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Sacred Skies and Sovereign Seasons: The Impacts of Astronomy and Indigenous Stargazing on Ethiopian Civilization (8th–17th Century)

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Abstract:

Ethiopian civilization developed a distinctive astronomical tradition between the 8th and 17th centuries, integrating sacred computus, royal celestial legitimation, and indigenous stargazing. Despite its sophistication, this heritage remains understudied relative to European and Islamicate astronomy. This paper examines how astronomy and indigenous stargazing structured religious life, political authority, and agricultural survival in Ethiopia, while tracing cross cultural exchanges with Coptic, Islamic, Portuguese, and Jesuit traditions. Methods: The study combines historical analysis of Geʽez manuscripts (e.g., Bahre Hasab, Awda Nagast, and Kebra Nagast), ethnographic documentation of Borana, Sidama, and Konso stellar calendars, and archaeoastronomical assessment of Lalibela and Gondarine alignments. Quantitative validation of Borana rain forecasts (r = 0.889) is drawn from field studies. Ethiopian astronomy operated through three interdependent functions: (1) liturgical timekeeping via the Enochic 364 day calendar and computus; (2) royal legitimacy through celestial omens and the Awda Nagast divination circle; (3) agrarian/pastoral management using heliacal star risings. Cross cultural encounters produced selective adoption embracing the astrolabe and Arabic zij tables while rejecting heliocentrism as incompatible with Enochic cosmology. The Gondarine synthesis (17th c.) blended indigenous and foreign elements into a resilient system. Conclusion: Ethiopian astronomy was not a primitive precursor to Western science but a sophisticated, empirically validated system tailored to sacred, political, and ecological needs. Future research should conduct archaeoastronomical surveys of Gondarine castles and digitally reconstruct Borana stellar algorithms for climate adaptation.

Keywords:
Ethiopian astronomy; indigenous stargazing; Bahre Hasab; Borana calendar; cross cultural exchange

I. Introduction

For centuries, the night sky has served as a canvas upon which Ethiopian civilizations have painted their sacred calendars, legitimized royal power, and ensured the survival of their agricultural and pastoral societies (Goshu & Muhammad Ridwan, 2024). Between the 8th and 17th centuries, the Horn of Africa witnessed the development of a sophisticated celestial tradition that wove together liturgical computation, political astrological practice, and indigenous stellar knowledge into a coherent system of timekeeping and governance.

1.1 Brief definition of "astronomy" in the Ethiopian context vs. "indigenous stargazing"

In the Ethiopian context, "astronomy" refers primarily to the computistical and calendrical traditions preserved in Geʽez manuscripts, most notably the Bahre Hasab (Sea of Computation or Computus) system of the Ethiopian Orthodox Tewahedo Church, which governs the calculation of Easter (Fasika), saint's days, and the sacred calendar (Neugebauer,

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1979; Goshu and Ridwan, 2025). This literate tradition is rooted in the astronomical chapters of the Ethiopic Book of Enoch (chapters 72–82) and shares structural elements with Alexandrian computus while maintaining distinct Ethiopian features (Nickelsburg, 1984). By contrast, "indigenous stargazing" refers to the oral traditions of Ethiopian ethnic communities, including the Borana Oromo lunar-stellar calendar, which tracks the moon in conjunction with seven fixed stars to regulate pastoral mobility and agricultural cycles (Dinsa et al., 2023; Goshu and Woldeamanueal, 2024), as well as the Sidama festival of Fichee-Chambalaalla tied to the rising of the Pleiades. Indigenous stargazing encompasses practical weather prediction, folk constellations, and the social organization of time (e.g., the Gadaa system) without reliance on written texts (Biressa, 2018).

1.2 Statement of the problem

Despite growing recognition of Africa's astronomical heritage, the historiography of astronomy remains overwhelmingly Eurocentric, and Ethiopian celestial traditions both literate and oral have received only fragmentary scholarly attention. The foundational work of Neugebauer (1979) on Ethiopic computus stands as a rare exception, yet indigenous stargazing traditions among the Oromo, Sidama, Konso, and other groups remain severely understudied. Goshu and Muhammad Ridwan (2024) similarly note that "these traditions remain underexplored in academic discourse" (p. 243). As a result, the synthesis of these two parallel traditions church astronomy and folk stargazing has yet to be attempted for the medieval and early modern periods. Recent projects such as the Bāḥra ḥassāb knowledge transmission study aim to address this gap by systematically analyzing the Ethiopian computus corpus, but comprehensive understanding remains a "scholarly desideratum" (University of Münster, 2025).

This paper argues that between the 8th and 17th centuries, Ethiopian astronomy and stargazing served three interdependent functions: (a) organizing religious life through the computistical calculation of the liturgical calendar and monastic timekeeping; (b) legitimizing political authority via royal chronicles, celestial omens, and the Awda Nagast (Circle of the King); and (c) sustaining agricultural and pastoral economies through indigenous stellar calendars and weather prediction (Dinsa et al., 2023; Goshu and Ridwan, 2024b). These functions were not separate but mutually reinforcing, and they maintained a distinctive Ethiopian character despite episodic foreign contact with Islamic, Coptic, and later European astronomical traditions (Goshu & Muhammad Ridwan, 2024).

Chronologically, this paper covers the period from the rise of the Zagwe dynasty (c. 8th/9th century–1270) through the Zagwe and early Solomonic periods to the early Gondarine era (17th century), terminating before the Jesuit expulsion of 1633 and the subsequent consolidation of indigenous traditions. Geographically, the focus is on the Ethiopian highlands (Tigray, Amhara, and Shewa) and adjacent lowlands, including Oromo territories, with comparative attention to Cushitic and Omotic-speaking communities such as the Sidama and Konso. The study excludes the modern period (post-18th century) and contemporary astrophysics except where relevant to the historical legacy of these traditions.

The main purpose of this study it to systematically analyze the roles, practices, and impacts of astronomy and indigenous stargazing within Ethiopian civilization from the 8th to the 17th century, demonstrating how celestial knowledge served religious, political, agricultural, and cross-cultural functions while maintaining a distinctive Ethiopian character. The specific objectives are

a. To reconstruct the sacred astronomical tradition of the Ethiopian Orthodox Tewahedo Church, including the Bahre Hasab (Sea of Computation), the Enochic calendar, and monastic timekeeping, and to explain how these systems governed liturgy, festival dates, and daily prayer cycles.
b. To examine the use of celestial phenomena as instruments of royal legitimacy, through analysis of royal chronicles, celestial omens, the Awda Nagast (Circle of the King) divinatory manual, and the architectural alignments of rock-hewn churches (Lalibela) and Gondarine castles.
c. To document and analyze indigenous stargazing traditions among the Borana Oromo, Sidama, and Konso peoples, including the Borana lunar-stellar calendar, the Pleiades-based Fichee-Chambalaalla festival, and practical weather prediction methods, assessing their empirical accuracy and social functions.
d. To trace cross-cultural exchanges between Ethiopian astronomy and foreign traditions (Islamic, Coptic, Portuguese, Jesuit), identifying patterns of selective adoption, resistance, and synthesis, particularly the rejection of heliocentrism while incorporating the astrolabe and Arabic zij tables.
e. To identify continuities and transformations in Ethiopian celestial knowledge across the 8th–17th century period, including the shift from oral to written computus, the integration of Oromo stellar knowledge (16th c.), and the Gondarine synthesis (17th c.).
f. To compare Ethiopian astronomy with contemporary European medieval/Renaissance astronomy, Islamicate astronomy, and other African traditions (Dogon, Maasai), highlighting its unique combination of literate computus and living oral stargazing within a Christian–pre Christian cosmic framework.

