Tools for Ancient Indian Astronomy and Cosmography

Session 2 · From Visual Demonstration to Research Workflow

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Recap and Roadmap

Session 1 covered

- Meru — cosmographic visualization
- Stellarium basics and sky culture
- Dhruva, Thuban, and precession intuition
- Sun: daily and annual motion
- Nakṣatras: stars, shapes, arc-zones
- Precession as a dating tool — VGJ sun-transit examples

Session 2

1. Moon and the equinoctial full-moon problem
2. The dial plot and Maghādi scheme
3. Eclipses — Parāśara Tantra and NASA/JLEX
4. Digital tools and CAHC resources
5. AI-assisted chores

Session 2 extends the same precession arc from the Sun to the Moon, then broadens to the research toolkit.

The Moon Problem

- Session 1 used the **Sun's nakṣatra position** to date texts.
- Session 2 adds the **Moon**: *where is the full moon at the equinox?*
- The Brāhmaṇḍa Purāṇa (BP) ch. 21 gives quarter-nakṣatra precision:
  - Spring equinox full moon at **¼-Kṛttikā** (η Tau)
  - Autumn equinox full moon at **¾-Viśākhā** (α^1 Lib)

WHY THIS IS A DATING CONSTRAINT

- The equinox point drifts through the nakṣatras via precession.
- These two stars were in the correct equinoctial sectors only during a specific window.
- Astropy epoch scan over −2400 to −800 locates that window.

STELLARIUM DEMO

- `ssc/s21-moon-swing.ssc` — 30+ successive moonrises showing the monthly horizon swing

> The same precession logic — now applied to the full moon rather than the seasonal sun.

BP 21 - The Text

Epoch of **Brahmāṇḍa Purāṇa** passages
using 2 **Seasonal Nakṣatras**
and 2 **Equinoctial Full Moons**

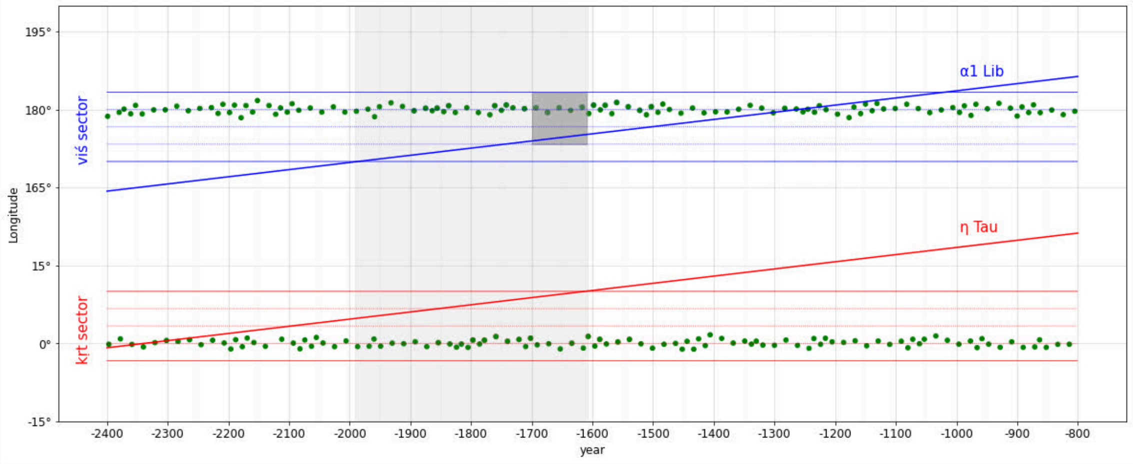
- Equinoctial full moons in terms of named nakṣatra sectors
- Day and night are equal - **Equinox**
- Sun ¼Kṛttikā, Moon ¾-Viśākhā — **Vasanta Full Moon**
- Sun ¾-Viśākhā, Moon head-Kṛttikā — **Śarat Full Moon**
- The BP text is in its present form from early CE, but these astronomical statements belong to a much older observational layer.

