Tools for Ancient Indian Astronomy and Cosmography

Stellarium as a tutorial instrument for seeing, checking, and explaining ancient astronomical ideas.

Sunder Chakravarty
CAHC, Jain University

Sessions

Session 1

- Meru — cosmographic visualization
- Stellarium basics and sky culture
- Dhruva, Sun, and Nakṣatra demonstrations
- Precession as a visual and textual dating aid

Session 2

- BP chapter 21 and equinoctial full moon
- Astropy-supported scanning
- Eclipses and digital research aids

Session 1 emphasizes visual and observational foundations. Session 2 extends the same arc with Moon-focused and computational examples.

Session 1 Roadmap

1. Meru Cosmology
2. Stellarium basics, coordinates, and sky culture
3. Dhruva, Thuban, and Śiśumāra
4. Sun: daily and annual motion
5. Nakṣatras: stars, shapes, and zones
6. Precession and textual dating

Why Stellarium?

- It makes **astronomical ideas visible** quickly.
- It lets us change location, epoch, and viewing frame.
- It helps *connect text* to **sky appearance**.
- Prepared scripts improve repeatability and reduce demo friction.

Meru — Cosmographic Visualization

- An 3-D cosmographic visual of the Meru model.
- Draws from:
  - Taittirīya Āraṇyaka 1.7; Aitareya Brāhmaṇa 3.44;
  - Brāhmaṇḍa/Viṣṇu/Vāyu/Liṅga Purāṇas;
  - Mahāsailam
  - and others.
- Built to explore and explain, not to prove.

IT SHOWS

- Meru as the polar axis of a concentric world model.
- Dhruva at the apex; the nakṣatra wheel rotating around it.
- Seasons and geographic zones as concentric rings.

STORY LINE

https://meru-cosmos.netlify.app/

1. महासलिलम् → पृथ्वी / ध्रुवः emerge
2. द्वीपाः emerge
3. मेरु rises, with ध्रुव above its center
4. नक्षत्राणि and सूर्यः emerge
5. सूर्यः creates day and night
6. अयने, विषुवे, and ऋतुवः

The app is a visualization aid — it makes an older descriptive cosmology navigable and discussable.

Stellarium Basics

TOPICS

- **Location:** The visible sky changes with latitude and longitude.
- **Date and time:** Epoch and local time are essential to historical sky reconstruction.
- **Ecliptic and equator:** These overlays make solar and seasonal motion easier to read.
- **Alt-Az and meridian:** These help separate horizon phenomena from meridian phenomena.
- **Projections:** Different projections make different features easier to see.
- **Sky culture:** Naming systems and sky groupings matter when texts are interpreted visually.

WHY THIS MATTERS

- These controls make the Stellarium screen readable and comparable across epochs and locations.
- Once the viewing frame is understood, the astronomical demonstrations become easier to follow.
- Stellarium can then function as a repeatable observational aid.

These controls establish the visual vocabulary for the rest of the session.

