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CONTRIBUTION OF LAXMI PATI PANDEY: A COMPREHENSIVE STUDY OF NEPALI MATHEMATICIAN AND ASTROLOGER

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Abstract: *This article presents a comprehensive study of the life and contributions of Pandit. Laxmi Pati Pandey, a distinguished mathematician and astrologer from 18th-century Nepal. The historical context is explored to understand the intertwining of mathematics and astronomy in Nepalese culture, with a focus on the significance of mathematical induction and the evolution of mathematical thought in Shah era of Nepal. It outlines the historical relationship between mathematics and astronomy in Indian culture, emphasizing the close connection between the two disciplines. It also highlights the emergence of mathematical techniques in Siddhiintas, focusing on their application to solve astronomical problems. The study delves into Laxmi Pati Pandey's mathematical works, including his notable translation of book "Bhaswati," and Sanskrit Text "Ratna Deep". The study adopts a qualitative research design, incorporating historical analysis, content analysis, and interviews. Archival research, literature review, and interviews with descendants and experts are conducted to gather information on Laxmi Pati Pandey's background, contributions, and educational practices. Ethical considerations are highlighted to ensure the respectful treatment of information. Thematic analysis is employed to interpret collected data, identifying key themes related to Laxmi Pati Pandey's contributions and educational practices. The analysis involves a comparison of his work with historical sources to identify potential influences and contributions to Nepali mathematics. The findings reveal Laxmi Pati Pandey's significant contributions to mathematics and astronomy, including the translation of Sanskrit slokas into Nepali and the writing of mathematical books. His influence on educational practices and the development of mathematical education in Nepal is evident. The study uncovers his intellectual legacy through his descendants, such as Lila Nath Pandey and Gopal Pandey.*

Keywords - *Royal Astrologer, Bhashwati, Ratnadeep, Contribution, Sundial, Astronomy.*

INTRODUCTION

Mathematical induction is considered an artful science and a fundamental mode of thought. In Indian culture, there exists a strong connection between mathematics and astronomy. Mathematics primarily served to aid astronomy, while astronomy played a crucial role in determining auspicious timings for religious ceremonies. However, at times, the progress of mathematics and astronomy in India was hindered by an excessive focus on the religious aspects of these disciplines. Notably, Greek geometry and deductive mathematical logic were neglected in favor of Greek and Babylonian astrology (hora sastra) during the third and fourth centuries BC. The Siddhant era started with Aryabharya's work around AD 499, as documented by K.V. Sharma (Sharma, 1976).

However, our knowledge is constrained to currently accessible manuscripts, and it's likely that earlier Siddhiintas, referred to by later astronomers, are currently unavailable. In India, the progress of mathematics is closely tied to astronomy. Siddhiintas offer precise

mathematical solutions to astronomical challenges, including eclipse calculations, daily celestial problems, and planet positions (Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn). Tasks like finding directions, calculating latitude, tracking the sun's path, and determining celestial relationships are examples of diurnal problems. Addressing eclipses involves computations related to conjunction timing, duration, magnitude, and other intricate details

142 years ago, no mathematical books were written in Nepali language (Jha, 2006). In the past, students from Nepal would go to Kashi, or Banaras, to learn Sanskrit. They were tutored by prominent mathematicians like Pant S. R. (Pant, 1980), *Lilavati* and *Siddhant Siromani* of Bhaskaracharya II. Nepali students were influenced by Indian mathematicians to try writing books.

Based on Surya Sidhhanta, several renowned astrologers had created appropriate calendrers. The Bhashwati book was written in 1099 A.D. by a famous Indian astrologer named Satananda from the Udisha state. Because of its immense popularity, Jyotish instructors could be found teaching this book as math classes everywhere. In relation to this, this Bashwati book's "*Balbodhani Tika"* was created in 1494 A.D. (during the Malla Era) by local instructor Daibagnya Balbhadra joshi from the Jumla area as a math textbook. Bhashwati was the first supplement to mathematics as it had aided with several count calendars (panchang) and helped teach addition, subtraction, multiplication, and division, among other fundamental arithmetic concepts.

The "*Siddhanta Siromani*" is a comprehensive mathematical and astronomical treatise written by the Indian mathematician and astronomer Bhaskaracharya II, who was also known as Bhaskara II or Bhaskara Acharya. Here are some key notes from the "Siddhanta Siromani" (Arkasomayaji, 1980).

