



Eminent Indian Scientist
Shri Venkatesh Bapuji Ketkar



Siddhi Nitin Mahajan

EMINENT INDIAN SCIENTIST

VENKATESH BAPUJI KETKAR



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VENKATESH BAPUJI KETKAR

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From Editor's Desk

From time antiquity, India possesses a great legacy in Science and Technology which needs to be communicated and informed to the young generation. We need to bring out stories of such unsung heroes from India. We are happy to present this book titled 'The eminent Indian scientist: Shri. Venkatesh Bapuji Ketkar'.

This forgotten star from the field of Indian Astronomy, the legendary 'Jyotirvid' born in 1854, dedicated his life for the research and purification of Indian almanac system (*Pañcāṅga*) of timekeeping. It is a lesser known fact that he predicted the existence of 'Pluto' in 1911; even before its discovery in 1930. He authored a number of books on astronomy, *Pañcāṅga* and literature and also published many research papers in European science journals. Apart from being a polyglot and a teacher by profession, V. B. Ketkar was passionate about observational astronomy, higher mathematics, literature, painting-sculpting and music. In spite of his remarkable contribution to the field of science, not much has been written about him except for a couple of biographies. One of them was written by his son late Shri. Dattatreya Ketkar and the other by Late Dr. Prabhakar Kunte, a scientist from Tata Institute of Fundamental Research, Mumbai and a founder member of Vijnana Bharati, konkan prant.

We, as organizers of Vidyarthi Vigyan Manthan (VVM), produce exclusive study material on life stories and contribution of Indian scientists every year. VVM is a national science talent search program for school children which is one of the initiatives of Vijnana Bharati aimed to inculcate the spirit of scientific enquiry and national pride by exposing them to the immense contribution of Indians to the field of Science and Technology. Maintaining this tradition, Vijnana Bharati, a swadeshi science movement of Bharat, decided to have its own publication on the life story of Shri. Venkatesh Bapuji Ketkar, written in a form that appeals to young minds. We are confident that Ketkar's lifelong passion for scientific research, despite the adversities of the pre-independence period in India, will inspire the young minds. We

appreciate the painstaking efforts of the author Siddhi Nitin Mahajan from Goa for the research and discussions about the available literature on Ketkar and her proactive approach to contact his great grand-sons, Shri. Raghunath Ketkar from Pune and Shri. Prabhakar Ketkar from Ratnagiri, Maharashtra. Due to this networking, we could access the original texts, images and authentic information. We are grateful for the suggestions given by Shri. Suhas Gurjar and Shri. Deepak Joshi from Jyotirvidnyan parisanstha, Pune. We must mention the Sanskrit experts Shri. Vedanti Pande from Dhekulia, U.P. and Prof. Manjiri Patil from Goa for helping us to interpret some verses.

As the editors of this book, it was an enriching experience for both of us. The discussions about the content, the form of writing, and interpretation of the astronomical concepts written in Marathi language was indeed an exercise worth doing!

We must mention the constant guidance offered by Shri. Jayant Sahasrabuddhe, the national organizing secretary of Vijnana Bharati during the process of writing this book. His personal involvement and an eye for detail has improved the quality of the book. We are optimistic that the readers of the book will appreciate the Indian Almanac System and contribution of Shri. Venkatesh Bapuji Ketkar in the field.

Vijnana Bharati will continue to strive to bring such original contributors and their contributions in the field of science and technology to the forefront; so that every Indian feels proud of the Indian scientific heritage. As the members of the core team of VVM, we wish that this book does not remain mere study material for the students, but gets a larger readership across India. We are happy to mention that this book is being translated and published simultaneously by Vijnana Bharati in eleven official languages of the country, in addition to English, ensuring a greater outreach to the nooks and corners of India.

Ms. Sangeeta Abhyankar

Content Coordinator, VVM

Dr. Arvind C Ranade

National Convener, VVM

Preface

We, being quintessentially Indians, often forget the name of our own astronomer, who predicted the existence of Pluto and dedicated his life to do the research on almanac-Shri. Venkatesh Bapuji Ketkar.

Even I wasn't much aware of him or his work, until a member of the core committee of Vidyarthi Vigyan Manthan Ms. Sangeeta Abhyankar approached me. Her idea was for me to translate the biography of the aforementioned astronomy titan, in English. This was to be included in the study material given for a National level exam called 'Vidyarthi vigyan manthan' conducted by 'Vidyan Bharati'. Afterwards, Dr. Arvind Ranade, the National convener of this examination, sent me the scanned copy of the biography of Shri. Venkatesh Bapuji Ketkar authored by Prabhakar Kunte, which was in Marathi. First step was to translate this book in English.

I, being a Physics student, was very curious about Ketkar. It is while trying to quench this thirst for knowing more about him, did I realise that the language used in the biography was somewhat archaic. How could we expect the new generation to even understand, let alone utilise the abundance of information within? Quite naturally, the only logical subsequence to this obstacle was the simplification of the language. But, while pondering over the risen situation, it was collectively decided to rewrite the biography altogether. Dr. Ranade and Prof. Abhyankar immediately sought the valuable opinion of Shri. Jayant Sahasrabuddhe, the National organising secretary of Vidnyan Bharati. Shri. Sahasrabudhhe, agreeing to the idea, lent his inestimable time and guidance to the project.

I already had Mr. Kunte's book. Unfortunately, the pandemic lockdown had tied my hands regarding further sources of information. I contacted my teachers from Gogate Jogalekar

College at Ratnagiri, Prof. Babasaheb Sutar, Prof. Uday Bodas who provided the contact of Prof. Prabhakar Ketkar, from the same college who was the great grandson of Venkatesh Bapuji Ketkar himself. Prof. Prabhakar Ketkar connected me to his brother in Pune, Mr. Raghunath Ketkar, who runs a school in the name of Shri Venkatesh Bapuji Ketkar. This magnificent Ketkar-duo, through frequent phone calls and emails, provided me with indispensable information, documents and even old photographs. They sent me the original biography of Venkatesh Bapuji Ketkar, written by his son, Dattatray Ketkar, in marathi. They came to be of great help, providing references and information regarding their great-grandfather, even in these dire times of pandemic.