STELLARIUM DEMO

- `ssc/s22-bp-eqfm-best-case.ssc` — vasanta and śarat best-case views near 1700 BCE

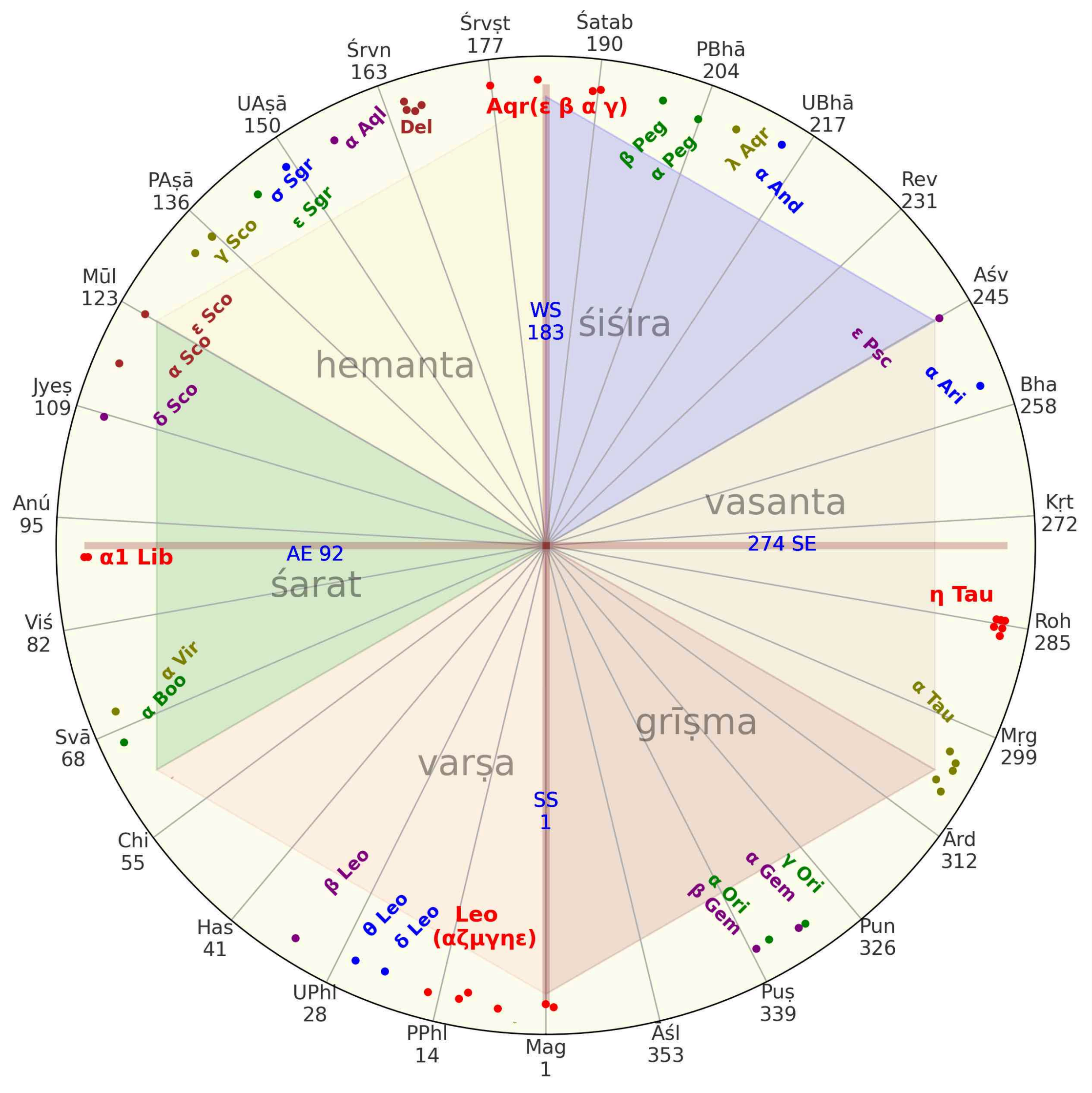
They belong to an observational layer earlier than PT, VGJ, and Lagadha's Jyotiṣa Vedāṅga (around

Equinoctial Full Moon - Analysis method



- All full moons in −2400 to −800 are gathered first using Astropy, about 1300 per century.
- We then select full moons with the Sun within ±1 day of the equinox, about 13 per century.
- These Full moons are plotted as green dots in chart
    - **Vaiśākhī** - Spring Eqnx Sun ¼Kṛttikā 0°
    - **Kārttikī** - Autumn Eqnx Sun ¾Viśākhā 180°
- The nakṣatra proxy stars are then precessed
    - **Red line**: drift of η-Tau (Kṛttikā)
    - **Blue line**: drift of α¹-Lib (Viśākhā)
- The **shaded window** ~ 1980–1610 BCE - stars in their equinoctial sectors. The sharper spring equinox constraint **~1700–1600 BCE**.
- `ssc/s25-eqfm-search-visualizer.ssc` — epoch-by-epoch traversal of 2400–800 BCE candidates