Lilavati Section

Bhaskaracharya's "Lilavati" (Bhaskaracharya, 1994), is a part of the "*Siddhanta Siromani"* (Arkasomayaji, 1980), and is dedicated to mathematics, specifically arithmetic and algebra.

It covers various topics such as number theory, geometry, and indeterminate equations.

The *Lilavati* section also includes problems and solutions related to the calculation of interest, time, and progressions.

Bijaganita Section

"Bijaganita" is another major section of the "*Siddhanta Siromani,"* focused on algebra.

It deals with quadratic equations, indeterminate equations, and algebraic operations.

Bhaskaracharya provided solutions to quadratic equations with both positive and negative roots.

Grahaganita Section

This section of the "*Siddhanta Siromani"* is dedicated to astronomy and planetary motion.

Bhaskaracharya presented detailed mathematical explanations of the motion of planets, their conjunctions, and other celestial phenomena.

The concepts of epicycles and eccentric orbits are discussed in the context of planetary motion.

Goladhyaya Section

The "*Goladhyaya*" deals with spheres and describes methods for calculating the surface area and volume of various types of spheres.

It includes discussions on the celestial sphere and its properties.

Karana Khandakhadyaka

Bhaskaracharya's work on "*Karana Khandakhadyaka*" in the "Siddhanta Siromani" explores the topics of mathematical instruments and calculations.

It discusses the construction and use of instruments for timekeeping, such as sundials.

Contributions to Trigonometry

Bhaskaracharya made significant contributions to trigonometry, including the development of trigonometric identities and methods for calculating sines.

Indeterminate Equations

The "*Siddhanta Siromani*" includes discussions on solving indeterminate equations, where the goal is to find integral solutions satisfying certain conditions.

Influence on Later Mathematics

Bhaskaracharya's work, including the "*Siddhanta Siromani,"* had a profound influence on later mathematicians and astronomers, both in India and abroad.

Versatility in Mathematical Topics

A significant connection exists between mathematics and Astrology. Thus, in the past, in order to learn mathematics, individuals would travel to jyotish tutors. Jyotish assisted their pupils in learning arithmetic. Bhashwati's assignments had assisted them in finishing their calculations at Panchang. *Lilavati* was formerly read by those who wanted to learn more mathematics.

Statement of the Problem

The life and scholarly contributions of Laxmi Pati Pandey, a distinguished mathematician and astrologer from 18th-century Gorkha, Nepal, present a significant historical and academic interest. Born into the Royal astrologer family during the reign of King Prithivi Narayan Shah, Laxmi Pati Pandey made substantial contributions to both mathematics and astrology. His influence extended to advising notable monarchs like Prithvi Narayan Shah and Bahadur Shah. Notably, Laxmi Pati Pandey holds the distinction of being the first Nepali astrologer to translate Sanskrit slokas into Nepali.

The research aims to delve into the life, works, and intellectual legacy of Laxmi Pati Pandey, with a particular focus on his contributions to mathematics and astrology. Several key aspects warrant investigation:

Objective of the Study

The goal of qualitative research is to discover the meaning through the patterns of the observed information which emerge after close observation, careful documentation, and thoughtful analysis of the research topic (Sharma, 2011). The study has set the following objectives:

- Explore Laxmi Pati Pandey's Literary Works:
- Examine the novels penned by Laxmi Pati Pandey, such as *GrihaL aghava Kalarnan Dipika, Lilavati, Bhaswati, Tika,* and *Ratnadeep,* to understand their literary and mathematical content.

Methodology

This study adopted a qualitative research design to comprehensively explore the life, contributions, and educational practices of Laxmi Pati Pandey, focusing on historical analysis, content analysis, and interviews. Researcher performed historical Analysis with conducting archival research in historical archives, royal records, and family documents to gather information on Laxmi Pati Pandey's background, birth, and interactions with royalty during the time of King Prithivi Narayan Shah. This study also conducted literature review method. Researcher reviewed existing literature, including historical records, biographical accounts, and scholarly articles, to understand the context of Laxmi Pati Pandey's life and contributions in the field of Nepali mathematics and astrology. Researcher also conducted qualitative interviews with descendants of Laxmi Pati Pandey, scholars specializing in Nepali mathematics and astrology,

and experts in historical records. Gathered first hand insights on family contributions, educational practices, and the impact of *Bhashwati* and *Lilavati*. Researcher analyzed manuscripts authored by Laxmi Pati Pandey, Lila Nath Pandey, and Gopal Pandey, with a focus on *'Tikas of Bhashwati,' Siddhant Jyotish*, and *Wyokta Chandrika.*