Now the crux of the matter was, to make the content easily understandable for school going children. Now obviously, these kids love stories falling into the 'Nana-Nani' category. Hence, the key to their attention and hopefully comprehension, simply lay in writing the story as a narration by grandpa to his grandchildren. This idea, too, was very well-bolstered.

As I said before, Ketkar had used archaic language in his texts, which made it a difficult job to grasp the different ideas he put forth in those writings. Personally speaking, I had to widen my horizon on different astronomical terminologies and learn the different hues of their meaning. For this, Shri Deepak Joshee and Shri Suhas gurjar of Jyotirvigyan Parisanstha helped me, as and when needed, unhesitatingly. Additionally, Dr. Arvind Ranade suggested changes in the form and matter from time to time. And I can never forget Ms. Sangeeta Abhyankar's help in all discussions and in guiding me through many mistakes, and in finalizing the form of the whole book. She lent me a hand patiently and wholeheartedly the entire way. My family provided me with all kinds of support imaginable. I am grateful to Vijnana Bharati for offering me the opportunity to propagate Ketkar's spectacular work in the society.

May this book inspire the already bloomed, as well as the budding generation. I, thus, feel happy to put this book, as a tribute to the insurmountable works of well known indian scientists, before you all.

Siddhi Nitin Mahajan

1

Introduction

Isha and Suraj have come home after school. Both have funny expressions on their faces. Both run to their grandfather after they step inside.

Isha - "Do you know, Grandpa, what were we arguing about, today?"

Sooraj - "Oh no, Don't blurt out, let me tell Grandpa. So today we were arguing about Pluto. Is Pluto a planet or not?"

Grandpa - "Oh, very nice. So What did you discover, little scientists?"

Isha - "Sooraj was saying that Pluto is a planet. But According to my opinion, it is not. Right, Grandpa?"

Sooraj - "But Pluto revolves around the sun. It's round in shape."

Isha - "Yes, Pluto is not a planet, it is a dwarf planet. Its orbit is not independent, it intersects the orbit of Neptune, also it is elliptical in shape, but more eccentric than the orbit of any other planet. This planet is very small in size. Its diameter is about 2370 km. Due to these factors, "International Astronomical Union" or IAU in its conference held in 2006, refused to consider Pluto as a planet ".

Grandpa - "That's absolutely right, Isha. But do you know, who invented Pluto?"

Isha - "Yes. After the discovery of Neptune, scientists started taking observations again. From those observations, they concluded that the orbit of Uranus is

being affected by a planet other than Neptune. In 1906, Percival Lowell built an observatory in Flagstaff, Arizona and started a big project for discovery of the new planet. They named the planet as Planet X. "

Sooraj - "Yeah, but Lowell couldn't find this planet in his lifetime. After his death in 1929, the observatory's director, Vesto Melvin Slipher, handed over the responsibility of the search for Planet X to 23-year-old Clyde Tombaugh from Kansas."

Isha - "Yes, after a year of tireless search, on February 18, 1930, Tombaugh discovered the planet X. This planet was named as Pluto. The name was suggested by Venetia Burney, an 11-year-old schoolgirl from Oxford, England."

Grandpa - "But do you guys know, even before Clyde Tombaugh, in 1911, an Indian astronomer predicted the existence of the ninth planet."

Both children - "Really Grandpa?"

Grandfather - "Yes children. According to Laplace's mathematical resonance rules for the moons of Jupiter, he believed that there should be two planets beyond Neptune. He named the first planet as 'Brahma' and the second as 'Vishnu'. Now we all are familiar with 'Brahma', at least by its modern name!"



Venkatesh Bapuji Ketkar

Kids - "Is it Pluto ??"

Grandfather- "That's right. This great astronomer who inherited the legacy of Indian astronomy or the *Jyotiśaśāstra* from *Āryabhata* and *Varāhamihira*, was none

other than, Venkatesh Bapuji Ketkar from India. He dedicated his life towards research and creation of almanac (*Pañcāṅga*) and authored a number of texts on astronomy.

2

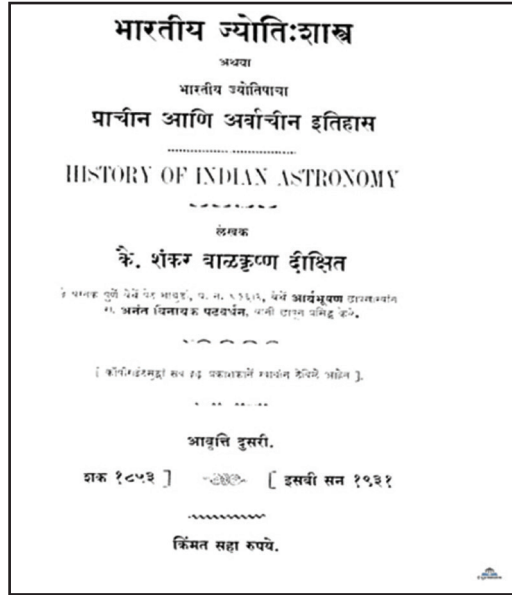
Brief History of Indian Astronomy

Sooraj:- "Grandpa, you mentioned him as an astronomer who inherited the legacy of Indian astronomy or *Jyotiśāśāstra*. But we know about *Jyotiśāśāstra* in different contexts, i.e in terms of future predictions or astrology. *Jyotiśāśāstra* (astrology) and *Khagolaśāstra* (astronomy), are two different things as far as we know them, aren't they?"