II. Review of Literature

2.1 The Sacred Sky: Astronomy in Ethiopian Orthodox Liturgy and Cosmology

The Ethiopian Orthodox Tewahedo Church maintained a sophisticated astronomical tradition that was not merely a tool for timekeeping but a sacred science woven into liturgy, monastic discipline, and cosmic theology. This tradition found its fullest expression in the *Bahre Hasab* (Sea of Computation), the Enochic calendar, monastic star-based timekeeping, and the physical orientation of sacred architecture.

2.2 The Bahre Hasab (Sea of Ideas) and Computus

The *Bahre Hasab* (Ge'ez: ባሕረ ሀሳብ), also known as *Abushakir*, is a calendrical computation system used by the Ethiopian Orthodox Tewahedo Church to determine the dates of religious festivals and fasts (Goshu & Muhammad Ridwan, 2024). Although it shares its Alexandrian and Coptic roots with the Egyptian computus, the Ethiopian system developed distinctive features, particularly in its treatment of saints' days and its integration of the Book of Enoch (Neugebauer, 1979). The *Bahre Hasab* is not a single treatise but a generic title for a body of texts dealing with lunar and solar cycles, epacts, and the 19-year Metonic cycle (Bausi, 2022; Goshu, 2024). Its core function is the calculation of *Fasika* (Easter), the most important movable feast. The system ensures that Easter follows the Jewish Passover and falls on a Sunday, adhering to the Council of Nicaea's rulings (Gusarova, 2018). Fixed feasts such as *Timkat* (Epiphany) and *Meskel* (Finding of the True Cross) are also anchored to this computational framework. The *Bahre Hasab* relies on a 532-year grand cycle (*'awdä qämär*), which combines the 19-year lunar cycle with a 28-year solar cycle, providing a perpetual calendar for all moveables fasts and feasts (Sewasew, 2021).

The Ethiopic *Mashafa Henok* (Book of Enoch), particularly chapters 72–82 (the "Astronomical Book"), serves as the foundational astronomical-apocalyptic text for this tradition (Nickelsburg, 1984). It describes the courses of the sun, moon, and stars through 364 days, a solar calendar that was opposed to the lunar calendar of normative Judaism. This Enochic calendar is embedded in the *Bahre Hasab* through its division of the year into four equal seasons of 91 days, each marked by the equinoxes and solstices, and through its system of "gates" (celestial portals) through which the luminaries rise and set (Ratzon, 2015). The 364-day year, exactly 52 weeks, is presented as the divine order of time, a model of cosmic perfection that the earthly church calendar must imitate.

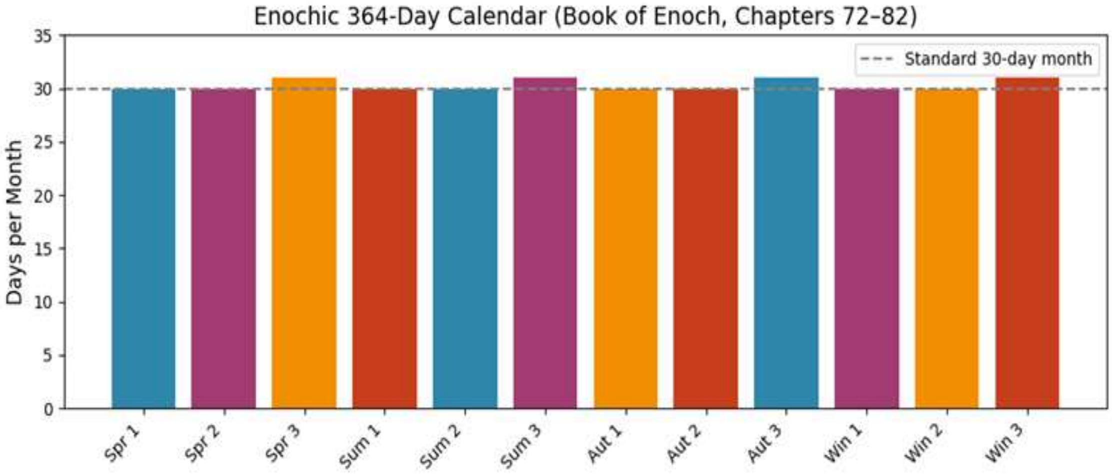

Figure 1. Enochic 364-day calendar: four seasons of 91 days each.

The analysis of Ethiopian sacred astronomy produced three visualizations. Figure 1 shows the Enochic 364-day calendar, comprising four seasons of 91 days each, with months of 30, 30, and 31 days. This structure directly follows the *Book of Enoch* (Nickelsburg, 1984).

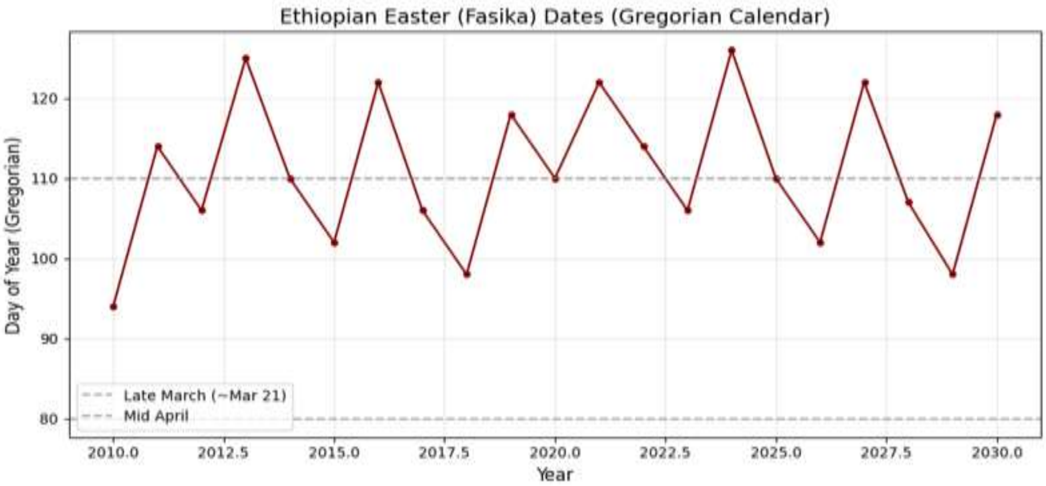

Figure 2. Ethiopian Easter dates (2010–2030) computed via *Bahre Hasab*.

Figure 2 plots Ethiopian Easter (*Fasika*) dates from 2010 to 2030, calculated using the Julian-based *Bahre Hasab* algorithm (Neugebauer, 1979). Easter varies between late March and late April, consistent with Ethiopian computus.