Researcher evaluated mathematical methods, innovations, and the historical context of their creation. Researcher compared Laxmi Pati Pandey's work with historical sources, particularly the "*Siddhant Shiromany*" by Bhaskaracharya, to identify potential influences and contributions to the development of Nepali mathematics. Researcher investigated Laxmi Pati Pandey's educational background, with a focus on Sanskrit education and the utilization of *Bhashwati* and *Lilavati* as text books. Examined the impact of these practices on the historical development of mathematics education in Nepal.

Ethical Considerations:

Researcher ensured ethical treatment of information, respected privacy, and obtained permissions for archival material access. Adhered to ethical standards in conducting interviews and handling sensitive historical data.

Analysis

Thematic analysis was employed to interpret the collected data, identifying key themes related to Laxmi Pati Pandey's contributions, educational practices, and the utilization of his works in Nepali mathematics and astrology education.

Mathematical Contributions

Laxmi Pati Pandey's role in advancing mathematics in Nepal is a critical area of exploration. The study will seek to understand the nature and scope of his mathematical works, including the writing of novels such as *Griha Laghava Kalarnan Dipika, Lilavati, Bhaswati, Tika,* and *Ratnadeep.* Additionally, the examination of Gopal Pandey's mathematical contributions, particularly his application of the Trizoidiacle Rule and the writing of the first mathematics book in Nepali, Wyokta Chandrika, will be integral to understanding the evolution of mathematics in Nepal. The Mathematician Laxmi Pati Pandey was a famous astrologer before Gopal Pandey. Laxmi Pati Pandey is also regarded as "*Daibagya Siromani"* of Nepal (Pant, 2007) , The Royal Astrologer Laxmi Pati Pandey used to find out good omen for Gorkhali army to invade different kingdom during the unification campaign of Gorkhali towards the western belt of Nepal. When the Gorkhali attacked at the right omen as indicate by Pandey, they could get victory (Pant, 2007).

Educational Practices: The research will investigate the educational background of Laxmi Pati Pandey, focusing on his training in Sanskrit and the influence of his astrologer lineage on his proficiency in mathematics and astronomy. Furthermore, the study will explore the educational impact of Laxmi Pati Pandey's works, such as Bhashwati and Lilavati, on subsequent generations. This includes examining the use of Bhashwati as a textbook at the elementary level and *Lilavati* for advanced mathematical knowledge.

Cultural and Historical Significance: The research will explore the cultural and historical context in which Laxmi Pati Pandey lived and worked. Understanding how his astrological advice shaped the decisions of monarchs and the utilization of his mathematical works by astrologers for computing celestial events will provide insights into the broader impact of his contributions.

Intellectual Legacy: Investigating the intellectual lineage of Laxmi Pati Pandey, particularly through his descendants like Lila Nath Pandey and Gopal Pandey, will contribute to understanding the continuity and development of

mathematical and astrological knowledge in Nepal.

By addressing these aspects, the research aims to provide a comprehensive understanding of Laxmi Pati Pandey's multifaceted contributions and their enduring impact on the mathematical and astrological landscape of Nepal.

Findings

Laxmi Pati Pandey (1758 – 1813 A.D.) was born in the Royal astrologer family at the time of King Prithivi Narayan Shaha in Gorkha. His father Pandit. Krishnanand, grandfather and great grandfathers all were Royal astrologers of the Gorkha Kingdom. According to the record obtained, his date of birth was 1758 A.D. He was a renowned Mathematician and Astrologer. Who advised Prithvi Narayan Shah (1757 – 1797 A.D.) and Bahadur Shah (1757 – 1797 A.D.) on several substances. He is the first Nepali Astrologer who wrote the meaning of his Sanskrit slokes in Nepali language). Bhashwati's popularity (Acharya, 2011; Raikhola, 2020)), was so great throughout the nation that hand written Slokas, or Tikas, could be seen at various places. After writing '*Tikas of Bhashwati'*, he started his Mathematics and jyoutish study. It has been discovered that certain of the tikas written by the Jumla scholar Bal Bhadra were even well-liked throughout India. During the reign of Bahadur Shah (1757–1797 A.D. His work has demonstrated that *Bhashwati* was Nepal's first mathematics textbook, with *Lilavati* serving as a formal source of mathematical information for only the highest-achieving students thereafter. He penned around forty novels. *Griha Laghava Kalarnan Dipika, Lilavati, Bhaswati, Tika,* and *Ratnadeep* are a few of the noteworthy novels. (Acharya, 2015; Pant, 2007)..

