

A Study of Ancient Indian Astronomy through Architectural Marvels

Keerthi Krishnanath Prabhu Shirodkar

UG Scholar, PMCs, School of Sciences, Jain Deemed to be University. keerthip.shirodkar@gmail.com

Abstract: Ancient Indian astronomy has a rich legacy that spans millennia, encompassing intricate observations, advanced calculations, and skillful implementations. This review article explores the intersection of astronomy and architectural marvels in ancient India. By examining the architectural marvel, the profound astronomical knowledge embedded within its design and construction is inspected. The study aims to unveil the celestial alignments, geometric patterns, and symbolic representations reflecting the deep understanding of cosmic phenomena of ancient Indian astronomers and architects. With this review, through a comprehensive analysis of the temple's architectural elements, it is expected to gain insights into the intricate methods employed by ancient Indians to encode astronomical principles into monumental structures and the cultural significance of these celestial pursuits.

Keywords: architecture, astronomy, equinox, Konark sun temple, Modhera sun temple, solstice

1 INTRODUCTION

For centuries, scholars and researchers have been captivated by studying ancient Indian astronomy. This knowledge, extending beyond theoretical realms, manifests itself in the enduring architectural wonders that have withstood the test of time. Among these wonders, the Sun Temples in various states serve as examples, showcasing the remarkable astronomical insights and engineering prowess of ancient Indian civilizations [1]. India's temple tradition, a cornerstone in cultural and societal studies, has been the subject of extensive research exploring diverse facets such as culture, tradition, and social structures. Yet, a noticeable gap exists in recognizing temples as invaluable repositories of historical astronomical knowledge. Passed through generations, these temples intricately integrate astronomical concepts into architectural design, religious practices, and festive traditions. Despite standing for over 2,000 years, the exploration encounters challenges in decoding the original astronomical significance [2]. The following sections present the detailed case study of Konark and Varanasi Sun Temple.

2 METHODOLOGY

This review article is written based on the analysis of the findings of various archaeo-astronomical surveys that discuss the possible integration of ancient astronomical and cosmological knowledge with temple architecture. Multiple reports concerning traditionally passed knowledge in locals and their beliefs are also considered.

3 KONARK SUN TEMPLE

The Konark Sun Temple in Odisha, constructed in the 13th century by Raja Narasimha of the Ganga Dynasty [3], is a remarkable fusion of architectural grandeur and astronomical precision. Its intricate design and construction reflect the profound understanding of celestial movements, astronomical alignments, and symbolic representations that were deeply ingrained in ancient Indian cosmology [4].



Fig. 1 Konark Sun Temple, Odisha [5]

3.1. Architectural Features

Situated on the eastern coast of Odisha, India, the temple was meticulously designed to align with the sun's movement, capturing the essence of solar worship prevalent in the region. However, the precise reasons for its placement near the Bay of Bengal and the now-dry holy river Chandrabhagam remain unclear. The temple is still celebrated for its architectural marvel and intricate stone carvings. It is observed to be built in *Kalinga* style [6], recognized by a tall sanctum or Garbhagriha, a majestic entrance hall, and a separate dance pavilion or *Nat Mandir*. The main entrance is towards the east. The structure also hosts a representation of twelve pairs of intricately carved wheels, each 10 feet in diameter [7]. Seven horses are seen dragging the temple, and two lions and crushing elephants guard the temple [8].

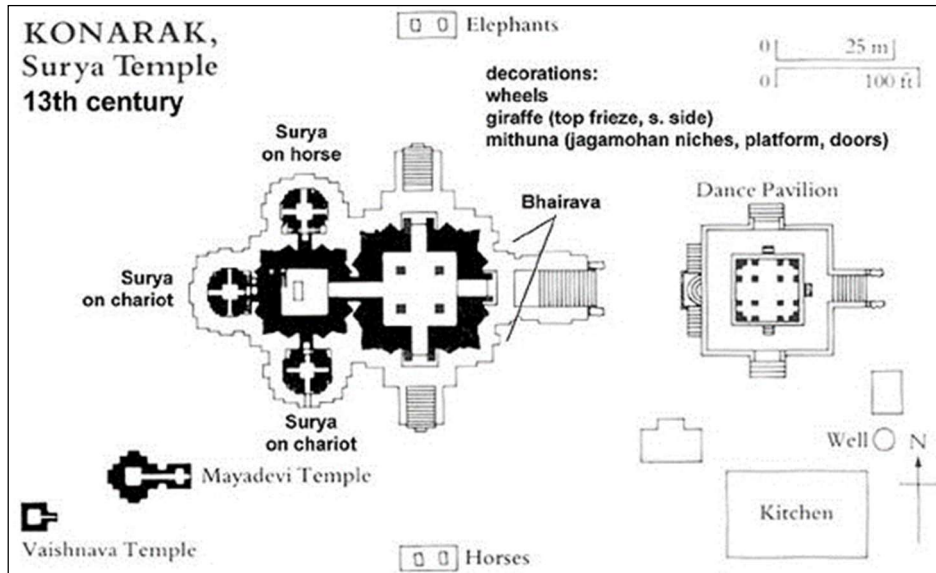


Fig. 2 Plan of Konark Sun Temple [9]