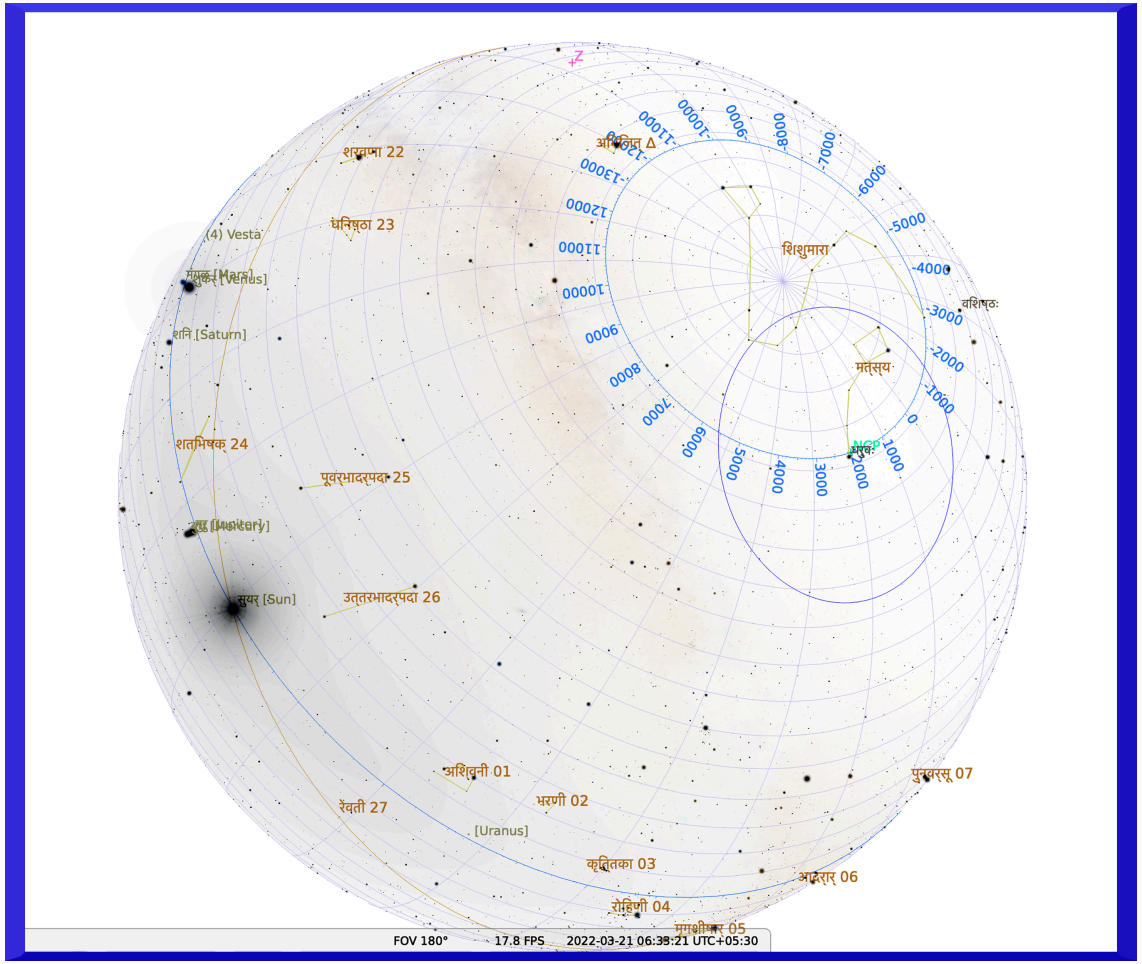
Dhruva, Thuban, and Śiśumāra

MAIN IDEA:

- The identity of the **pole star** is historical, not timeless.

MAIN SCRIPT - `SSC/S11-DHRUVA-POLE-DRIFT.SSC`

- Location: about 30°N
- 2830 BCE, **Abhaya Dhruva** (Thuban) of Śiśumāra close to the north celestial pole
- Step forward in time and watch the pole drift away from Thuban
- End in the modern sky, with the pole near **Polaris**



Sun: Daily and Annual Motion

TOPICS

- **Daily path:** The Sun rises, culminates, and sets in a regular daily pattern.
- **Sunrise shift on the horizon:** The rising point moves north and south through the year, the sun's **annual swing** best seen with `ssc/s12-sun-swing.ssc`.
- **High and low Sun:** The Sun also changes in noon/meridian height, appearing higher in summer and lower in winter, best seen with `ssc/s13-sun-meridian-high-low.ssc`.
- **Dakṣiṇāyana and Uttarāyaṇa:** The turning points of the annual swing can be explained with `ssc/s13-sun-meridian-high-low.ssc`.

WHAT TO NOTICE

- The horizon view makes annual movement immediately visible - *Dakṣiṇāyana and Uttarāyaṇa, annual swing*
- The meridian view explains high and low Sun more clearly - *High and low Sun*

This is clearer in live motion than in a static figure.