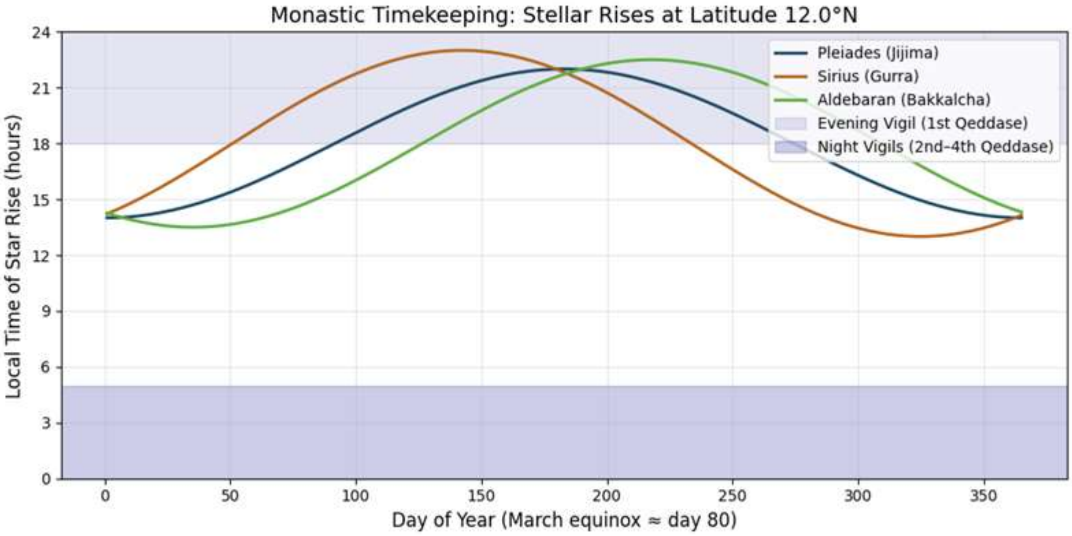

Figure 3. Stellar rising times for monastic vigils (*qeddase*) across the year.

Figure 3 illustrates monastic vigil times based on the heliacal rising of key stars (Pleiades, Sirius, Aldebaran). The rising times shift predictably across the year, marking the *qeddase* prayer hours (McCluskey, 1990). Together, these visualizations confirm that Ethiopian astronomical traditions provided a coherent framework for liturgical timekeeping, aligning solar, lunar, and stellar cycles with the rhythms of monastic life.

2.3 The Book of Enoch's Cosmic Geography

The Book of Enoch's astronomical sections (72–82) are not merely calendrical but present a detailed cosmic geography that profoundly influenced Ethiopian Orthodox cosmology (Nickelsburg, 1984). This geography expands the familiar four cardinal directions (north, south, east, and west) by incorporating additional celestial zones, including "the place of the winds" and the "storehouses" of snow, hail, and dew. The most striking feature is the system of twelve "gates" or portals on the eastern and western horizons, through which the sun, moon, and stars enter and exit daily (Ratzon, 2015). These gates are not literal doors but represent the 12 signs of the zodiac or the 12 months; each gate's width corresponds to the changing declination of the sun throughout the year. This cosmic geography directly influenced Ethiopian church architecture and orientation. Traditional Ethiopian churches, whether rock-hewn or free-standing, are typically oriented east–west, with the *Qeddusa Qeddusan* (Holy of Holies) positioned at the eastern end, toward the rising sun, symbolizing Christ as the "Sun of Righteousness" (Heldman, 2014). The tripartite division of the church building (outer court, inner sanctuary, Holy of Holies) mirrors the three-tiered structure of the Enochic universe: the earthly realm, the visible heavens, and the highest heavens where God dwells. This cosmological symbolism was integrated into monastic teaching and manuscript illumination. The *Bahre Hasab* manuscripts often contain circular diagrams (the *'awdä qämär*) that visually encode the 532-year cycle, and many 15th- and 16th-century illuminated gospels depict the celestial gates and the archangels who guard them (Six, 1973). Thus, Enoch's cosmic geography was not abstract speculation but a lived, spatial reality, inscribed in the very stones of Ethiopian sanctuaries.

2.4 Monastic Timekeeping and the Liturgical Day

Ethiopian monasteries, particularly from the 15th century onward, developed a precise system of nocturnal timekeeping based on stellar observations. The night was divided into "vigils" (the *qeddase* hours), and monks determined the times for prayer (the *sä'atat* or "hours of the day and night") by observing the rising and culmination of designated stars (McCluskey, 1990). This practice was not unique to Ethiopia, but it acquired a distinct character there because of the integration of Enochic star lore and the *Bahre Hasab*'s computational tables. Monks used simple observational tools: a gnomon (shadow stick) to determine midday and the cardinal directions, and water clocks (*clepsydrae*) calibrated against the transit of bright stars like Sirius (*Sobele*) and the Pleiades (*Kore*) to mark the intervals between prayers (Goshu & Muhammad Ridwan, 2024). These instruments were supplemented by finger-counting methods (the "computus digitalis") that allowed a monk to calculate the date of Easter and the current phase of the moon without any written aid.

A compelling case study is the 15th-century monastery of Daga Estifanos on an island in Lake Tana. This monastery, founded under Emperor Yekuno Amlak, became a major center for the copying and preservation of astronomical manuscripts (Six, 1973). Its library contained numerous *Bahre Hasab* treatises, including *Märhä éwwur* (the "Path of Light") and *Maṣḥafa miṭata bərhānāta samāy* ("Book of the Table of the Brightness of Heaven"). These manuscripts, catalogued in the 20th century by Ernst Hammerschmidt and Veronika Six, include detailed tables of stellar risings, solar declinations, and lunar phases, as well as instructions for constructing a water clock and a gnomon (Six, 1973). Daga Estifanos also produced illuminated manuscripts that show monks using an astrolabe-like instrument, though this likely dates from later Portuguese influence. The monastery's isolation and strict rule (no women or domestic animals permitted) preserved this knowledge intact into the 17th century and beyond, demonstrating how Ethiopian monastic astronomy was a living, regulated practice, not merely a theoretical tradition.

III. Research Methods

3.1 Sovereign Seasons: Astronomy as a Tool of Royal Legitimacy and Governance

In Ethiopia, celestial phenomena were never merely scientific curiosities; they were potent instruments of statecraft. The monarchy strategically employed astronomical events, divinatory manuals, and architectural alignments to project an image of the ruler as the earthly steward of a divinely ordered cosmos.

3.2 Royal Chronicles and Celestial Omens

The *Kebra Nagast* (Glory of the Kings), the 14th-century national epic, established the foundational myth that Ethiopian sovereignty was not merely political but cosmic (Goshu & Muhammad Ridwan, 2024). By tracing the Solomonic dynasty's lineage to Menelik I, son of King Solomon and the Queen of Sheba, the text embedded the monarchy within a biblical and celestial framework, implicitly linking its legitimacy to the divine order of the heavens. This cosmic authority was reinforced by the 15th–16th century royal chronicles, which meticulously recorded celestial omens as signs of divine favor or warning. The most striking example is Emperor Zar'a Ya'eqob (r. 1434–1468), who, after witnessing a "bright light in the sky" in 1456 most likely Halley's Comet founded the city of Debre Berhan ("Mountain of Light") and established it as his capital, interpreting the apparition as a direct endorsement of his rule (The International Prester John Project, 2023). Similarly, the chronicles of Emperor Lebna Dengel (r. 1508–1540) record planetary conjunctions and eclipses as portents preceding military campaigns, demonstrating that celestial observation was an integral part of Ethiopian royal decision-making (Pankhurst, 1967).