3.2. Symbolism and Astronomical Significance

The architectural features of the Konark Temple symbolically portray several measures of time. The main complex is observed to be crafted in the form of a chariot. The twenty-four wheels of this chariot are intended to signify either the twenty-four hours of a day or the twenty-four fortnights in a year. It is also sometimes thought that the twelve pairs signify the twelve months of the year. Each wheel incorporates eight spokes, representing the eight *Praharas*, or periods, in a day [10] [7]. This representation emphasizes the wheel as a central symbol of time, portraying a still centre enabling movement and change. Additionally, the wheel signifies the sustained separation between the earth and the heavens, supported and separated by the axle that maintains the division between the turning wheels of earth and sky. The axle's function is crucial, allowing creation by facilitating the necessary separation. The wheels embody the concept of *Kala* time, bringing forth life from darkness and ultimately returning life to darkness and death [11].



Fig. 3 Wheel of the Chariot in Konark Sun Temple [11]

The team of horses adjacent to the main gate have varying interpretations regarding their symbolism. According to some traditions, these horses represent the seven days of the week, while other sources suggest they symbolize the seven colors constituting the sunlight [7]. Sun rays must also pass through seven layers of the atmosphere before reaching the Earth, which is also associated with the representation of horses [3]. Additionally, the temple features three standing images of the deity Surya, depicting the rising, midday, and setting sun [3].



Fig. 4 Standing images of the deity Surya. (a) Rising Sun (b) Midday Sun (c) Setting Sun. [12]

Presently, the Konark Sun Temple stands recognized as a UNESCO World Heritage Site and falls under the protective purview of the Archaeological Survey of India. Restoration initiatives have focused on stabilizing the extant structures and safeguarding the detailed carvings. Despite the main tower being in a state of ruin, the surviving sections persist, serving as a captivating astronomical relic. As the sun's rays cast shadows upon the remaining structures, it continues to function, in a celestial sense, as a living sundial, attracting awe and fascination from global visitors [4].

4 MODHERA SUN TEMPLE

The Sun Temple in Modhera, Gujarat, lies 100 km northwest of Ahmedabad in the Mehsana district. Positioned along the collinear line parallel to the Tropic of Cancer at a latitude of 23.5° in the Northern Hemisphere, it was commissioned by Bhima-I of the Chalukya (Solanki) dynasty during 1026-27 CE. Built on the banks of the Pushpavati River, it once belonged to the ancient state of *Anahitapataka*, present-day Patan in Gujarat. The Modhera Sun Temple was constructed in the distinctive architectural style called *Maru Gurjara* [13]. This unique architectural design, particularly its connection with water bodies, renders it a marvel of engineering [14].



Fig. 5 Modhera Sun Temple [15]

4.1. Architectural Features

The architectural features of the Modhera Sun Temple are distinctly organized into three segments: Surya Kunda, Sabha Mandapa, and Surya Mandir (Sanctum-Garbh Griha/Gudha Mandapa) [13]. Adhering to the *Maru Gurjara* style, the temple's design exhibits symmetrical geometry along its longitudinal axis. The entrance, marked by the *Kirti Torana* (an arch), guides visitors to a descending flight of steps leading to the Surya Kunda reservoir [14].

Within the central niches of the Sun Temple at Modhera, the life-sized sculptures are dedicated to three groups: the Adityas, Lokapalas, and Devis. The western section of the cella is adorned with the twelve Adityas, strategically arranged to emphasize the prominence of Surya. These depictions showcase Surya standing gracefully, holding lotuses, and guiding a celestial chariot drawn by seven majestic horses [16].

4.2. Astronomical Significance

Strategically located near the Tropic of Cancer at 23.5835° N, 72.1330° E, the temple showcases deliberate solar alignments. During the equinox, the rising sun's first rays illuminate the Sun God's image in the sanctum, establishing a celestial connection. Moreover, the sun illuminates the temple's apex during the summer solstice without casting shadows [14]. This intentional alignment highlights the meticulous integration of astronomical considerations into the architectural blueprint of the Modhera Sun Temple.

