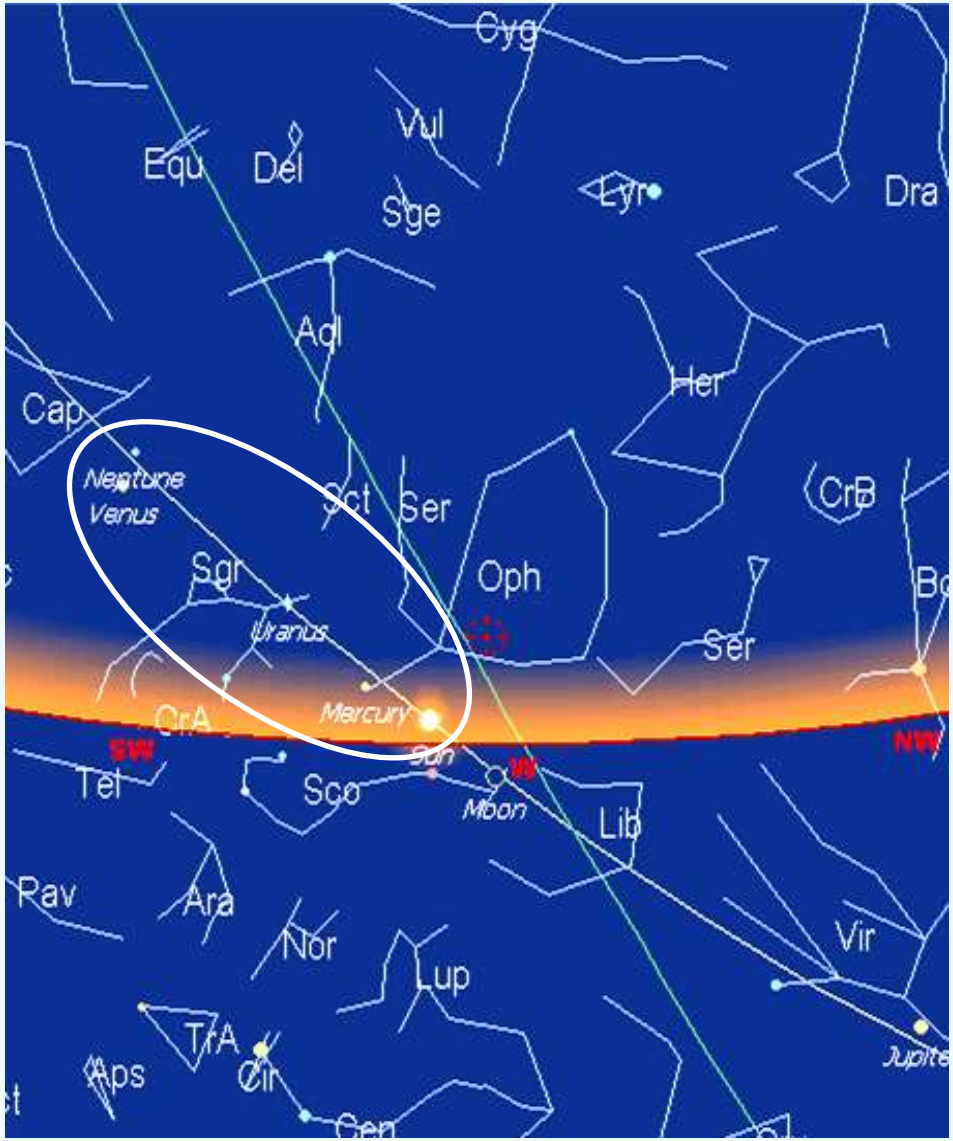
Morning (before sunrise)