Grandfather:- "Your doubt is absolutely correct. Now let me tell you the meaning of *Jyotiśāśāstra* or Astrology. *Jyoti* (ज्योतिः) means luminous celestial objects. Thus the science of *Jyoti* was known as *Jyotiśāśāstra*. Similarly, *Kha* (खः) means the sky, thus science of spheres in sky was called *Khagolaśāstra*. Thus *Jyotiśāśāstra* and *Khagolaśāstra* were one and the same in ancient times. Knowledge of astronomy prevalent in ancient India was profound and scientific. Later on, it got connected with prediction of terrestrial events based on celestial observations *Phalajyotiśa* (फलज्योतिष), which assigned the term of *Jyotiśāśāstra* or astrology, a different identity.

Let me tell you the history of Indian astronomy. Ancient humans used to stay in caves, and would hunt wild animals for subsistence. As time passed, man began to live in groups. After establishing settlements, he started planting trees and cultivation of crops. Meanwhile, he felt the need to have a permanent system for knowledge of the time and seasons. He wanted to know about the occurrence of harvest season, sowing season, rainy season and the overall seasonal cycle. He thought that these things should be acknowledged, because it made him easier to cultivate crops and plan other deeds. Man could relate himself to nature, through day and night, rainy season and cold season, wind and tides. Some events were recorded by observing the relationship between the positions of certain planets and stars in the sky. Thus the progress in indian astronomy began gradually."

Isha:- "Are there any books recording the history of Indian astronomy available today?"



Grandfather:- "Yes. I will introduce you to a couple of outstanding literary works on the history of Indian astronomy and development of almanacs. The first book is ‘The ancient and modern history of Indian astronomy’ authored by Shri. Shankar Balkrishna Dixit. The second important book titled ‘Indian and foreign chronology’ was written by Shri. V. B. Ketkar. Both books are available for reference even today.”

“Shankar Balkrishna Dixit has considered three stages of the development of the indian astronomy.

1. Vedic period: The oldest of these is the Vedic period, which dates back from unknown times to 1500 BC. During this period, ancient scriptures like Rig Veda, Samhita, Brahmanas were written. In the *Vedās* the year is solar. The months are lunar. 360 days of a year were considered and they were divided into 12 months. The months were named as Madhu, *Mādhav*, Shuka, Shuchi, Nabh, Nabhasya, Isha, Urja, Sahasa, Sahasya, Tapasa, Tapasya. At that time, the lunar calendar was luni-solar. But the beginning of the year was considered from the spring equinox.

2. Vedang jyotish period: Then comes the *Vedānga* jyotish period. Its time is considered from 1500 BC to 400 BC. There are 36 verses in this *Vedānga* Jyotish scripture composed by a sage named Lagadh. According to this scripture, the beginning of the year was on *Māgh* (11th month in Indian calendar) Shukla *Pratipadā*. *Vāra* (week day) and *Rāśis* were not mentioned in *Vedānga* astrology.

3. Siddhānta jyotish period: The third important period is the period of *Siddhānta* Jyotish, which started from 400 AD, and is currently running. During this period, a text called 'Aryabhatiya' was written by *Āryabhata* in 499 AD and Varahmihir's '*Panchasiddhāntika*' was written in 505 AD. The mathematics of the motion of the planets was studied during this period.

We do not find evidence of any significant progress in Indian astronomy between the *Siddhānta* Jyotish period and the *Vedānga* jyotish period, but it is certain that it continued to happen. The *Siddhānta* Jyotish lineage of *Āryabhata* and Varahmihira was continued by Venkatesh Bapuji Ketkar."

Suraj: - "Oh wow! Such a great heritage was inherited in our culture. Indeed, our ancestors have left an immensely precious treasure for us!"

Isha: - "Grandpa, we would like to know more about Ketkar's life."

Grandfather starts to narrate the story of Venkatesh Ketkar, along with interesting details of astronomy.



3

The Family Legacy

Grandfather - "Ketkar family inherited an ancestral legacy that would make one feel proud. The family of Venkatesh Bapuji Ketkar originated from a small village called "Ketaki Bivali", near Chiplun, situated in the Konkan belt of Maharashtra. Its history dates back to the period of Chhatrapati Shivaji Maharaj. After the assassination of Sambhaji Maharaj, Mughals established their stronghold in maharashtra. Many Maratha chiefs and soldiers took military action against the Mughal stronghold. Among these was a chieftain named *Bhālerāo*, who led raids called *Bhālerāi*. The *Bhālerāi* raids caused chaos, resulting in the migration of many families, including the Ketkar family.

Ketkar's ancestors settled in Paithan (Pratishthan) on the banks of Godavari river. Paithan was famous in eighteenth-century Maharashtra for education, moneylending and textile. Paithan was also the ancient capital of king *Śālivāhana*, initiator of the famous shalivahan *Śaka*. The ancestral business of the Ketkar family was of the apparels of zari work. (a weave of golden or silver threads) The business suffered many ups and downs over the time. During the time of Sakharam Ketkar (grandfather of Vekatesh Ketkar), the business suffered big losses, and had to be closed down eventually. On January 15, 1815, Ramkrishna alias Bapuji Ketkar was born to Sakharam Ketkar on the next day of Makar Sankraman.

Bapu Shastri Ketkar was born with innate intelligence. At an early age, he mastered grammar, *Vedānta* and astronomy. He had tremendous expertise over astronomy. Bapu Shastri realised that after Ganesha Daivajna (born 1507 AD), there was no remarkable progress in Indian astronomy. During this period many important changes took place in astronomical sciences in the west. Newton proposed the law of gravity. Galileo invented the telescope. But in India, the progress was not as profound and remarkable as it should be. The astronomical calculations of events like eclipses, evolved from the book 'Suryasiddha Grahalaghav' did not match with the

calculations of Western texts. After observing this, Bapu Shastri Ketkar wrote a book called 'Jyotishashastra Subodhini', in Sanskrit.