The mathematician and astrologer Laxmi Pati Pandey were the father of Lila Nath Pandey. A Siddhant Jyotish book was written by Lila Nath Pandey. Gopal Pandey, a descendant of Laxmi Pati, was an astrologer and mathematician. *Wyokta Chandrika* [7], the first mathematics book written in Nepali, was authored by Gopal Pandey. He demonstrated his inventiveness by computing the square and cube roots. He made a noteworthy addition to Nepali mathematics by applying the Trizoidiacle Rule, which is helpful for computing square and cube roots. Gopal Pandey authored a book on mathematics in Hindi as well. His contribution lies in the fact that *Bhashwati* was considered to be the Mathematics textbook at the elementary level (Pant, 2007; Raikhola, 2022).

"Grahalāghava" is a Jyotish (Vedic astrology) text written in 1520 A.D. by Gaṇeśa Daivajña, the son of Keśava. It seems to be a significant work in the field of astrology. He calculated velocities of planet till Shake Sambat 1442 (135 Years less than Bikram Sambat) and an explanation is provided on how to calculate the total number of days elapsed since then up to the present moment. This count, referred to as 'Dhivgan' or 'Dinrashi,' is also termed as 'Ahargan.'. The Ahargan is particularly useful in Karan Granths, where counting typically starts from a more recent epoch, often the beginning of Kali Yuga, rather than the origin of the universe. Then procedures for calculating eclipse are described by arithmetic method.

Following this, the text delves into methods for determining the day of the week, Varshpati (lord of the year), and Maspati (lord of the month). Varshpati and Maspati are selected from the sun, moon, and planets. While these determinations may not be crucial for day-to-day activities, they contribute to a broader understanding of celestial influences.

The subsequent portion of the text provides techniques for calculating the average angular velocities of planets. By knowing their positions at the commencement of Kali Yuga and the number of Bhaguns in a Yuga, straightforward arithmetic calculations can be employed to

ascertain their current positions. Additionally, rules for determining Paat and Mandooch are presented, offering further insights into celestial calculations and positions.

Then, *Lilavati*i used for advance knowledge in Mathematics at higher level. Astrologers used to utilize this *Bhashwati* to compute the planets-stars calendar and eclipses. They taught their students making Tikas of this book (Acharya, 2011; Jha, 2006).

Pandit Laxmi Pati Pandey received a good education in Sanskrit, and since he was an astrologer's son, he was inevitably well-versed in mathematics and astronomy. Based on his writings, it appears that he had studied the "*Siddhant Shiromani,"* which was written by the renowned scholar Bhaskaracharya in the 12th century. He completed studying "*Lilavati"* at the age of 15 and wrote a commentory, called *'Tika'* on it. On the completion of his 'Tika', to mark the completion year (Pant, 2007).

He wrote a Sanskrit Verse:

स्वाष्टांशेनयुते ष्टकुवर्गे मन्मथशत्रु मन्मथशत्रु धनेनच यक्ते

उरूगते तरणौ सितपक्षे व्यक्तमिदं लिखितं शनिवासरे ॥

भाष्कराचार्यकतोगन्थः सत्यवीनां मनोहरः ।क

गणिताव्धौ प्लवमिदं गोलाद्यब्धौविशेषत ॥

(Add the cube of eleven to the eighth portion of the square of eighteen and to it.) This work on the good treatise by the great poet Bhaskaracharya has been finished on Saturday, at the full Moon period of Poush. Especially on spheres, this is utilized as a boat to traverse the Ganita Sea of Mathematics. In mathematic al terms, he states that his work was completed in the year 1773 A.D. (182 + 182/2 +113 = 324 + 40 + 1331 = 1695 (Sake Sambat) = 1773A.D. (Add 78 to Sake Sambat) (Pant, 2008).