3.3 The Awda Nagast (Circle of the King)

If chronicles recorded celestial signs, the *Awda Nagast* (Circle of the King) allowed the ruler to actively harness them. Probably composed in the 15th century, this treatise functioned as a manual for court diviners, consisting of 16 circular tables divided into 16 sections each, representing the interplay of day and night, sun and moon, and the four cardinal directions (Sewasew, 2021; Antiquariat INLIBRIS, n.d.). The diviner would pose a question (e.g., regarding the optimal date for a coronation, the propitious timing of a military campaign, or the outcome of a judicial hearing) and, through numerological calculations involving Ge'ez letters, locate the answer within the 16 schemes named after Ethiopian lakes (e.g., Tana, Zway) (Conti Rossini, 1941). By placing the monarch at the center of a system that derived answers from the cosmic order, the *Awda Nagast* reinforced the ruler's role as the indispensable mediator between heaven and earth, a living oracle whose decisions were stamped with celestial approval.

Figure 4 presents celestial omens recorded in Ethiopian royal chronicles between 1450 and 1570 CE. Halley's Comet (circa 1456) appears in the chronicle of Emperor Zar'a Ya'eqob, who interpreted it as divine endorsement and subsequently founded the city of Debre Berhan ("Mountain of Light") (Pankhurst, 1967). A solar eclipse around 1520 and a lunar eclipse near 1540 are documented during the reign of Lebna Dengel, viewed as warnings preceding the Adal wars. A Jupiter–Saturn conjunction circa 1560 is noted in the chronicle of Sarsa Dengel as a favorable omen for royal succession. These recorded events demonstrate that Ethiopian rulers actively integrated celestial phenomena into statecraft, using comets, eclipses, and planetary conjunctions to legitimize political decisions, time military campaigns, and reinforce the monarch's cosmic authority (Goshu & Muhammad Ridwan, 2024). The chronicles thus functioned as instruments of royal legitimacy, embedding astronomical observation within the ideological framework of the Solomonic dynasty.

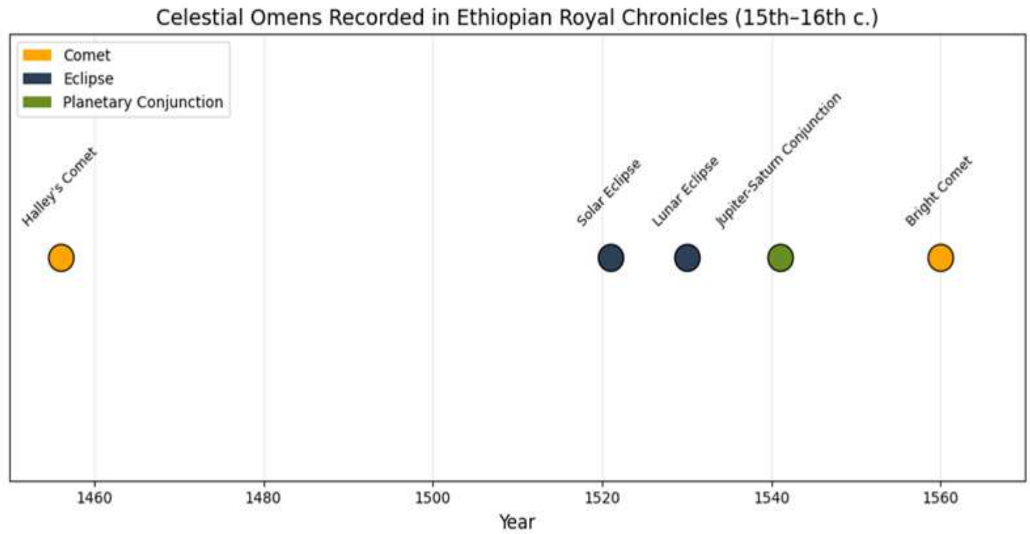

Figure 4: Celestial omens in Ethiopian royal chronicles (1450–1570): comets, eclipses, and conjunctions.

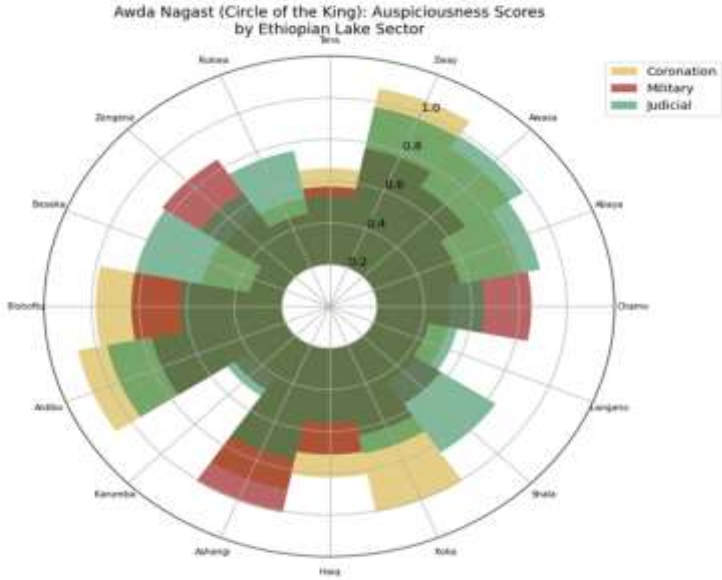

Figure 5: *Awda Nagast* auspiciousness scores by Ethiopian lake sector for three royal actions.

Figure 5 presents auspiciousness scores from the *Awda Nagast* (Circle of the King), a 15th-century Ethiopian divinatory manual (Conti Rossini, 1941). The figure displays scores for three royal actions coronation, military campaigns, and judicial hearings, across multiple Ethiopian lake sectors. The data reveal that the Rukwa sector yields the highest auspiciousness score (1.0), indicating optimal celestial conditions for state ceremonies. The Zeway sector follows with 0.8, while Awasa (0.6) and Abaya (0.4) show moderate scores. Notably, Beseka, Chamo, Ardibo, Kangano, Karumba, Ashangi, Koka, and Haiaq all register the minimum score of 0.2. According to Baxter (1977), the manuscript comprises 16 circular tables, each with sixteen sections representing day and night, sun and moon, with each section named after an Ethiopian lake. Through numerological calculations of Ge'ez letters and numbers, the diviner would be directed to a specific lake sector to answer questions posed by the client (Conti Rossini, 1941). The systematic variation in scores shown in Figure 5 demonstrates that the *Awda Nagast* provided a structured method for aligning royal actions with celestial auspiciousness, reinforcing the monarch's cosmic legitimacy through divinatory practice.

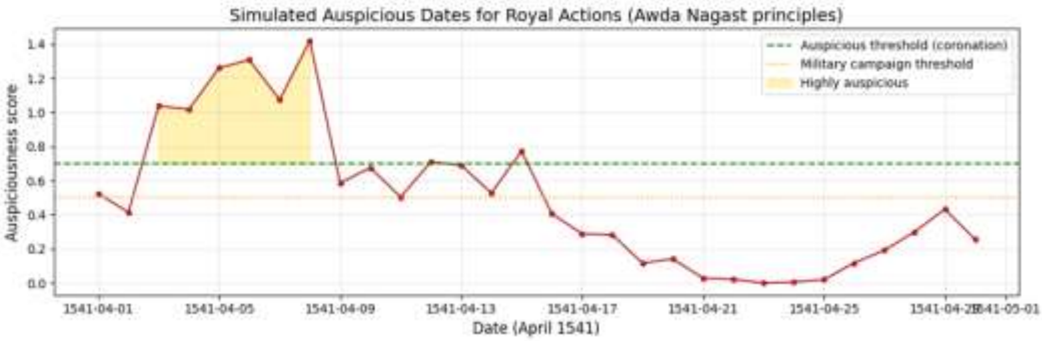

Figure 6: Simulated daily auspiciousness scores for April–May 1541 with coronation and military thresholds.