Bapushastri was also a music lover. After acquiring proficiency in academics at the age of 27, he decided to study Rudraveena, an instrument of Indian classical music. In order to master the instrument, he prepared to move to Thanjavur, the stronghold of Rudraveena. But on the way, he met Pandit Vaikobuwa Mhaiskar, a master of Rudraveena. During this visit, Panditji urged him to settle in Nargund near Gadag in Karnataka (which was a marathi province) and learn Rudraveena from him. Bapu Shastri accepted this offer and in a short interval of time his fame spread far and wide among many scholars there. The court of Nargund Sansthan recognized his merits in a very short time.

In the changing circumstances that followed the War of Independence of 1857, the Maharaja of Nargund handed over this gem to the Ramdurg Sansthan. He acquired royal patronage and great honor there. At the request of the King of Ramdurg, he translated Professor Kero Laxman Chhatre's Marathi treatise '*Grahasādhana*' into Sanskrit."



Shri Kero Laxman Chhatre

Venkatesh Ketkar : Early Life and Career

“Bapu Shastri Ketkar was blessed with a son on January 18, 1854 during his stay in Nargund. He named the son 'Venkatesh'. After losing his father at the age of 16, Venkatesh Ketkar had to face dire financial difficulties. He was studying English in a school called ‘Sardar’ in Belgaum. He used to get a scholarship of three rupees per month. Two rupees had to be spent for food, hence he had to fulfill other expenses in remaining one rupee. He never had money to buy books, so he used to study with his school friends. Since there was no place to stay, he had to spend nights in the verandah of someone's house. Eventually, when he got a chance to teach mathematics to a boy named Bhadbhade, he got a place to sleep there.

Coping with the adverse financial condition, Venkatesh Ketkar passed the matriculation examination in 1874 and secured third place. For this achievement, he was felicitated with the ‘Bai Manik Bairamji Jijibhoy Award’. But the deteriorating financial condition made it impossible for him to continue his education. He had to skip further education and accept a job as a school teacher at the age of 21. After Accepting the teaching profession, he continued his service for 25 years at school in Bagalkot. Venkatesh Ketkar worked in various other schools till he retired in 1911.

But the retirement was only from the job. He never retired from actual research work. After facing hardships of life, Ketkar’s nature became very assertive with a sense of pride. He was adamant about his own point of view. Basically, he was highly self-esteemed with a strong determination. He never asked favours from anybody to get his books published.

Calm and serious, he was very straightforward and fair witted. He always adhered to the principles of moral duty taught by his father. *Vedānta* should not be a mere subject of giving speeches. The principals in *Vedānta* are the principles of good conduct as stated in *Vedās* and it

is the duty of man to follow them. He was of the opinion that the knowledge of *Vedānta* should be practiced and not merely parroted.

His attire consisted of a white dhoti, a white shirt, a black coat with a closed neck, a large *Pāgote* (a kind of headgear), scarf, spectacles and a tilak on his forehead. Due to simple living and high thinking, brilliance of erudition, he possessed a respectable personality. The serious expression on his face and penetrating gaze indicated his impressive disposition.

Venkatesh Ketkar married Lakshmibai in 1872. In 1881, he got married to Ramabai. They had thirteen children in total. He fulfilled the educational needs of his children and inculcated values in them.

Ketkar's love for his subject, conscientious thinking and self esteem were undisputed qualities. He was fluent in many languages including English, French, Sanskrit and Hindi. Intense intelligence was his gift, and most importantly, the scientific approach."



Venkatesh Ketkar and Ramabai Ketkar

Ketkar and his Amanac Research

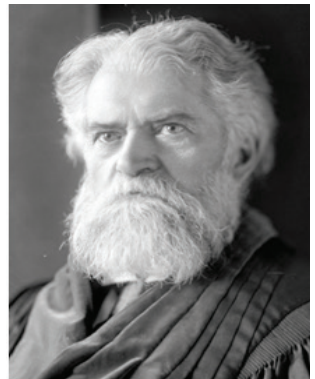
Suraj: - "Grandpa, How did he become so interested in astrology? From where did he get the inspiration? "

Grandfather: - "Ketkar was in Kolhapur at the time of the Total solar eclipse in 1868. At the time of eclipse, suddenly it all went dark and some stars started to twinkle in the sky. After observing this, his mind was filled with immense curiosity about space and astronomy. He studied higher mathematics on his own as no means of studying it were available at University of Mumbai and University of Madras. He sought guidance from the famous American mathematician and astronomer Simon Newcomb and added his own hard work. He acquired knowledge in the fields of spherical geometry, algebraic geometry, trigonometry statistics and other complex mathematics and Newton's 'Principia Mathematica'. Combining hard work and keen intelligence, he became so proficient in mathematics that at the age of thirty-one he wrote a separate treatise on astronomy.

Simon Newcomb himself and Kero Laxman Chhatre had freely praised his knowledge, in their letters in 1879.

The extensive study of all of the above texts made it easy for Ketkar to understand why the occurrence of actual events does not correspond to the solar and lunar eclipses, planetary alliances, rise and falls of planets etc., predicted from earlier texts like 'Suryasiddha Grahalaghav'.

Keeping this in mind, he made the necessary corrections and published his new almanac, called 'The Ketaki *Pañcāṅga*'."



(Simon Newcomb)

Isha: - "Grandpa, we have heard a lot about the *Pañcāṅga* or Almanac. What is it? How was it formed?"

Grandpa: - "The *Pañcāṅga* is a Hindu calendar and almanac, which follows traditional units of Hindu timekeeping, and presents important dates and their calculations in a tabulated form. Although different *Pañcāṅgas* are used in different states of India, they consist of some common factors. These factors i.e *Tithi* (lunar day), *Vāra* (week day), *Nakṣatra* (asterism), *Yoga* (sum of solar and lunar longitudes) and *Karaṇa* (half lunar day) are the five attributes of daily timekeeping. The almanac consisting of these five attributes is known as a '*Pañcāṅga*'.