Maghādi scheme - MAU , BP - 1800 BCE



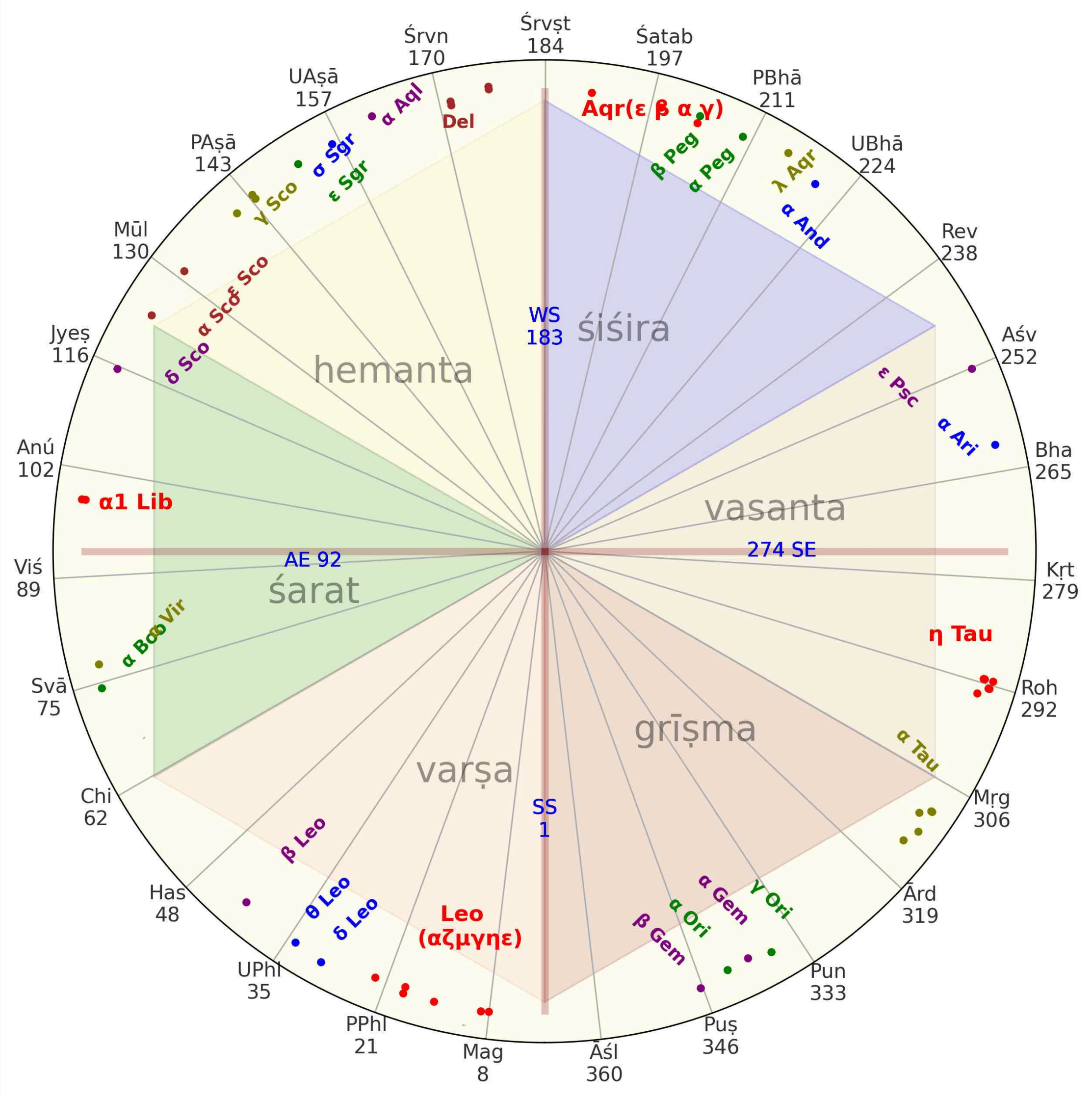
TWO AXES, ONE DIAL

- The **N–S axis** (MAU): winter solstice in ½-Śraviṣṭhā, summer solstice in Āśleṣā.
- The **E–W axis** (BP): spring equinox at ¼-Kṛttikā, autumn equinox at ¾-Viśākhā.
- Both axes are consistent on a single 27-sector dial — the **Maghādi scheme**.