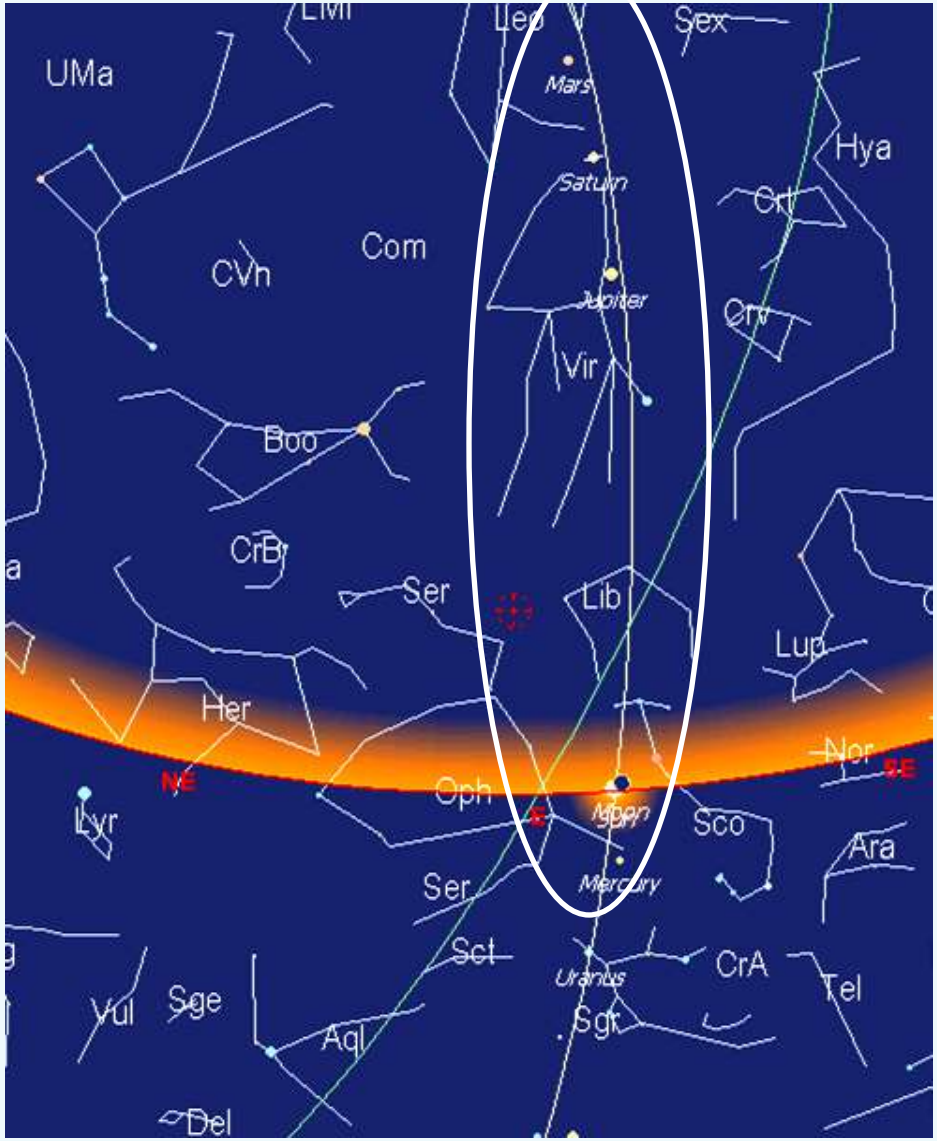
13/14 Oct -1792; Sun, Moon & 5 Planets 'blazing in night sky'

MB 6.17/2 & MB 6.3/17

Evening (13th after sunset)



Morning (14th before sunrise)



Planets…

सकानना: साद्रि चयाश चकम्पु:; प्रविव्यथुर भूतगणाश च मारिष|
बृहस्पति रोहिणीं संप्रपीड्य; बभूव चन्द्रार्कसमानवर्ण: ||

sakānanāḥ sādri cayāś cakampuḥ; pravivyathur bhūtagaṇāś ca māriṣa|
bṛhaspatī rohiṇīṃ saṃprapīḍya; babhūva candrārkasamānavarṇaḥ

MB 8.94/51 (Cr Ed 8.68/49)

'The planet Jupiter, afflicting the constellation Rohini assumed the hue of the moon or the sun'. (On Karna falling)

Issues resolved- Planets before and during war

- Various position indicators of planets described in respective slokas are summarized in Table 1 below.
- The location is simulated for 5 Oct and 14 Oct -1792, just before the war as shown in Table 2.
- The positions of Moon and Mars in *Magha* and Saturn in P./U. Phalguni are reproduced as per the slokas shown.
- In order to explain the dual positions mentioned in the text, we used astrological terminology for 'afflicted' or 'aspected' houses. The aspected house(s)/nakshatra are shown in the table 2 as per common usage.
- We find that the afflicted or aspected house thus determined correctly shows the position of Sun, Moon, Mars, Jupiter and Saturn as indicated in respective sloka as shown in Table 2.

Table 1. Summary of location of Sun, Moon and Planets

Object	*Sloka*	Location indicator	Time
Sun	6 Bhishma/3/17	*Rohini*(afflicted)	Before war
Moon	6 Bhishma/3/17	*Rohini* (–do–)	Before war
	6 Bhishma/17/2	*Magha*✓	Before war
Venus★	6 Bhishma/3/15	*P.Bhadra/U. Bhadra* ★	Before war
Mars	5 Udyog/143/9	*Jyesth/Anuradha*	Before war
	6 Bhishma3/14	*Magha*✓	Before war
	6 Bhishma/3/18	*Sravana* (in line with)	Before war
Jupiter	6 Bhishma3/14	*Sravana*	Before war
	6 Bhishma/3/27	*Visakha* for 1 yr	>1 yr Before war
	8 Karna 94/51	*Rohini* (afflicted)	17th d of war
Saturn	5 Udyog/143/8	*Prajapati* (*Rohini*) affl.	Before war
	6 Bhishma/3/14	*Approaching* affl *Phalgn* ✓	Before war
	6 Bhishma/3/27	*Visakha* for 1 yr	>1 yr Before war