Other than the above five attributes, *Pañcāṅga* consists of useful religious, astronomical, and astrologically useful information.

Many Indian festivals are based on the position of the moon in the sky. For example, the festival of *Rakṣābandhana* is observed on 'Śrāvana poornima' (the full moon day of the 5th month of Hindu calendar), when the moon is in *Srawan Nakṣatra* (asterism). A common Indian can easily retrieve this information from '*Pañcāṅga*'.

In India, three distinct seasons viz. the summer, the rainy season and the winter are recognised. The rainy season is typically the 'summer monsoon' of India. The position of the Sun and the Moon in the sky has a direct correlation with the rainfall. Traditional Indian farmers and fishermen make use of *Pañcāṅga* to get or calculate the precipitation, tides, seasonal changes etc. *Pañcāṅga* provides us information about the position of planets in the sky, information of eclipses and religious rituals. *Pañcāṅga* also consists of information about daily timekeeping of other religions in India. The Indonesian Hindus of Java and Bali also use this almanac.

The Indian national calendar is the official calendar of India approved by the government of India. It is used for the Gazette of India, All India Radio, Doordarshan and parliamentary affairs.

Indian national calendar is different from the traditional Hindu *Pañcāṅga* in some aspects. It is a solar calendar. As per this calendar, the beginning of new year i.e. '*Caitra shukla Pratipadā*' corresponds to the spring equinox which falls on 22nd March as per the Gregorian calendar. In

the leap year of the Gregorian calendar, it is on 21st March.

[Spring equinox: The time when the sun crosses the plane of the earth's equator, making night and day of approximately equal length all over the earth]

In India, the seasonal cycle is considered very important. It depends on the movement of the sun and not the moon. With the initiative of India's first prime minister Pt. Jawaharlal Nehru, a calendar reform committee was formed. This committee designed Indian national calendar under the chairmanship of renowned scientist Dr. Meghnad Saha along with secretary Shri N. C. Lahiri and brought it in use from 1957.

The Gregorian calendar (English or Christian calendar) is also a solar calendar, but it doesn't coincide with all natural events. But Indian National calendar does coincide with all celestial events. Thus, this calendar has global utility beyond the Indian cultural ethos.”



Shankar Balkrishna Dixit

“According to Shankar Balkrishna Dixit, three out of five aspects of *Pañcāṅga* viz. *Tithi* (lunar day), *Nakṣatra* (asterism) and *Karaṇa* (half lunar day) have been in use since 1500 BC. *Vāra* (week day) came into existence from 1000 BC and *Yoga* (sum of solar and lunar longitudes) came into circulation only after the year 700 BC.

As we have seen in the history of Indian astronomy, the importance of the book 'Surya Siddhānta', which was written and published at the beginning of the 'Siddhānta Jyotish period', is indisputable. It is noteworthy that this book had been in use for about 1000 years. It has 14 chapters and 500 verses. All modern topics including the Planetary motion, directions, location, time of celestial events, eclipses, sun-moon rise, have been covered in this book.

As mathematics began to gain importance in ancient astronomy, planetary mathematics was introduced in real sense . Ketkar has shared some of his views on the history of Indian astronomy. According to Ketkar, the Chaldeans should be given the credit of being the first to observe planetary motion. In ancient Assyria, there was an intelligent tribe called the Chaldea. So was the influence of their intelligence on the royal court, that the name of this country

changed to 'Chaldea'.

According to Ketkar, After Alexander conquered this kingdom in 323 AD, Seleucus Nicator became king of the Graeco- Bactrian empire (today's Afghanistan). This kingdom shared the border with the Magadha empire ruled by emperor Chandragupta. There was good communication between these two states as well as blood relation. The creator of 'Surya Siddhānta' may be an Assyrian or (Asura) named Maya. The original text was brought to Kusumpuri (Patna) in the Magadha Empire and a second copy was sent to the city of Alexandria. This manuscript later came to the aid of Hipparchus and Ptolemy, who afterwards wrote a popular astronomical treatise called the 'Almagest'. Thus an inevitable relationship of the 'Surya Siddhānta' with the Greek text, 'Almagest', can be estimated as stated by Ketkar.

Around 500 A.D., Aryabhata wrote a 'Siddhāntagrantha' or a treatise based on 'Surya Siddhānta'. At the beginning of the text, the 'Aryabhatiya', he has mentioned that he got this knowledge at Kusumpuri. After this, Varahmihir from Ujjain (500-588 AD), Brahmagupta from Bhinmal (598-668 AD), *Bhāskarācārya* second from Beed-Maharashtra (1114-1185 AD), and Ganesh Daivajna from Nandgaon, Konkan (16th century) were some of the prominent astronomers in India.

Let me tell you more about the Daivajna family. A village called 'Nandgaon' near Murud-Janjira in Konkan, which is situated in Maharashtra. There lived a scholar named Keshav Daivajna. He used to worship daily in Siddhivinayak temple. He used to create *Pañcānga* (almanac) based on the treatise of 'Surya Siddhānta', and narrate it to villagers. He wrote a treatise called 'Graha Kautuk' and a book called 'Muhurta Tattva' on '*Muhūrtaśāstra*'. He realised that there was a difference between calculations based on this text and the events actually taking place in the sky. His son Ganesh Daivajna studied treatises on 'Surya Siddhānta'. He also observed the planets, constellations, the moon and the sun in the sky. He wrote a new edited version of 'Surya Siddhānta' titled as 'Suryasiddha Grahalaghav' in 1520 AD. This book gives the accurate mathematical calculations of actual celestial events.