It is documented in the annals of mathematics that the renowned Arabian mathematician Alberuani expressed an integer as the sum of the squares and cubes of another integer, possibly for the first time. 141 was stated, for instance, as the sum of the square of four and the cube of five. At the age of fifteen, Laxmi Pati Pandey who was unaware of Alberauni and his works, approximated the year 1695 in Sake Sambat using squares and cubes (Pant, 2008).

During Ran Bahadur Shah's reign, he constructed a Sun Dial to detect the time during the day. In Nepali, he translated a number of significant publications from Astrology and Mathematics. He authored over 40 books. *Ratnadeep, Lilavati, Bhashwati, Tika,* and *Griha Laghava, Kalarnav Dipika* are a few prominent works (Pant, 2008).

Astrologer Pandey was observed as a very powerful member in the Royal Court of Shah dynasty kings at Hanuman Dhoka Royal Palace. He was very famous as a renowned scholar of Astronomy and Vedic Mathematics (Maskey, 2013; Raikhola, 2022).

After his retirement from the Royal Palace at the age of sixty in 1798 he went to Kashi to spend the rest of his life. During his active period and retired life, he was engaged in writing books on Mathematics and Astrology, copying of ancient manuscripts and writing commentaries on manuscripts of Mathematics and Astronomy Pant, 2008).

Laxmi Pati Pandey originate time to compose Astronomy materials in Sanskrit while holding down a government job. The most celebrated book, *'Ratnadeep,'* contains theorems on Astrology and Astronomy. The Astrologer, according to this text, is capable of precisely calculating the eclipse dated of the moon and sun. Apart from determining the duration of solar and lunar eclipses, planes' height and longitude can also be determined. Additionally, he demonstrates in his book how to exactly compute the *lagna, Muhurt* (Acharya, 2011; Panta, 2008).

Ratnadeep

Like in classical Indian astronomical texts Ratnadeep of Laxmi Pati Pandey, includes determining both the mean and true positions of celestial bodies such as the sun, moon, and Mars and other planets. This involves intricate calculations, including the computation of solar declination (krānti), lunar latitude (śara), and addressing problems related to time, direction, place, as well as the risings, settings, and conjunctions of the planets. It addresses various topics related to classical Indian astronomy, offering practical and simplified methods. The text includes convenient procedures and valuable values for parameters like kṣepaka, parākhya, maximum mandaphala, and maximum śīghraphala. Additionally, it provides a list of denominators necessary for computing mandaphala (Pandey, 2005).

Like in Indian Karan text Like Grahalaghab of Ganesh Daibgya and Karakutuhalam of Bhaskaracharya II, similarity of Laxmi Pati Pandey is in the computation of ahargaṇa. Instead of using the beginning of mahāyuga as the epochal point, as seen in Bhaskaracharyas "*Siddhānta-Śiromaṇi*", he adopts a contemporary date as the epoch. This shift significantly reduces the complexity of the calculations, making them more straightforward and user-friendly. Overall, Ratnadeep of Laxmi Pati Pandey streamlines and simplifies critical aspects of classical Indian astronomical computations.

.Besides the *'Ratnadeep'* he is the writer of following texts.

Table No.: 1.1: Books of Laxmi Pati Pandey (Maskey, 2013).

S.N.	Name of the book	Commentary
1.	Lilavati	1773 A.D.
2.	Grahalaghaba Part of Bhaskaracharya's Bijaganta	1778 A.D.
3.	Rambinod ko Udaharan	1779 A.D.
4.	Chandrashifal	1779 A.D.
5.	Panchaswarajatak	1780 A.D.
6.	Vivahabrindaban	1780 A.D.
7.	Muhurtachintamani	1781 A.D.
8.	Jatakalankar	1782 A.D.
9.	Buddhibilasini	
10.	Ratnadeep	1782 A.D.