Table 2. Simulated locations and house aspected (afflicted)

Object	Aspects House	Simulated Location 5 Oct -1792	Simulated Location 14 Oct -1792	Houses/Nakshatras Aspected (afflicted)
Sun	7th from its position	8 Sco/ *Anur-Jysth*	8 Sco/ *Jyesth*	2 Tau/*Rohini*✓(MB 6.3/17)
Moon	7 th do-	5 Leo/ *Magha*✓	8 Sco/ *Jyesth*	11 Aqr/P. Bhadrapada 2 Tau/*Rohini*✓(MB 6.3/17)
Venus★	7 th do-	9Sgr/ *U. Ashad*★	10 Cap/ *Sravn*	3 Gem/*Punarvasu*, 4 Cancer/*Pushya* (MB 6.3/14,15)
Mars	4th,7th,8th do-	5 Leo/ *Magha*✓	5 Leo/ *Magha*✓	8 Sco/*Jyesth*,✓(MB 5.143/9)
Jupiter	3rd,7th,9th do-	6 Vir/ *Hasta*	6 Vir/ *Hasta*	2 Tau/*Rohini*✓(MB 8.94/51)
Saturn	3rd,7th, 10th do-	5 Leo/ *P/U.Phalg*✓	5Leo/ *P/U.Phalg* ✓	2 Tau/*Rohini*✓(MB 5.143/8)

Issues resolved- Planets before and during war

- ⋆ As regards Venus, it was in *Purvashadha* on 20 Sep. and in *Uttarashadha* on 5 Oct. -1792
- Translator of *MB 6.3/15* interprets it to be in *Purva Bhadrapada*
- Astronomically, it is not possible- Venus cannot go farther than about 46° from Sun in the sky
- In end of *Kartik* month (in autumn), Sun is in *Jyestha* and *Purva Bhadrapada* is> 100° away from *Jyestha*
- We therefore suggest that the correct interpretation is *Purvashadha/Uttarashadha* and not *Purva Bhadrapada*
- This would perhaps resolve most of the ambiguities in planetary positions stated.

Mahabharata events in chronological order

Event	Ref. MB Cr Ed	Date
Pandavas departure to Varnavrat	*1.133/30*	05 Jan -1828
Arjun's exile for 12 years	*1.205/30*	Around -1825
Eclipse Pair	*6.3/28,29*	Apr 5 &19 -1792
Autumn Equinox (reference to autumn)	*5.81/7*	23 Sep -1792
Krishna's Peace Mission	*5.81/7*	26 Sep -1792
Lunar Eclipse on Kartik Purnima	*6.2/23*	28 Sep -1792
Planets: Moon, and Mars in Magha	*6.17/2*	5 Oct -1792
Venus in P/U Ashadha	*6.3/14*	20 Sep to 5 Oct -1792
Sun, Moon afflict Rohini (from Jyestha)	*6.3/16 (17-Cal Ed)*	14 Oct -1792
Mars afflicts Jyestha (from Magha)	*5.141/7,8*	5-14 Oct -1792
Jupiter afflicts Rohini (from Hasta-Vir)	*8.68/49*	5-14 Oct -1792
Saturn in P/U Phalguni; afflicts Rohini	*5.141/7,8*	5-14 Oct -1792
War to Begin on Kartik Amavasya	*5.140/17,18*	14 Oct -1792
Bhishma falls on 10th day of war	*1.2/26*	24 Oct -1792
Karna killed on 17th day of war	*8.68/49*	30 Oct -1792
Bhishma's demise on WS-Magh S 8 on 68th day (from 1st day of war)	*12.47/3; 13.152/10; 13.153/5,6,26,27,28.*	20 Dec -1792

Concluding Remarks

- By simulating the astronomical phenomena described in ancient texts we have determined the dates of earliest references to calendar in *Rigveda* as the year -7000 and its subsequent development through *Taittiriya Samhita (-6000), Ramayana (-5100)*, and *Shatpat Brahmana (* -2100).
- The *Kali* era seems to have its beginning based on a legendary planetary assemblage on on 13th January, -3103, 25 days after the Winter Solstice and again on 22 January -3101 in Psc/Ari.
- We have shown how various astronomical phenomena of solstices and equinoxes described in *Mahabharata* could provide the date of the great War as 14 October -1792 and reproduce accurately several events in the epic sequentially.
- The astronomical framework that evolved from the Vedic times through *Mahabharata* has survived until the present and forms the backbone of Indian cultural life to this day. □

Thank you