KEY RESULT

- Kṛttikā-¼ at spring equinox ≡ Śraviṣṭhā-½ at winter solstice.
- MAU and BP are the same scheme stated from different starting points.
- The Maghādi zodiac thus predates the Śraviṣṭhādi zodiac by ~480 years (6°40' of precession).

Śraviṣṭhādi scheme - PT, VGJ ~1300 BCE

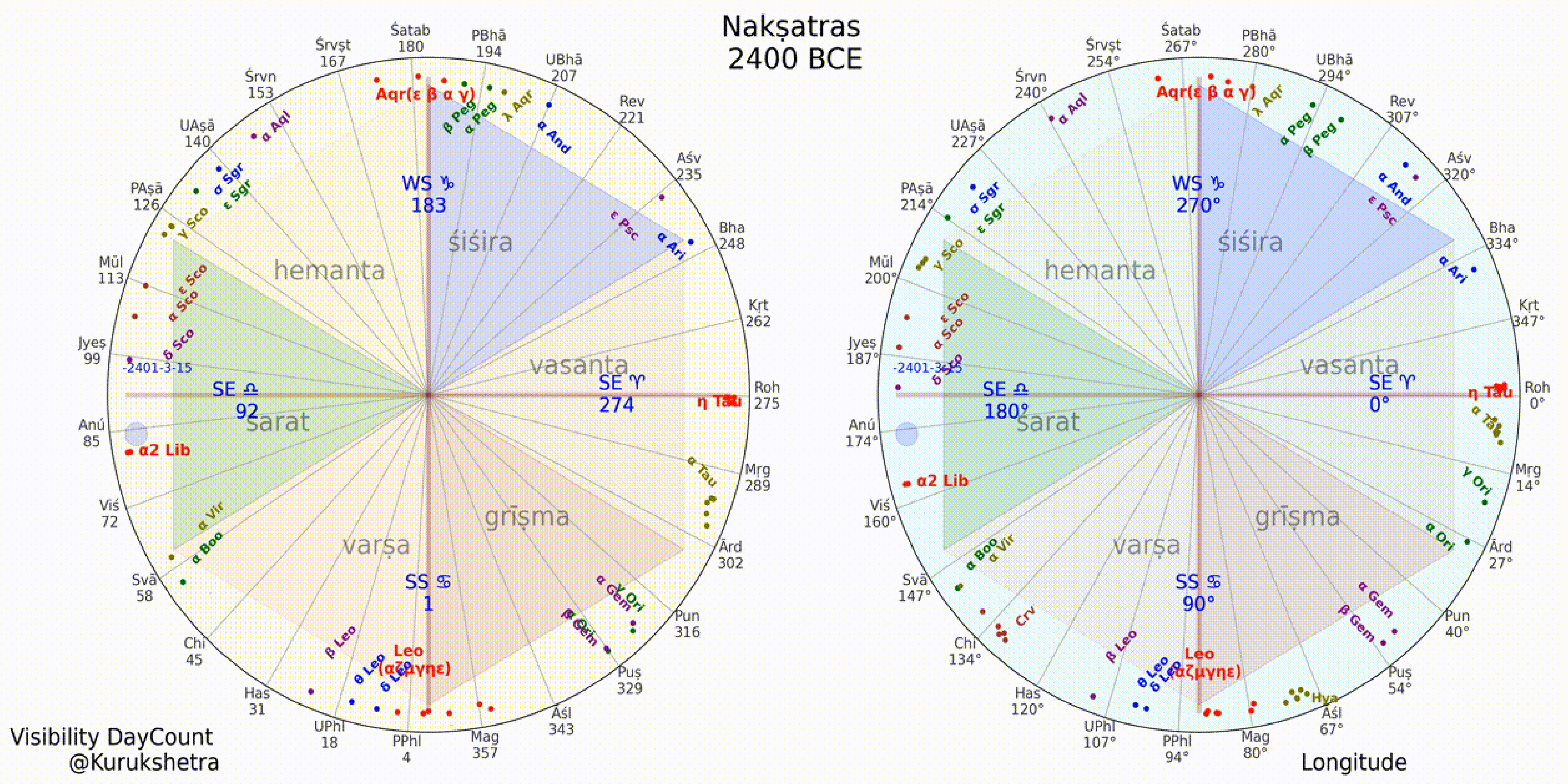


WHAT HAS CHANGED

- Precession has shifted the stars relative to the cardinal axis.
- By ~1300 BCE, Maghā is no longer visible at the summer-solstice sunrise — the Maghādi anchor is broken.
- The winter solstice has drifted: the beginning of the Śraviṣṭhā *sector* now coincides with the solstice point — the **Śraviṣṭhādi scheme** takes over.
- This is the regime of PT and VGJ.