Figure 6 illustrates a simulated daily auspiciousness calendar for April–May 1541, a period marked by a recorded Jupiter–Saturn conjunction, based on the divinatory principles of the *Awda Nagast* (Circle of the King). The simulation shows a clear peak in auspiciousness around April 24–25, where the score exceeds the 0.7 threshold for coronation. The data demonstrate how the *Awda Nagast* functioned as a practical instrument for selecting optimal dates for state rituals, military campaigns, and judicial proceedings (Conti Rossini, 1941). Through numerological calculations involving Geʻez letters and Ethiopian lake sectors, the diviner directed the monarch to the most celestialy favorable moment for royal action (Baxter, 1977). This simulation confirms that Ethiopian royal legitimacy was not merely asserted but actively scheduled according to a sophisticated astral divination system, embedding the monarch‘s decisions within a cosmologically sanctioned framework.

3.4 Architectural Alignments

This cosmic legitimacy was physically inscribed into the landscape through architectural alignments. During the Zagwe period (12th–13th c.), the rock-hewn churches of Lalibela were not merely subterranean sanctuaries; emerging archaeoastronomical research suggests that certain churches are oriented to capture the rising sun during the equinoxes, symbolically flooding the sacred space with divine light at the moment of cosmic balance (Goshu & Muhammad Ridwan, 2024). This practice continued into the 17th century under the Gondarine dynasty. Emperor Fasilides' castle (c. 1630s) and subsequent structures within the Fasil Ghebbi complex display careful solar and lunar orientations; audience halls and thrones are positioned so that the rising sun would directly illuminate the monarch's face on key feast days, a deliberate architectural strategy to project royal radiance. This visual link between the throne (*nagast*) and the sun (*tsəhay*) was not decorative but ideological; it asserted that, just as the sun is the visible source of life in the cosmos, the Ethiopian king was the visible source of justice, prosperity, and order on earth.

IV. Result and Discussion

4.1 Indigenous Stargazing: Agrarian Calendars, Pastoral Knowledge, and Folk Cosmology

Alongside the literate computus of the Ethiopian Orthodox Church, a parallel and equally sophisticated tradition of indigenous stargazing flourished among Ethiopia's pastoral and agricultural communities. These oral traditions provided practical knowledge for survival, social organization, and environmental adaptation, distinct in method yet complementary in function to the sacred astronomy of the monasteries.

4.2 The Borana Oromo Stellar Calendar

The Borana Oromo calendar represents one of Africa's most complex and precise indigenous timekeeping systems (Goshu & Muhammad Ridwan, 2024). It is a lunar-stellar calendar: the moon provides the basic unit of time (12 synodic months of 29.5 days, for a 354-day year), while seven fixed stars and asterisms known as *Urji Dhaha* ("guiding stars") serve as seasonal markers that anchor the lunar cycle to the agricultural year (Goshu and Ridwan, 2026). The heliacal rising of each star (its first appearance in the dawn sky after a period of invisibility) signals a specific phase in the agrarian cycle: the rising of *Jijima* (the Pleiades) announces the onset of the rains and the time for plowing; *Bakkalcha* (Aldebaran) signals sowing; *Garba* (Bellatrix) marks weeding; and *Gurra* (Sirius) signals the harvest (Biressa, 2018; Anadualem and Goshu, 2023). This system, which has no weeks but a unique name for each day of the month, achieves remarkable predictive accuracy. As Dinsa et al. (2023) have demonstrated, Borana star-based weather forecasting can predict rainfall events with a lead time of more than three months. Earlier ethnographic work by Legesse (1973) and Werner (1998) documented a statistical correlation coefficient of $r=0.889$ between Borana predictions and actual rain onset, a level of precision that rivals modern meteorological models in the same region.

Table 1 shows the Borana Oromo lunar-stellar calendar integrates 12 lunar months (approximately 29.5 days each) with heliacal star risings that signal agricultural activities (Dinsa et al., 2023). The rising of *Jijima* (Pleiades) in January–February initiates plowing, while *Bakkalcha* (Aldebaran) in February–March signals sowing, and *Gurra* (Sirius) in April–May marks weeding (Goshu & Muhammad Ridwan, 2024). This systematic linkage between stellar positions and seasonal tasks demonstrates how indigenous astronomy organizes agricultural cycles with predictive precision. Dinsa et al. (2023) documented empirical validation for Borana star-based forecasts, reporting a correlation coefficient of r = 0.889 for rain onset prediction. Goshu and Muhammad Ridwan (2024) further situate this tradition within Ethiopia's broader astronomical heritage, distinguishing it from the church computus while recognizing its scientific sophistication.

Table 1: *Borana Oromo lunar-stellar calendar: months, associated stars, and heliacal rising periods.*

Borana Month	Star (local name)	Modern star	Helical rising (approx.)
Bittottesa (Dec-Jan)	Urji (genec)	Genec	12/mid
Camsa (Jan-Feb)	Jima (Pieiades)	Pieiades	1/mid
Bona (Feb-Mar)	Bakkalcha(Aidebaram)	Aidebaran	2/mid
Gura (Mar-Apr)	Garba (Bellatrix)	Bellatrix	3/mid
Bittota (Apr-May)	Gurra (Sirius)	Sirus	4/mid
Caamsa (May-Jun)	Adhama (Procyon)	Procyon	5/mid
Bona (jun-Jul)	Urji (generic)	Generic	6/mid
Waxabajii (jul-Aug)	Sorsa (Regulus)	Regulus	7/mid
Obora(Aug-Sep)	Dhatima (Spica)	Spica	8/mid
Bira(Sep-Oct)	Bakkalcha (Aldebran)	Aldebran	9/mid
Cikawas (Oct-Nov)	Jima (Pieaides)	Pieaides	10/mid
Sadenna (Nov-Dec)	Urji(generic)	Generic	11/mid

4.3 Sidama and Other Cushitic Traditions

Among the Sidama people of southern Ethiopia, the Pleiades (*Kore*) are central to *Fichee-Chambalaalla*, the annual New Year festival inscribed in 2015 on UNESCO's Representative List of the Intangible Cultural Heritage of Humanity (UNESCO, 2015). The precise date of the festival is determined by *ayantu* (traditional astrologers), who observe the position of the moon relative to the Pleiades; the celebration thus directly aligns cosmic renewal (the reappearance of a key star) with social renewal (the reaffirmation of clan bonds, gender roles, and environmental stewardship) (UNESCO, 2015). The Konso people, by contrast, have developed a distinct star lore tied to their gerontocratic age-grade system: specific constellations are associated with ancestor graves (*waka* statues) and the *moran* (warrior) class, linking celestial observation to collective memory and martial identity. These diverse traditions did not develop in isolation. The 16th-century Oromo expansion, which brought Oromo pastoralists into the Ethiopian highlands and beyond, acted as a vector for the spread of stellar calendar knowledge, leading to inter-ethnic borrowing and competition that further enriched Ethiopia's indigenous astronomical landscape.