After that, many almanacists started making their own versions of almanacs adapted from 'Grahalaghav' instead of the 'Surya Siddhānta'. This treatise was propagated all over India. People started calling the *Pañcānga* based on the '*Grahalāghava*' as '*Grahalāghaviya Pañcānga*'. Ganesh Daivajna's 'Suryasiddha *Grahalāghava*' acquired tremendous fame similar to

Bhāskarācāryā's 'Siddhānta Siromani'. Let us now see the propagation of the *Pañcāṅga* tradition further.

The books '*Siddhānta Darpan*' written by Chandrasekhar Singh of Cuttack and '*Jyotirsiddhanta Grahasangrah*' written by Purnaya Siddhanti from Andhra Pradesh were published in 1898-99. An important connection in the *Siddhānta* Jyotish tradition is Venkatesh Bapuji Ketkar.

Ketkar was considered as one of the leading almanacists in India. He spent a lot of energy on the making and research of the almanacs. He remained firm on his opinions and refuted the dissenting voices. There were occasional arguments between him and scholars like Lokmanya Bal Gangadhar Tilak, Prof. V. B. Naik etc. He was also critical about their opinions"



Lokmanya Bal Gangadhar Tilak

Tilak, Ketkar and Pañcānga

Suraj: - "Lokmanya Tilak? How is he connected to the almanac research?"

Grandfather: - "Let me tell you the connection. Apart from contributing to the Indian freedom struggle, Tilak had also made significant contributions to astronomical research. According to him" The almanac is a mirror of the sky, it should depict scenarios as seen in the sky and vice versa". He wrote about the *Pañcānga* in daily newspaper 'Kesari' frequently, and also organized astronomical conventions in Maharashtra to get consensus on this work.

Lokmanya Tilak wrote three books viz., 'Orion', 'Arctic Home in *Vedās*' and 'Vedic Chronology and *Vedānga* Jyotish' in English, to make the vedic knowledge accessible to the westerners.

He wanted the Indian almanac to become useful for navigation like the English nautical almanacs. He tried to establish an astronomical observatory in India. He was of the strong opinion that there should be a four-pillar system of Astronomical studies, based on the Observational science, observatories, Indian astronomers and the micro-almanacs issued by those observatories.

Lokmanya Tilak gave impetus to the *Pañcānga* movement and encouraged astronomical scholars all over the country. Among them, Venkatesh Ketkar was at the forefront. Tilak had written letters to him several times, urging him to write a book on the almanac. This shows the greatness of Ketkar.

Almanac includes three factors, astronomy, muhurtashastra and dharmashastra. But there were differences of opinion about these three factors. Due to this, different types of almanacs were formed. Tilak and Ketkar, both sacrificed their lives for the purification or betterment of the almanac."

Isha:- "Why so many different almanacs were formed?"

Grandfather:- "Different almanacists considered separate rate of precession of equinoxes, thus different almanacs were formed."

"In 1917, an almanac convention was held under the leadership of Lokmanya Tilak, in which the rate of precession of equinoxes was considered as 50.2 arcminutes. Raghunath Shastri Patwardhan, a famous astronomer from Pune, started 'Shuddha Tilak *Pañcānga*'.

Ancient astronomers have designed the system of zodiacs and constellations to indicate the positions of the sun, moon and different planets on the celestial sphere. Two systems to mark the start of the zodiac and constellations are in practice. They are called 'Sayan' and 'Nirayan' systems.

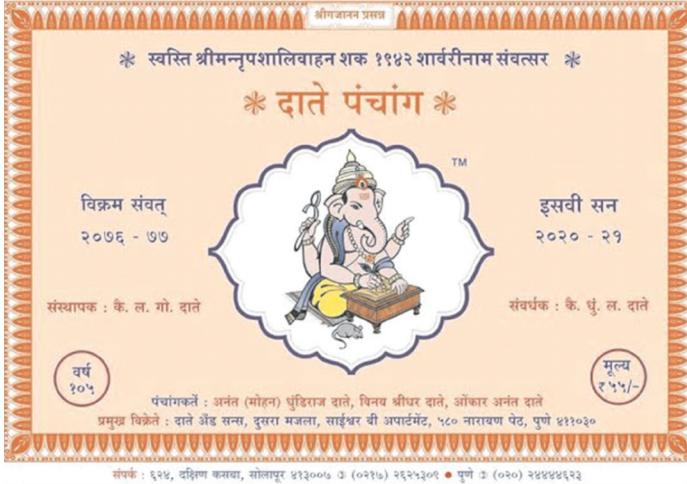
The system used to calculate the position of zodiacs and constellations from a moving point in the sky is called the 'Sayan' system. The system used to calculate the position of zodiacs and constellations from a fixed point in the sky is called the 'Nirayana' system.

Citrā Nakṣatra Paksha and Ketaki Pañcāṅga

Grandfather: - "There were Many disputes about the consideration of the position of the fixed point. Many almanac conventions were organised. This resulted in two major parties viz. the 'Revathi paksha' and the 'Citrā paksha'.

Lokmanya Tilak belonged to Revathi paksha, which considered the star named Zeta Piscium (Jayanti) as the fixed starting point. Venkatesh Ketkar supported the *Citrā* paksha, which considered the fixed point 180° away from the star 'Spica' in *Citrā* constellation. Both parties were adamant on their opinion, leading to many disputes between Tilak and Ketkar.

Today, Indian government endorsed *Ayanamśa*, Lahiri *Pañcāṅga* of north India and Date *Pañcāṅga* as per *Citrā* Paksha. Ketkar named his *Pañcāṅga* adapted from *Citrā* paksha as 'Ketaki *Pañcāṅga*'."



Modern Date Pañcāṅga

"Ketkar conveyed the importance of his almanac to scholars from Burma, Bengal, Darbhanga, Ayodhya, Rajahmundry, Madras, Thanjavur, Trivandrum, Mangalore and Mysore. His book 'Jyotirganit' was approved by the Government of India. Many Almanacs were prepared using the Ketki method in different parts of India. Here is the list.