Precession rotates the outer star dial. The season boundaries stay fixed.

Seasonal Nakṣatra Drift: 2400 to 1000 BCE



Animation shows precession rotating the star positions through the fixed season-domain framework, –2400 to –1000 BCE.

Stellarium , Astropy - Contrast

- Stellarium GUI
  - Shows *individual* cases convincingly.
  - Allows for targeted exploration of specific dates.
  - Scripting is possible but not as efficient as Astropy.
- Astropy supports repeatable computation
  - Measured example: next 1000 sunrise queries from a fixed Bangalore start JD
  - *Astropy/Astroplan: 10.4 s*
  - *Stellarium script: 19.3 s*
  - About *1.85×* faster on this repeated-query task

Method	Best For
Stellarium GUI	Visualisation
Stellarium script	Reproducible demo
Astropy scan	Exhaustive coverage

AI tools speed up writing the code — not running it. Computation time is physics, not productivity.

Eclipses - Parāśara Tantra

Table 5.1 Two sequences of seven eclipses visible at Jaipur at six monthly interval in 15th century BCE. Phases in grey were not visible due to altitude. LT: Local Time, P:Partial, T:Total, N:Penumbral

(After F.Espenak)

Calendar Date	Ecl. Type	Partial Eclipse Begins LT	Alt	Total Eclipse Begins LT	Alt	Mid. Eclipse LT	Alt	Total Eclipse Ends LT	Alt	Partial Eclipse Ends LT	Alt
-1496-Nov-10	P	02:53	+50	-	-	03:08	+47	-	-	03:23	+44
-1495-May-05	P	21:34	+34	-	-	22:56	+46	-	-	00:18	+51
-1495-Oct-30	T	*15:17*	*-34*	*16:27*	*-20*	*16:58*	*-14*	*17:30*	*-07*	18:40	+08
-1494-Apr-25	T	04:02	+25	05:03	+13	05:53	+02	*06:44*	*-09*	*07:44*	*-22*
-1494-Oct-19	T	23:01	+62	00:15	+68	00:48	+67	01:21	+64	02:35	+52
-1493-Apr-14	P	*18:36*	*-01*	-	-	19:39	+13	-	-	20:41	+25
-1493-Oct-08	N	(Near Total) Penumbral Eclipse. Magnitude 0.973, Mid-point 1.45 AM; Altitude +57									
-1492-Mar-05	P	04:33	+34	-	-	04:54	+29	-	-	05:16	+25
-1442-Dec-13	P	05:54	+15	-	-	06:03	+13	-	-	06:12	+11
-1441-Jun-07	P	*18:15*	*-10*	-	-	*18:48*	*-03*	-	-	19:22	+03
-1441-Dec-02	T	*17:31*	*-02*	18:42	+13	19:13	+19	19:45	+26	20:56	+41
-1440-May-27	T	01:25	+41	02:25	+34	03:14	+27	04:02	+18	05:03	+07
-1440-Nov-20	T	00:01	+80	01:15	+73	01:49	+67	02:22	+60	03:37	+43
-1439-May-16	P	*16:40*	*-29*	-	-	*18:06*	*-11*	-	-	19:31	+07
-1439-Nov-09	(Total) Penumbral Eclipse. Magnitude 1.019, Mid-point 1. 52 AM; Altitude +64										
-1438-Apr-07	(Partial) Penumbral Eclipse. Magnitude 0.667, Mid-point 4.07 AM; Altitude +31										

Rāhu's Movement 99 ॥ राहुचारः॥

- Parāśara Tantra records eclipse sequences over lunations.
- The text encodes a periodicity claim: specific lunation counts produce eclipse pairs.
- Location anchor: Jaipur

VERIFICATION WITH NASA/JLEX

- NASA/JLEX eclipse search is a free, browser-accessible tool.
- Query by location, date range, type.