Nakṣatras: Visible Stars, Arc Spans

#	Nakṣatra	Star Count					Astrograph	Constituent Stars	Proxy Star (Author's)	Abhyankar's Yogatara
		VGJ	PT	AVP	SKA	SCP*				
1	Kṛttikā	6	6	6	6	6	Knife/Cleaver	(17,19,20,23,27,η) Tau	η Tau	η Tau
2	Rohiṇī	5	5	1	5	5	Cart	(α,γ,δ1,ε,θ2) Tau	α Tau	α Tau
3	Mṛgaśira	3	3	3	3	3	Deer's Head	(α,γ,λ) Ori	λ Ori	λ Ori
4	Ārdrā	1	1	1	1	1	Bāhuḥ (Arm) Red Dot*	(γ) Gem	γ Gem	γ Gem
5	Punarvasu	2	2	2	2	5	Balance*	(α,β) Gem	β Gem	β Gem
6	Puṣya	1	1	1	3	3	Śarāva (Pot-lid)*	(δ) Cnc	δ Cnc	δ Cnc
7	Āśleṣā	6	6	6	1	6	Snake Head Flag*	(δ,ε,ζ,η,ρ,σ) Hya	ζ Hya	ζ Hya
8	Maghā	6	6	6	5	7	Enclosure	(α,γ1,ε,ζ,η,μ) Leo	ζ Leo	α Leo
9	P Phalgunī	2	2	2	2	2	Half-chair	(δ,θ) Leo	δ Leo	δ Leo
10	U Phalgunī	2	2	2	2	2	Half-chair	(93,β) Leo	β Leo	β Leo
11	Hasta	5	5	5	5	5	Hasta (hand)	(α,β,γ,δ,ε) Crv	δ Crv	γ Crv
12	Citrā	1	1	1	1	1	Madhupuṣpa (Flower)*	(α) Vir	α Vir	α Vir
13	Svātī	1	1	1	1	1	Kīlaka (Wedge)*	(α) Boo	α Boo	α Boo
14	Viśākhā	2	2	2	2	5	Divider Rope*	(α1,α2) Lib	α2 Lib	α Lib
15	Anūrādhā	4	4	4	4	5	Necklace	(β1,δ,π,ω1) Sco	δ Sco	δ Sco
16	Jyeṣṭhā	3	3	1	3	3	Elephant Tusk*	(α,ε,σ,(τ)) Sco	ε Sco	α Sco
17	Mūla	6	2	7	7	1	Root Scorpion Tail*	(ζ2,θ,ι1,κ,λ,ν) Sco	κ Sco	λ Sco
18	P Aṣāḍhā	4	4	4	4	4	Gajavikrama (Elephant Step)*	(γ,δ,ε,λ) Sgr	λ Sgr	δ Sgr
19	U Aṣāḍhā	4	4	4	4	4	Simhaniṣadya (Lion seat)*	(ζ,σ,τ,φ) Sgr	τ Sgr	σ Sgr
**	Abhijit	-	3	1	3	3	Gośīrṣāvali*	(?) Vega	-	α Aql
20	Śravaṇa	3	3	3	3	3	Ear Yavamadhya (Barleyseed)1	(α,β,γ) Aql	α Aql	β Del
21	Dhaniṣṭhā	4	5	5	4	5	Śakuni-pañjara (Bird cage)*	(α,β,γ2,δ) Del	β Del	β Aqr
22	Śatabhiṣak	1	1	1	1	100	Puṣpopacāra (Flower Boquet)*	(λ) Aqr	λ Aqr	α PsA
23	P Proṣṭapada	2	2	2	2	2	Cow's Foot	(α,β) Peg	α Peg	α Peg
24	U Proṣṭapada	2	2	2	2	2	Cow's Foot	(γ) Peg (α)And	γ Peg	γ Peg
25	Revatī	1	1	1	1	32	Boat*	(ε,(α,ζ)) Psc	ε Psc	ζ Psc (α And)
26	Aśvayuk	3	2	1	2	3	Horseneck	(α,β,γ) Ari	β Ari	β Ari
27	Bharaṇī	3	3	3	3	3	Bhaga (Perineum)	(35,39,41) Ari	41 Ari	41 Ari
		83	82	78	82	222				