- Vaijayanti *Pañcāṅga* - Shankarshastrī Joshi (Southern Canara)
- Tulunadu Almanac - Narayan Shastri (Udupi)
- Buggon Almanac - Rama Timanna Pandit (North Canara)
- Gokarna Almanac - Venkat Ram Pandit (North Canara)
- Urveri Almanac
- *Citraśālā Pañcāṅga* - G. B. Joshi (Pune)
- Aundh Princely state *Pañcāṅga*
- Shastrasuddha Vaijayanti *Pañcāṅga* - Bijapur
- Ketaki *Pañcāṅga* (Bagalkot)
- Mangalore *Pañcāṅga* (Mysore)
- Prabhakar *Pañcāṅga* (Elichpur)
- Vishwahitak *Pañcāṅga* (Ayodhya)
- Manipuri Ketaki *Pañcāṅga* - Atom Bapu Sharma (Imphal, Manipur)
- Sinhalese Almanac - (Sri Subramanian Iyer)
- Gosevak *Pañcāṅga* - B. R. Joshi (Belgaum)
- Ketki *Pañcāṅga* - M. M. Padam Godrej (Mumbai)
- Jeevan Vijay *Pañcāṅga* - Nainital



Citraśālā Pañcāṅga

8

Ketkar's Prediction about Existence of Pluto

Suraj:- "Ketkar devoted his life for the research over *Pañcāṅga*. But Grandpa, he carried out research in many other areas other than *Pañcāṅga*. Didn't he?"

Grandpa:- "Yes, He did. Ketkar had predicted about the existence of Pluto, before its actual discovery. The six planets in the solar system viz. Mercury, Venus, Mars, Jupiter and Saturn and earth were known to the ancient astronomers from the time unknown. These are the center of attraction for a long time. In the last 200 years, Uranus (Herschel), Neptune (Varun) and Pluto had been discovered. These three planets remained ignored for a long time.

Venkatesh Ketkar was born in 1854, after the discovery of Neptune in 1846. In 1909, William Pickering and in 1915, Percival Lowell had predicted about the existence of the ninth planet. After many years, working through sleepless nights, on February 18, 1930, a young American astronomer, Clyde Tombaugh discovered the ninth planet, Pluto."

"Before Tombaugh, Venkatesh Ketkar had written a scholarly article in the scientific research journal of Société astronomique de France 'astronomique de France' in 1911, stating that there should be two planets revolving outside the orbit of Neptune. He also predicted the figures depicting the position of the orbit of the ninth planet, which were again closer to those discovered afterwards. He also suggested names for these two planets. The Ninth Planet was named as 'Brahma' and the Tenth as 'Vishnu' by him. The period of revolution of Brahma was 242 years as predicted by him. After the discovery of Pluto, scientists have estimated the period of revolution of Pluto as 247.7 years. He had also predicted the



Clyde Tombaugh

distance of the ninth planet from the sun, which was 38.95 Astronomical Units, which matched with the distance of 39.5 AU, found out afterwards.

Sadly, Ketkar could not get the appropriate recognition and fame for this discovery. The calculations of this discovery are available today with his descendants. Renowned scientist Dr. Jayant Narlikar has mentioned the important contribution of Ketkar from time to time in his speeches and writings."

Other Research by Ketkar

"Ketkar made his other important research public, from time to time. Some of his research papers include, 'importance of the year 432', 'How should the 'varshmaan' be calculated from 'Suryasiddhanta'?' 'The time of creation of the text 'Taittiriya Brahmana', 'The theory of precession of earth's axis in 4600 BC', 'The times of Mahakavi Kalidas', 'Kannada words in Dnyaneshwari'

A few of his other important research papers were 'Bhagavad Gita', 'Kalnirnay', 'Chronology of aryaans', 'Estimation of Shivaji Maharaj's Birth date', '*Āryabhata* and Kuttaka Mathematics'.

After going through the string of research articles published by Ketkar, some of his scholar friends requested him to apply for the Springer scholarship of the University of Mumbai. Only due to the insistence of his friends, Ketkar submitted the application for the scholarship to the University of Mumbai.

After going through his application, Mr. Dastur, the registrar of Mumbai University, replied to him without giving any valid reason, "I have the honour by direction of Syndicate to inform you that your request cannot be granted."

Though Ketkar's research papers were published in the Société astronomique de France 'astronomique de France' in Paris, and he was congratulated for it, University of Mumbai did not consider him worthy of the scholarship nor did they appreciate his qualities.

As many educational and research institutes in India including University of Mumbai were under the control of British government, many Indian scientists like Ketkar might have been neglected. Due to this reason, Pandit Madan Mohan Malviya along with the like minded people,

founded Central Hindu College (Banaras Hindu University) in 1916 inviting the researchers and educationists of nationalist ideology.

In 1918, Pandit Madan Mohan Malviya, Vice Chancellor of Banaras Hindu University, met Ketkar in the city of Pune. This was followed by the correspondence revealing Ketkar's intelligence and his work which resulted in offering the letter of appointment as the professor of astronomy in Banaras Hindu University. But due to his mother's sad demise, Ketkar could not accept the post."

Multi-talented Ketkar

Grandfather:- "Despite the neglect, Ketkar remained focused on his work. Ketkar had made his mark not only in astronomy and mathematics but also in many other fields.

Very few people know that Venkatesh Ketkar was an ideal scholar and also a voracious reader. Ketkar's favorite English authors were Gibbon, Edmund Work, Goldsmith, and Shakespeare. He used to spend time reading their literary works. He was fluent in Sanskrit and thus used to give discourses on the books written by Shrimat Shankaracharya, Mahakavi Kalidas and poet Jaydev. He loved literature.