STELLARIUM SUPPORT

- `ssc/s23-total-eclipse-india.ssc` for the visual/location demo
- `ssc/s24-pt-eclipse-jaipur.ssc` for the PT sequence support

Meru — Cosmographic Visualization

WHAT IT IS

- An interactive 3-D cosmographic visualization of the Meru model.
- Draws from multiple textual sources — not tied to one text.
- Built to explore and explain, not to prove.

WHAT 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.

ACCESS

- Live: meru-cosmos.netlify.app

NOTES

- Useful for connecting the textual descriptions of cardinal directions, Dhruva, and the nakṣatra wheel.
- The same precession intuition from Stellarium applies here in a cosmographic frame.

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

Digital Tools and CAHC Resources

CAHC SEARCH PORTAL

- Full-text and metadata search across CAHC-associated papers.
- Supports keyword and author search.
- *Live demo if time and connectivity allow.*

PATRA DARPAN

- Digitized journal index covering selected publications
- An informal, more available repository of papers in our areas
- Not complete but convenient
- Patra Darpan

SANCHAYA

- Corpus of Sanskrit texts with text search.
- Not complete but convenient
- Example: Useful for locating nakṣatra references across texts.
- Sanchaya

SEMANTIC SEARCH

- Embedding-based search over CAHC paper abstracts.
- Surfaces papers by conceptual proximity, not keyword match.

> These informal tools reduce the friction of source-chasing — leaving more time for careful reading.

AI-Assisted Chores — What and Why

- Modern LLMs can help with **repetitive scholarly tasks** — not replace judgment.
- Two examples relevant to Jyotiṣa research:
  - **Kaṭapayādi decoding** — the numerical cipher used in astronomical mnemonics
  - **Sanskrit anvaya** — unpacking technical sūtra prose into readable order

THE GUARDRAIL

> *Always verify. The model is helpful for reducing drudgery and exploratory friction — not for final authority.*

- Errors are plausible-sounding and not self-flagged.
- Works best with a domain-aware human in the loop.

AI Example 1 — Kaṭapayādi

THE PROMPT

> *Explain this verse and decode the kaṭapayādi rule it encodes:*
> नञावचश्च शून्यानि संख्याः कटपयादयः।
> मिश्रे तूपान्त्यहल् संख्या न च चिन्त्यो हलस्वरः ॥

WHAT THE MODEL RETURNED

- Full padaccheda and anvaya
- Mapping table: क=1 … ञ=0, ट=1 … न=0, प=1…म=5, य=1…ह=8
- Rule for conjunct consonants: only the *last* consonant counts
- Directionality note: **अङ्कानां वामतो गतिः** — digits read right to left
- Example: भवति → भ(4), व(4), त(6) → reads as **644**

Useful as a quick reference check. The mapping table should be verified against a standard commentary.

AI Example 2 — Nidānasūtra Anvaya

THE PROMPT

> *Parse and give anvaya for Nidānasūtra 5.12 on the Āditya-Saṃvatsara.*

THE TEXT

त्रयोदशाहं त्रयोदशाहम् एकैकं नक्षत्रम् उपतिष्ठति। अहस्-
तृतीयं च नवधा कृतयोः अहोरात्रयोः द्वे द्वे कले च।

WHAT THE MODEL RETURNED

- Padaccheda and anvaya in Sanskrit, then English
- Derivation: 13 + ⅓ + 2/9 = **122/9 days per nakṣatra**
- Total: 27 × 122/9 = **366 days** (6 × 61 = ṣaṇṇava-vargāḥ)
- Identified *navadhā* as a 1/9-day unit predating the 60-nāḍī system

The arithmetic derivation is correct and checkable. The unit interpretation (navadhā) is a reasonable scholarly reading — treat as a hypothesis.

Wrap-Up

- Stellarium makes ancient sky visible and testable.
- Precession turns visible sky change into a dating instrument.
- In both sessions, a textual sky description becomes a dating clue:
  - in Session 1 through the Sun,
  - in Session 2 through the Moon.
- Astropy extends individual visual checks into exhaustive epoch scans.
- Eclipses can be checked with NASA/JLEX and Stellarium.
- Digital tools widen the research toolkit.
- AI helps with drudgery — never with final interpretation.

These tools are most useful when they reduce repetitive effort and leave more time for careful scholarly thinking.