TOPICS

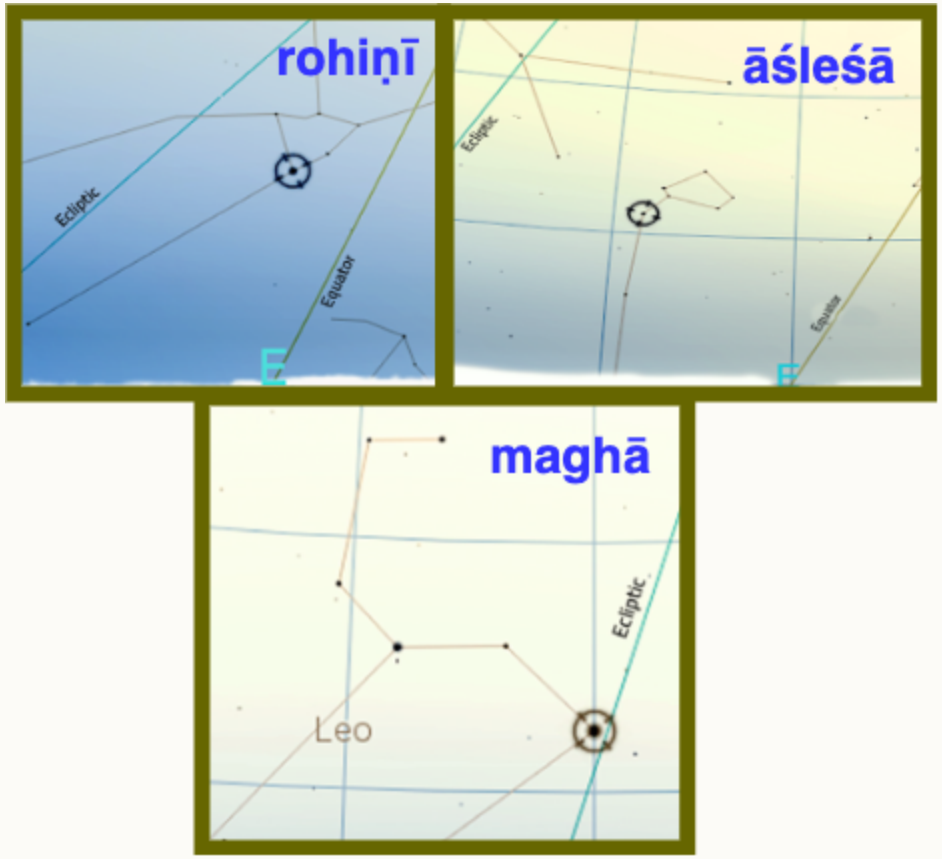
- **27 nakṣatras** : 83 stars on the ecliptic
- **28th nakṣatra** : Abhijit : 3 stars
- Are either **visible stars with shapes** or **arc spans**
- **Equal spans** of 13°20' each - for Sun tracking
- **Variable spans** - for Moon tracking in some traditions

Nakṣatras are **not lunar mansions**

STELLARIUM SCRIPT

- `ssc/s14-nakshatra-tour.ssc` - tour of the 27 nakṣatras.

Nakṣatra Shapes and Proxy Stars



NOTES

- **Rohiṇī** has a shape of *vedic triangular cart*
- **Āślesā** as a *snake*
- **Maghā** as an *enclosure*
- Some nakṣatras are easier to identify than others
- Our work shows 27 proxy stars yield results close to using 83 actual stars

Precession as a Dating Tool

- Precession slowly shifts the relation between seasonal points and nakṣatras.
- This makes certain astronomical statements in texts date-sensitive.