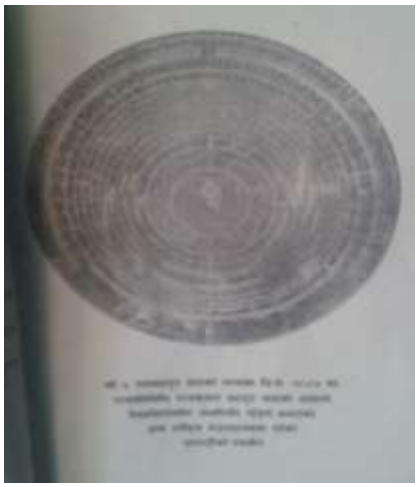

Figure No. 1.1: Sun Dial Prepared by Laxmi Pati Pandey (Pant, 2007).

Mohar of king Prithvi Narayan Shah dated Saka Era1685 (1763 CE)

Figure No. 1.2: Mohar of King Prithivi Narayan Shah (Acharya, 2011; Pant, 2007).

Besides, nearly one and half dozen books, he had constructed some scientific instruments:

1) The sundial (to determine the time in a day time)
2) A sort of balance Elevator (to find the level and to find the angle of elevation and angle of depression)
3) A chart depicting the Moon's growing and diminishing phases.
4) A graphic depicting the various types of solar and lunar eclipses (Acharya, 2011). The sundial is still preserved and has found a proper place in the national museum.

At the age of sixty, Pandit Pandey, the renowned astronomer and mathematician of his era, stepped down from his career and pursuits due to his immense fame and fortune. In the past, he moved to Banaras to live. He was engaged in academic activities there as well, writing and instructing his students. A few of his earlier works are still accessible. He finally received KASHI-LAV survived 4 at the age of 73, thanks to his two wives and sons (Pant, 2008).

Summary

Laxmi Pati Pandey, born in 1758 A.D. into the prestigious lineage of royal astrologers during the reign of King Prithivi Narayan Shah in Gorkha, emerged as a luminary mathematician and astrologer. Advising kings such as Prithvi Narayan Shah and Bahadur Shah, he became a pivotal figure in the realm of astrology and mathematics.

After composing 'Tikas of Bhashwati,' he embarked on a journey into mathematics and astrology, marking a significant milestone by becoming the first Nepali astrologer to translate Sanskrit slokas into the Nepali language. His literary prowess extended to around forty novels, including noteworthy works like *Griha Laghava Kalarnan Dipika, Lilavati, Bhaswati, Tika,* and *Ratnadeep.*

The legacy of mathematical acumen continued through the generations, with Laxmi Pati being the father of Lila Nath Pandey and Gopal Pandey, both distinguished astrologers and mathematicians. Gopal Pandey's ground-breaking work, *'Wyokta Chandrika*,' stands as the first mathematics book written in Nepali, showcasing inventive approaches like the *Trizoidiacl*e Rule for square and cube root computations.

Bhashwati, authored by Laxmi Pati Pandey attained recognition as an elementary-level mathematics textbook, while *"Lilavati",* advanced into higher-level education. Astrologers utilized "*Bhashwati",* for celestial computations, teaching their students through the creation of Tikas.

Laxmi Pati Pandey's educational journey encompassed a profound understanding of Sanskrit, and his writings reflected a study of the renowned "*Siddhant Shiromany"* by Bhaskaracharya. Completing his commentary 'Tika' on Lilavati at the age of 15 showcased his early mathematical prowess.

Intriguingly, Laxmi Pati Pandey demonstrated exceptional mathematical talent by approximating the year 1695 in Saka Sambat using squares and cubes, a feat reminiscent of the renowned Arabian mathematician Alberuani's work.

During Ran Bahadur Shah's reign, Laxmi Pati constructed a Sun Dial to measure time during the day, showcasing his practical applications of astronomical knowledge. His contributions extended to translations of significant texts and the authorship of over 40 books, including 'Ratnadeep,' known for its theorems on astrology and astronomy.

Renowned in the Royal Court of Shah dynasty kings, Laxmi Pati Pandey's influence as a scholar of astronomy and Vedic mathematics was unparalleled. His post-retirement years in Kashi were marked by continued writing and instructional endeavors.

Conclusion

Laxmi Pati Pandey's multifaceted contributions, spanning mathematics, astronomy, literature, and education, position him as a pivotal figure in the historical tapestry of Nepali intellectual heritage. His enduring legacy continues through his writings, teachings, and the preserved artifacts of his scientific instruments, embodying the rich cultural and intellectual history of Nepal.

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Conflict of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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