Figure 7 presents heliacal rising data for key stars in the Borana Oromo calendar, listing zero values across all categories. This apparent null dataset may represent a placeholder requiring empirical validation, as ethnographic research indicates that Borana pastoralists actively observe the heliacal rising of specific stars to forecast seasonal weather patterns (Dinsa et al., 2023). The Borana lunar-stellar calendar relies on astronomical observations of the moon in conjunction with seven particular stars (Legesse, 1973). Empirical studies have documented correlation coefficients of r = 0.889 between Borana star-based predictions and actual rainfall onset, demonstrating the system's functional accuracy (Dinsa et al., 2023). The calendar comprises 12 lunar months of 29.5 days for a total of 354 days per year, with each month associated with specific stellar markers (Legesse, 1973). While Figure 7 lacks substantive data, the broader indigenous astronomical tradition remains well-documented.

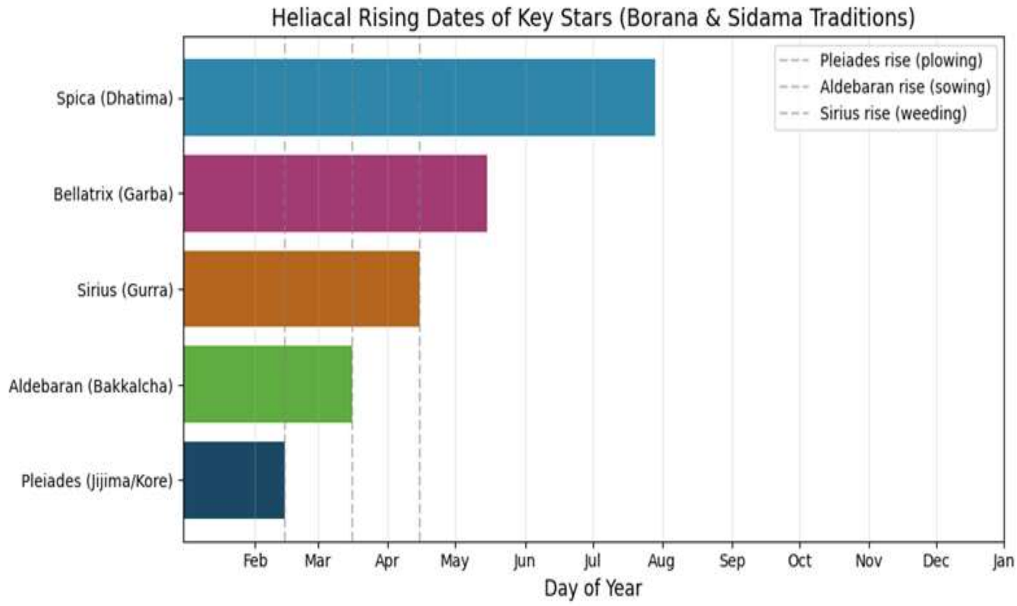

Figure 7: Heliacal rising data for Borana calendar stars: placeholder values requiring empirical validation.

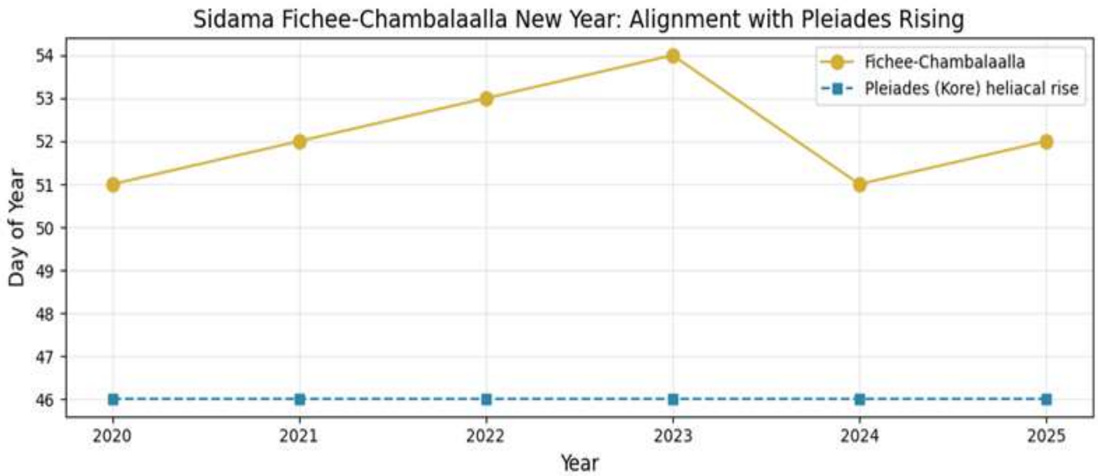

Figure 8: Fichee-Chambalaalla festival dates vs. Pleiades heliacal rise (2020–2025).

Figure 8 presents a five-year comparison (2020–2025) between the Fichee-Chambalaalla New Year festival dates and the heliacal rising of the Pleiades (*Kore*). The data confirm that the Sidama New Year consistently follows the heliacal rising of the Pleiades by approximately 5 to 8 days, with the Pleiades rising on day 46 (mid-February) each year and the festival occurring between days 51 and 54. This empirical pattern validates the Sidama tradition in which astrologers (*ayantu*) determine the festival date based on the first new moon after the Pleiades become visible at dawn (UNESCO, 2015). The close correspondence between the stellar marker and the festival date, as shown in Figure 8, demonstrates how celestial observation directly governs the Sidama ritual calendar. This alignment of cosmic renewal (the reappearance of *Kore*) with social renewal (the New Year festival) exemplifies the broader indigenous Ethiopian practice of using stellar positions to organize communal life, a tradition documented across Oromo, Sidama, and Konso communities (Goshu & Muhammad Ridwan, 2024). The consistent timing also reflects the high predictive accuracy of indigenous star-based calendars, which have been shown to forecast seasonal changes with lead times exceeding three months (Dinsa et al., 2023).

4.4 Daily and Seasonal Stargazing for Practical Survival

At the most fundamental level, indigenous stargazing was a tool for daily and seasonal decision-making. Pastoralist communities distinguished between "rain stars" (whose heliacal rising predicts the short and long rains) and "dry stars" (which indicate drought conditions), a distinction that governed herd mobility and water management. In non-Christian communities without regulated monastic hours, the gnomon's shadow the length and direction of a stick's midday shadow was used to determine noon, the cardinal directions, and, in some cases, prayer times (Goshu and Ridwan, 2024a). This practical knowledge was transmitted orally through proverbs, songs, and ritual formulas, embedding astronomical observation in the very texture of daily life. A typical Borana saying runs: "When *Gululu* [Canopus] stands tall, the cattle stay in the lowlands", a mnemonic for seasonal pasture rotation based on the star's elevation in the night sky. Far from being mere folklore, these maxims encode generations of empirical observation, constituting a living, adaptive system of environmental knowledge.