CHRONOLOGICAL ARC

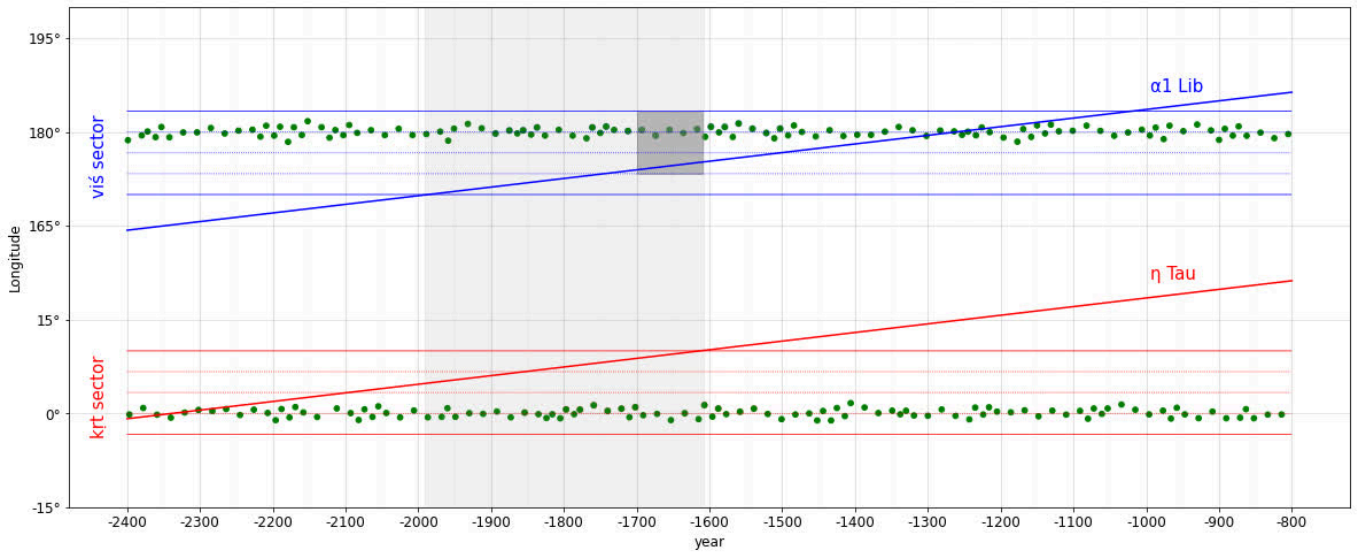
- **Brāhmaṇḍa Purāṇa Chapter 21** *(about 1800 BCE)*
- **Vṛddhagārgīya Jyotiṣa / Ādityacāra** *(about 1350 BCE)*
- **Vṛddhagārgīya Jyotiṣa / Ṛtusvabhāva** *(about 500 BCE)*
- 📽️ Watch: Precession Movie

THE ANALYTICAL METHOD

- **Extract** - text states the sun's nakṣatra at each season boundary
- **Compute** - for each candidate epoch, find the sun's nakṣatra at each textual season boundary
- **Measure** - error = mismatch between computed nakṣatra and textual target
- **Minimise** - epoch with smallest accumulated error is the best-fit date

Automation reduces repetitive checking and makes comparison across epochs practical.