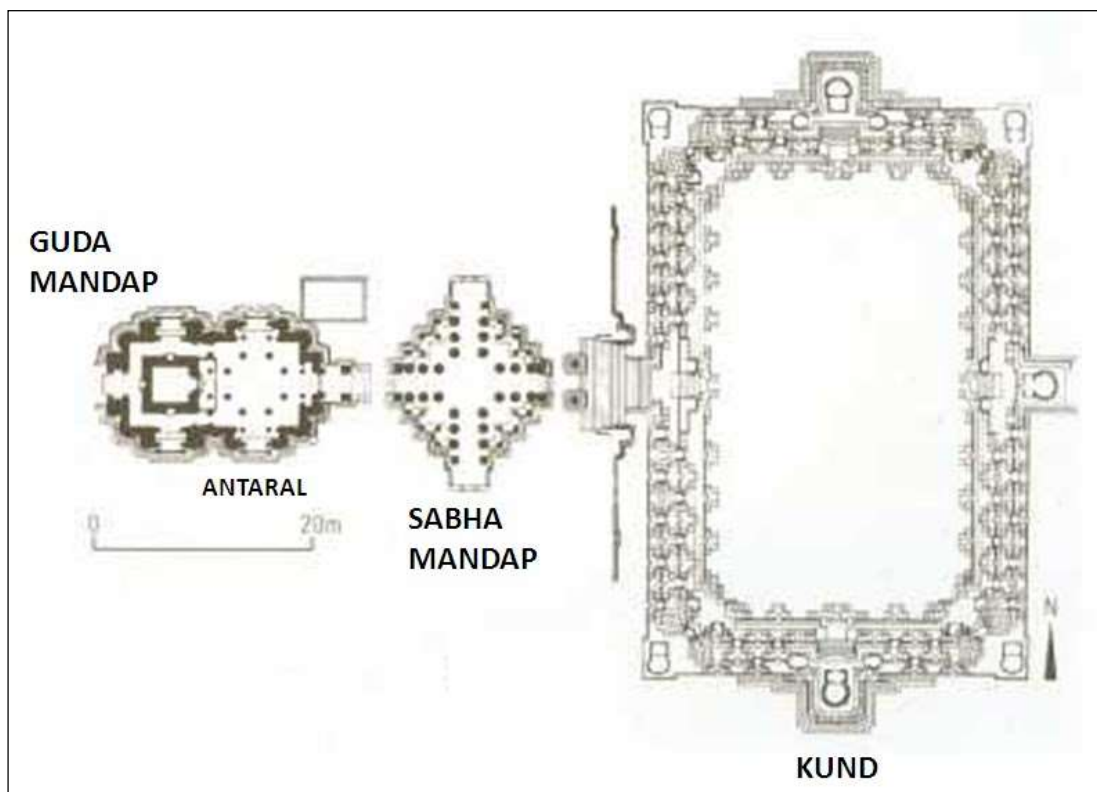


Fig. 6 Plan of Modhera Sun Temple [17]

The Surya Kunda also captivates the minds of visitors because of its symmetrical design. Within the Surya Kunda are 108 shrines, which have great significance in Vedic mythology. In the context of ancient knowledge, particularly in astronomy and astrology, the representation of information through monuments is a common practice. The number 108 holds particular importance in various ancient domains of knowledge.

The number 108 reveals intriguing relationships between celestial bodies. Notably, the diameter of the Sun is 108 times that of the Earth, and the distance from the Sun to Earth is also 108 times the Sun's diameter. Similarly, the distance from the Earth to the Moon corresponds to 108 times the diameter of the Moon. This numerical connection reflects the ancient understanding of celestial proportions and distances [14].

The Sun Temple at Modhera is a UNESCO World Heritage Site (Sun Temple, Modhera and Its Adjoining Monuments - UNESCO World Heritage Centre) and is considered a monument of national importance. The Archaeological Survey of India looks after it. Although worship is not performed here, the site holds great local significance and popularity [18][19].

5 CONCLUSIONS

The Konark Sun Temple and the Sun Temple in Modhera are remarkable examples of the ingenious fusion of architectural brilliance and astronomical significance in ancient Indian temple construction. The Konark Sun Temple is mesmerized by its intricate carvings and is celebrated for its sundial-like architecture, indicating the possible time measurement in eight *Praharas*. Similarly, the Sun Temple in Modhera, a jewel in Gujarat's temple architecture, showcases exceptional artistic mastery and technological prowess. Significantly, both temples strategically align with astronomical phenomena—the Konark Sun Temple with the sun's movements and the Modhera Sun Temple ingeniously positioned to allow the equinoctial sun to illuminate its shrine and successfully demonstrate the phenomena of zero shadow on the summer solstice. Beyond their cultural and religious importance, these temples serve as living symbols of the profound connection between ancient astronomy and temple construction, where meticulous planning harmoniously intertwines with celestial dynamics, creating enduring marvels that continue to evoke awe and admiration from visitors worldwide.

This extends to the revelation of ancient astronomers' profound observational and conceptual insights. These scholars recognized and encoded intricate celestial relationships into their architectural masterpieces, offering tangible and symbolic representations of their profound understanding of the cosmos. Such insights underscore the advanced knowledge of ancient cultures and provide valuable clues for contemporary astronomers delving into the historical development of astronomical understanding. The exploration of these ancient temples and a profound study of historical texts serve as a captivating journey into the archives of human understanding. In the current quest for knowledge, modern scholars must recognize the untapped reservoirs of wisdom embedded in the architectural wonders and literature of ancient civilizations. These temples beckon contemporary researchers to decode the knowledge lost over time. By delving into the past, decoding the intricacies of these architectural marvels, and reinterpreting ancient literature, doors are opened to rediscover forgotten wisdom. This endeavour not only enriches the present understanding but also holds the potential to unveil solutions to current enigmas and mysteries. Bridging the gap between the ancient and the modern unearths the possibility of finding missed answers, creating a continuum of knowledge that spans the ages.

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