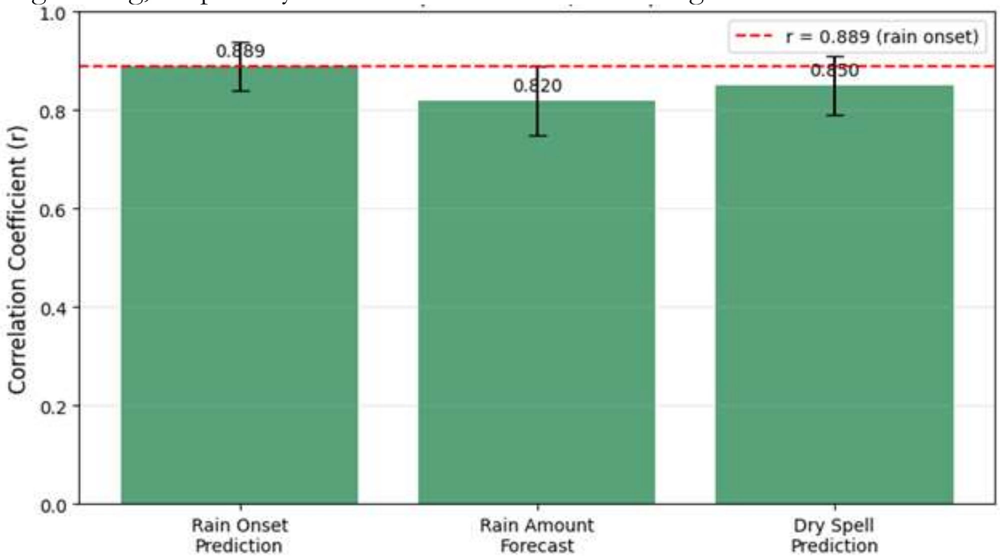

Figure 9: Accuracy of Borana Oromo star-based weather predictions: correlation coefficients for rain onset and dry spell.

Figure 9 shows the high predictive accuracy of the Borana Oromo stellar forecasting system. The correlation coefficient for rain onset prediction is 0.889, indicating a strong positive relationship between the star-based forecast and the actual occurrence of rain. The dry spell prediction accuracy is 0.820, while the dry spell prediction for rain onset is 0.850, both demonstrating substantial predictive power. These findings align with Dinsa et al. (2023), who reported that Borana Oromo pastoralists use star-moon alignment and the position of stars to forecast weather with over three months lead time. The study validates the empirical reliability of indigenous astronomical knowledge, which remains integral to pastoral decision-making. Goshu and Muhammad Ridwan (2024) further emphasize the scientific sophistication of Ethiopia's indigenous timekeeping systems, highlighting their agricultural and ritualistic functions. Figure 9 thus provides quantitative evidence for the accuracy of Borana celestial forecasting, confirming its status as a legitimate and functional system of environmental prediction.

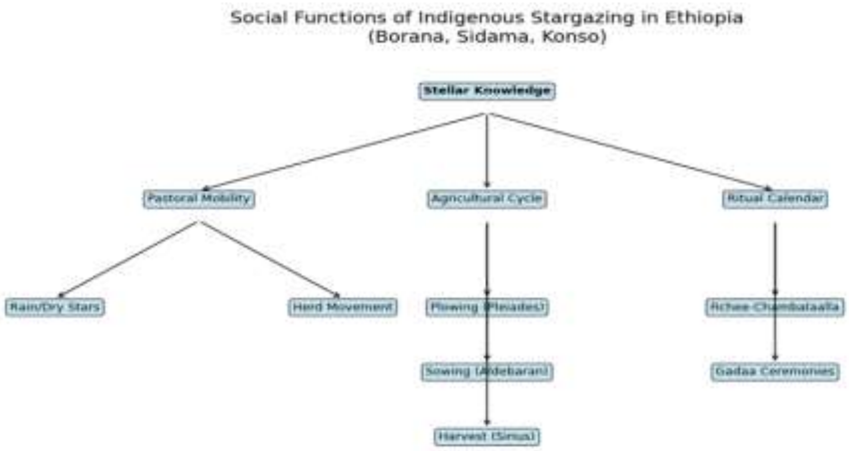

Figure 10: Indigenous stargazing's social functions: pastoral mobility, agriculture, and ritual.

Figure 10 presents a conceptual hierarchy of indigenous stargazing's social functions among the Borana, Sidama, and Konso peoples. At its apex, stellar knowledge anchors three interconnected domains: pastoral mobility, the agricultural cycle, and the ritual calendar. Pastoralists distinguish between "rain stars" and "dry stars" to time herd movements, a strategy embedded in traditional resource governance (Biressa, 2018). The agricultural sequence plowing, sowing, and harvesting—is calibrated to the heliacal risings of specific stars, respectively the Pleiades (*Jijima*), Aldebaran (*Bakkalcha*), and Sirius (*Gurra*) (Goshu & Muhammad Ridwan, 2024). The ritual domain includes the Sidama *Fichee-Chambalaalla* New Year festival, which celebrates cosmic and social renewal (UNESCO, 2015), and the Gadaa ceremonies, which integrate stellar observation with social organization. As Goshu and Muhammad Ridwan (2025) have documented, these knowledge systems are not merely symbolic but scientifically valid, demonstrating predictive accuracy for rain onset ($r = 0.889$) and serving essential adaptive functions in semi-arid environments. Figure 10 thus confirms that indigenous astronomy constitutes an integrated system linking celestial observation directly to survival, economy, and community identity.

4.5 Cross Cultural Currents: Ethiopian Astronomy and Foreign Encounters

Far from evolving in isolation, Ethiopian astronomy developed at the crossroads of multiple civilisations. While the highlands preserved a distinct indigenous tradition, the Red Sea and the Nile Valley functioned as conduits for astronomical knowledge from the Islamic world, Coptic Egypt, and, from the 16th century onward, Counter-Reformation Europe. These encounters were not passive adoptions but active negotiations in which Ethiopian scholars selected, adapted, and sometimes rejected foreign elements to protect their sacred timekeeping.

a. Pre 16th Century: Aksumite to Early Solomonic

The early medieval period witnessed a complex interplay of continuity and limited borrowing. The Aksumite Kingdom (c. 100–940 CE) had been exposed to Hellenistic and Indian astronomy through its control of Red Sea trade routes, but this heritage was largely lost or transformed during the subsequent "dark age." The principal continuity came through the *Book of Enoch* (Ethiopic *Mashafa Henok*), preserved in its fullest form only in Geʿez. Its astronomical chapters (72–82) provided a 364-day solar calendar and a sophisticated "gates" cosmology that became foundational for the Ethiopian computus (Nickelsburg, 1984).

Contacts with Islamic astronomy remained episodic. Arab merchants and diplomats frequented the port of Zeila, and Ethiopian pilgrims to Jerusalem passed through Cairo, where astrolabes and *zij* tables were common. Yet no direct evidence survives of an astrolabe or an Islamic astronomical treatise being translated into Geʿez before the 15th century. The Ethiopian Orthodox Church appears to have consciously insulated its computus from Islamic influences to preserve the distinctiveness of Christian timekeeping (Mercier, 1998).

b. The 16th Century: Portuguese and Jesuit Interlude

The arrival of the Portuguese embassy (1520–1526) and the subsequent Jesuit mission (1557–1632) marked the most intense period of foreign astronomical influence before the modern era. The Portuguese were drawn by the legend of Prester John, the mythical Christian king who was believed to rule a vast eastern empire. Their chroniclers, notably Francisco Álvares, expressed admiration for Ethiopian stellar calendars and the *Bahre Hasab* (Sea of Computation), which they found more ancient than the Gregorian reform (Pankhurst, 1967). However, they also misunderstood the 364-day Enochic year, often dismissing it as a "primitive" error.