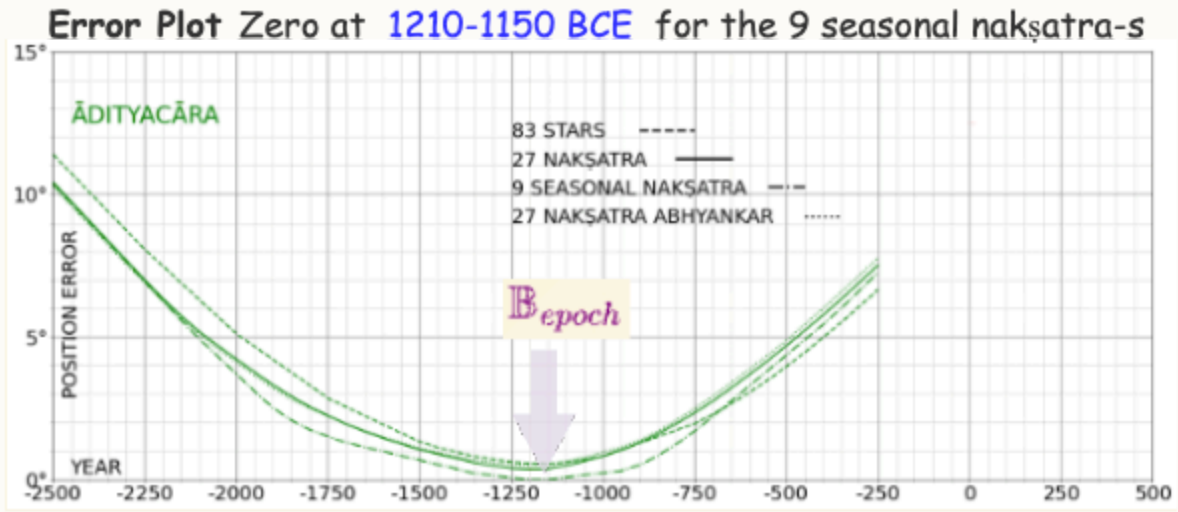
The Earliest Anchor in This Arc

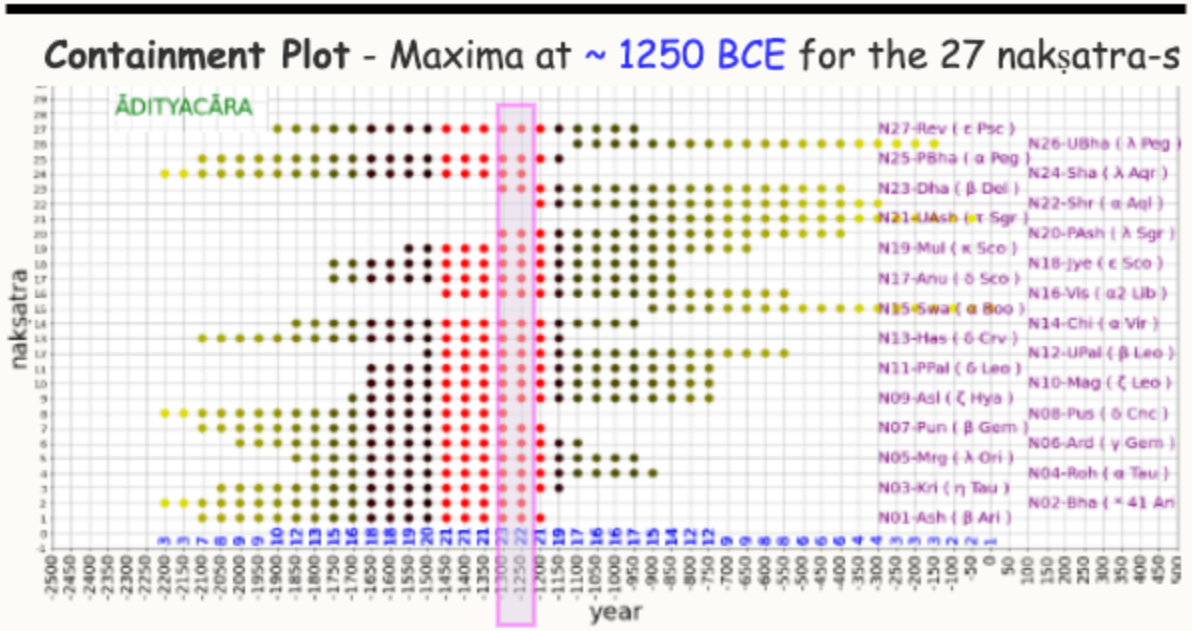


BP CHAPTER 21

- Specifies equinoctial full moons at quarter-nakṣatra precision.
- This is the earliest case in the chronological precession story here.
- It belongs to an earlier chronological layer than the VGJ examples.
- Its fuller Moon-focused treatment follows in Session 2.
- The **two slanting lines** show the precession-induced drift of the kṛttikā and viśākhā over time.