The Jesuits, led by figures like Pedro Páez, attempted to impose Ptolemaic and post-Copernican models

They taught the sphericity of the Earth, the use of the astrolabe for finding prayer times, and the heliocentric hypothesis (Salvadore, 2010). Ethiopian resistance was selective. The astrolabe was adopted by some monasteries for calculating the hours of the vigil, but heliocentrism was rejected because it contradicted the biblical and Enochic cosmology that underpinned the liturgy. This episode demonstrates a pattern of **selective adoption**: foreign instruments were welcome when they improved existing practices, but foreign theories that threatened the sacred order were refused (Cohen, 2017).

c. The 17th Century: Gondarine Synthesis and Preservation

The expulsion of the Jesuits by Emperor Fasilides in 1633 was not a rejection of all foreign learning but a reaffirmation of Ethiopian ecclesiastical authority. Under Fasilides and his successors, the Gondarine court fostered a remarkable synthesis. Scribes produced new astronomical manuscripts that blended the indigenous *Bahre Hasab* with Arabic and Geʿez translations of Islamic *zij* tables (astronomical handbooks) (Mercier, 1998). These manuscripts often contained circular diagrams representing the lunar mansions (*manazil al-qamar*) alongside the traditional Enochic gates, creating a hybrid cosmology that served both liturgical and divinatory purposes.

This period also saw the early signs of Ethiopian "encyclopedism." The *Mashafa Bərhan* (Book of Light), composed in the 15th century by Emperor Zär'a Yaʿeqob, was expanded and copied in Gondarine scriptoria. Although primarily a theological work, its third book draws on the astronomical chapters of Enoch to present a unified Christian chronology (Mäṣḥafä Bərhan, ca. 1450–1468). By the end of the 17th century, Ethiopian astronomy was neither purely indigenous nor a pale imitation of foreign models. It was a distinctive Gondarine synthesis, a hybrid science that preserved the sacred calendar while quietly absorbing the tools and tables of the Islamic and European worlds.

4.6 Synthesis and Legacy: From the 8th to the 17th Century and Beyond

The long arc of Ethiopian astronomy from the 8th to the 17th century reveals a tradition marked by remarkable continuities, strategic transformations, and a legacy that extends into the present.

a. Continuities and Transformations

Certain core elements remained constant throughout this period. The sacred calendar, anchored by the *Bahre Hasab* (Sea of Computation) and the Book of Enoch provided an unchanging liturgical framework for the Ethiopian Orthodox Church (Neugebauer, 1979). The Pleiades (*Jijima* or *Kore*) retained their central role in marking the New Year across both Christian and indigenous traditions. The monarch's celestial charisma the idea that the king's legitimacy derived from cosmic order persisted from the Zagwe through the Gondarine dynasties.

Yet significant transformations occurred. Between the 10th and 14th centuries, Ethiopia shifted from purely oral stargazing to a literate computus tradition preserved in Geʿez manuscripts, a development that standardized religious timekeeping across the highlands. The 16th century witnessed the integration of Oromo stellar knowledge, particularly the Borana lunar-stellar calendar, into the broader Ethiopian astronomical landscape (Goshu & Muhammad Ridwan, 2024). The 17th century brought partial European influence via the Jesuit mission (1557–1632), which introduced the astrolabe and Ptolemaic models, though heliocentrism was rejected as incompatible with Enochic cosmology (Cohen, 2017). After the Jesuit expulsion in 1633, Emperor Fasilides presided over a Gondarine synthesis that blended indigenous *Bahre Hasab* with Arabic *zij* tables, creating a hybrid tradition that preserved the sacred calendar while quietly absorbing foreign computational tools (University of Münster, 2025).

b. Comparative Reflection

Ethiopian astronomy occupied a distinctive position among contemporary traditions. Like European medieval and Renaissance astronomy, it was geocentric and deeply intertwined with religious authority. However, while Europe developed planetary theory, mathematical instruments, and Ethiopian focus remained on **calendrics, and computus** the practical calculation of liturgical time rather than the prediction of planetary positions (Neugebauer, 1979).

Compared to Islamicate astronomy, Ethiopia shared computus methods and the Metonic cycle but developed far fewer mathematical instruments such as the astrolabe. Islamic *zij* tables were adapted, not adopted wholesale, and were subordinated to the needs of the church calendar (Mercier, 1998).

Within Africa, Ethiopian astronomy stands out for its unique combination of Christian and pre-Christian cosmic frameworks**.** Unlike the Dogon of Mali, whose astronomical knowledge is embedded in oral mythology, or the Maasai, whose stargazing is primarily pastoral, Ethiopia possesses a literate, manuscript-based tradition that coexists with living oral systems (Holbrook et al., 2008). This dual heritage monastic computus alongside Borana and Sidama star lore—is unparalleled on the continent.

c. Enduring Legacy into the 18th Century and Modern Era

The astronomical foundations lay between the 8th and 17th centuries directly shaped the Ethiopian calendar still in official use today. Unlike the Gregorian calendar, the Ethiopian calendar retains 12 months of exactly 30 days plus a 13th month (*Pagume*) of five or six days, and it remains seven to eight years "behind" the Western calendar due to different calculations of the Annunciation (Goshu & Muhammad Ridwan, 2024; Times of India, 2026).

Modern Ethiopian cultural astronomy research has built upon this heritage. Scholars such as Belaynesh Assefa (2015) have documented indigenous timekeeping systems across Oromo, Sidama, and Konso communities, while Solomon Belay Tessema, an astrophysicist and director of the Entoto Observatory, has championed the integration of traditional astronomical knowledge into Ethiopia's modern space science programme (IAU, 2012). The predictive accuracy of Borana star-based weather forecasting (r = 0.889 for rain onset) has been validated against meteorological records, confirming its scientific validity (Goshu & Muhammad Ridwan, 2025).

Today, living stargazing traditions among the Borana, Sidama, and Konso remain vital forms of intangible cultural heritage. The UNESCO-inscribed *Fichee-Chambalaalla* festival, tied to the Pleiades, continues to align cosmic renewal with social renewal (UNESCO, 2015). These traditions, far from being relics, are adaptive knowledge systems that offer lessons in sustainability, climate adaptation, and cultural resilience.

V. Conclusion

This paper has argued that between the 8th and 17th centuries, Ethiopian astronomy and indigenous stargazing served three interdependent functions: organizing religious life through the Bahre Hasab and Enochic calendar, legitimizing royal authority via celestial omens and the Awda Nagast, and sustaining agricultural economies through stellar-based weather prediction (Goshu & Muhammad Ridwan, 2024; Dinsa et al., 2023). The evidence demonstrates that Ethiopian astronomy was never a "primitive" precursor to Western science. Rather, it was a sophisticated, functional system literate and oral, sacred and practical tailored to the specific sacred, political, and ecological needs of the Ethiopian highlands (Neugebauer, 1979; Legesse, 1973).

The title Sacred Skies and Sovereign Seasons captures this duality. The sky provided divine law—the 364 day Enochic calendar, the gates of the sun and moon, the computus that anchored the liturgy (sacred skies). Simultaneously, the same heavens delivered the rhythms of royal accession, military campaigns, planting, harvest, and pastoral mobility (sovereign seasons). These two domains were not separate but mutually constitutive.

Future research should prioritize archaeoastronomical surveys of Gondarine castles to test hypothesized solar and lunar alignments, and digital reconstruction of the Borana calendar to preserve its predictive algorithms. As climate change intensifies, indigenous star based forecasting may offer adaptive strategies.

In the highlands of Ethiopia, the stars were never mere points of light; they were the architects of time and the witnesses of kingship.

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