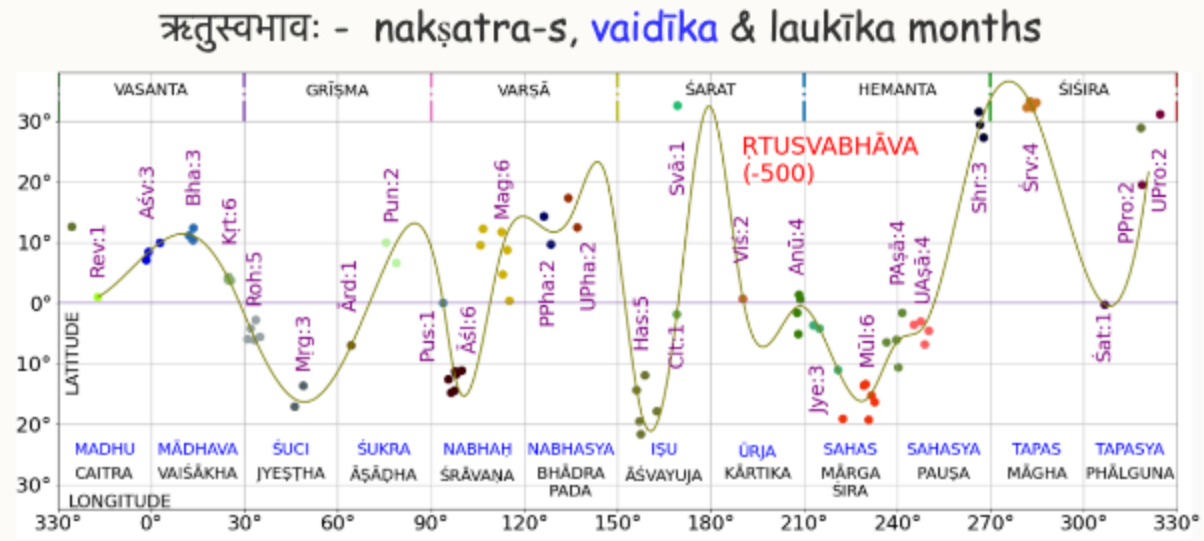
Ādityacāra - Vṛddhagārgīya Jyotiṣa 11

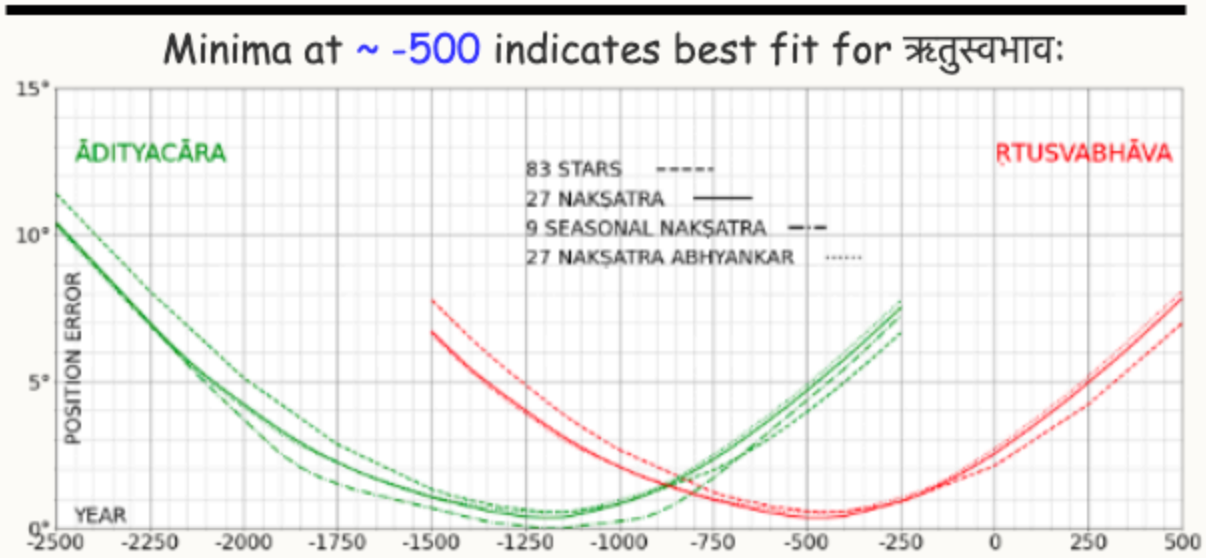




- The verse encodes 9 nakṣatra boundaries for 6 seasons; śiśira-ṛtu start anchors the sun at 270°
- Each nakṣatra's expected longitude span is 13°20' in the equal-division model
- Error = mean non-containment of the sun across the 3 boundary nakṣatra sets
- Top figure: error minimum at **1350 BCE** → best-fit epoch
- Dot figure: same result — maximum nakṣatra containment

Ṛtusvabhāva - Vṛddhagārgīya Jyotiṣa 59





- The verse maps seasons to
  - nakṣatra,
  - vedic solar months,
  - laukika months
- The *top figure* shows this mapping.
- e.g. **vasanta** is
  - *(revati,madhu,caitra)*,
  - *(bharaṇi,mādhava,vaiśākha)*
- We take
  - **mid-vasanta as sun at 0°**
  - and find best fit epoch by minimizing error
- The **red curve** in the *lower figure* shows the best fit epoch ~ **500 BCE**

Transition from unequal to equal regime

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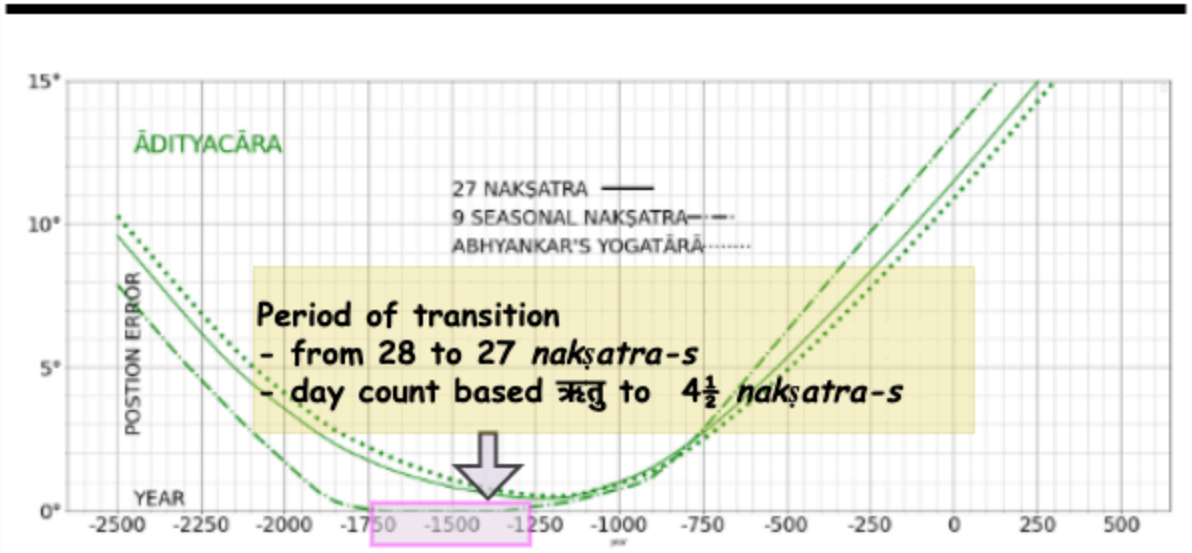
23	P Proṣṭapada	2	2	2	2	2	Cow's Foot	(α,β) Peg	α Peg	α Peg



- **Abhijit** (Aquila zone) elided
  - to equalize seasons at 4½ nakṣatras each
  - off ecliptic by ~10°
  - **Śravaṇa** inherited its Aquila slot
- Precession shifted winter solstice
  - from **Śraviṣṭhā** (β Aqr zone)
  - to newly named **Dhaniṣṭhā** (α/β Del)
- Older scheme
  - valid 1700–1350 BCE
  - breaks down after → reform pressure
- Reformed 27-equal system best fits **~1250 BCE**

End of Session 1

- Stellarium helps us see and rehearse the sky logic.
- Precession turns visible sky change into a dating aid.
- Seasonal and lunar textual constraints can then be tested more systematically.

SESSION 2 WILL CONTINUE WITH

- BP chapter 21 in fuller detail
- Moon-focused examples
- Astropy-supported scanning
- Eclipses, Meru, and digital research aids