Greek and Roman history were on the tip of his tongue. Ketkar was fluent in Sanskrit, Marathi, Kannada and English. He also had mastery over French language. Perhaps that is why he could send his own research papers to astronomers in France and also continued correspondence with them in French. Ketkar had great respect for Napoleon Bonaparte. He had not only read many English and French biographies of Napoleon but knew them by heart.

It is also mentioned in his biography that Ketkar had spent the two years, 1926 and 1927, learning Bengali. He always wanted to learn new languages. Drawing maps and sketching were also his favorite hobbies. He had learnt to repair watches. It is said that Ketkar taught the art of making clay idols of Ganesha to the sculptors of Bagalkot. He loved music. He would get absorbed in the devotional songs of Sant Tukaram, Saint Purandaradasa, and Saint Kabir.”

Review of Ketkar's Literature

"In addition to his research, Ketkar had also written several books. Some of his books are 'Jyotirganita' in Sanskrit, 'Ketki Grahaganita Parishisht', 'Bhumandaliya Suryagrahan', 'Saurarya Brahmatithi Ganita', 'Marathi Grahaganit', 'Nakshatra Vidnyan', 'Goladvaya Prashnavimarsh', 'Indian and Foreign Chronology' etc.

Let's take a look at three of his books."

1. Goladvayaprashna Vimarsh:

"This book has the answers to the questions regarding the law of attraction between two spheres. The concept of gravity between planets is explored in it. The book was written in 1918 and was published by his son Mr. Dattatreya Ketkar sixteen years later. There was no Indian text on gravity till then.

In this book, he has discussed the concept of gravity proposed by ancient Indian astronomers. *Bhāskarācāryā* in his book 'Siddhantashiromani' in Goladhyaya Bhuvan sloka 6, states that the earth attracts all material things towards it due to its gravity. But, how does the force of gravity vary depending upon the distance between the objects? Newton proposed the rules. But the credit goes to *Bhāskarācāryā* since he had come up with the original idea 900 years ago. The attraction is inversely proportional to the square of the distance between the objects was noticed by Horex before Newton. But Newton proved the law of gravitation by mathematical calculations.

The book is based on Isaac Newton's 'Principia Mathematica'. Gravity is a special force that applies to all the material things in the universe. Mass is the amount of matter in any body. It can't actually be seen, but the effect can be perceived.

According to Ketkar, gravity is the collective effect of jerks. The jerk (force applied to an object) accelerates the object. This speed determines the movement of the object.

Ketkar has given the example of a Kingfisher. This bird catches prey by trying to stay afloat in the air at a height of 15 to 20 feet above the water level. It looks like it constantly hits the air with its wings, but the head does not move at all. This is because the bird is constantly fluttering its wings in order to stay afloat to oppose its weight which is pulling it downward due to gravitational attraction. This neutralises the equal and opposite forces. Thus, the bird stays still in the air.

Ketkar also states the two qualities found in any substance in terms of attraction. The first is to attract and the second is to get attracted. In the case of planets, Ketkar has stated two types. First is the sphere like the sun which is huge and stable, and attracts an object that can be called an 'attraction sphere'. The second one called 'attractive sphere' is relatively light in weight, like the planets orbiting the sun.

In the other example, the earth is the 'attraction sphere', while the moon is the 'attractive sphere'. In this book, Ketkar also discusses the concept of weight in the context of gravity.

2.Nakshatra Vidnyan:-

The science of constellations. This book gives information about various stars in the constellations, their Indian names, the *Pañcāṅga* and its misinterpretations, improvements, star maps and the achievements of ancient Indian scientists in the field of astronomy.

This book was published by the financial aid of the King of Vishalgarh, Pant pratidhi Shrimant Rajashri Abajirao Krishna Pandit. Ketkar has dedicated this book to him.

He has also given tips about the exact time and place of sky observations. We will see them one by one.

1) After sunset, Go to any high hill or terrace of your house. observe how the colour of sky is changing on the west horizon. Note down the colours which are prominent in every season.

2) Observe the sunset noting down the part of the horizon in which it occurs. Simultaneously, set your clock according to the IST or international standard time.

3) Stars begin to appear in the sky, then the constellations. Nakshatras on the east horizon seem to ascend slowly and those on the west horizon seem to descend down slowly. This movement appears to be tilted towards the right of the observer.

Ketkar has also given information about the Polestar, Big dipper, the Orion, Kruttika or the Pleiades stars. The stars that rise between the north and east points are present in the sky for more than 12 hours. Therefore, it is not possible to see their rise and fall throughout the same night. Star that sets in the night rises in the day, thus we can't observe its rise, also the star which rises in the night sets in the day, thus we can't observe its fall.

But there is no such rule for the stars which rise between the eastern and southern points, their daytime is less than 12 hours, thus the time in which the sun is absent in the sky is greater than 12 hours, from September till March. At this time, the star which rises in the southeast in the evening, sets at night. We can measure its time with the help of a clock. For this, choose the southern stars, such as Sirius or 'Lubdhak', Canopus or 'Agastya', Trishanku (collection of three crosses around Crux, also known as the Southern Cross.)

The rising and setting points of various stars are different. They are at the same distance from each other, ranging from the northern to the southern point. The star which rises at east, sets at west. The star which rises at North East sets at the north west. Star which rises at the south east sets at southwest. Each star rises two hours earlier after every thirty days.

In the same way, the stars visible on the eastern horizon after the sunset change over the twelve months. Thus we can observe the constellations rise in the evening, those corresponding to the names of the lunar month, *Citrā* in the month of *Caitra*, jyeshtha in the month of jyestha, mrigashira in the month of margashirsha.

The ancient Indians might have assumed that the earth rotates around the sun, by observing this motion, once in 12 months. Thus they had given the names of the constellations to the corresponding months.

Ancient Indians had considered the moon as their imaginary clock. Consider the path of the moon as the dial of a clock. The main stars or the constellations can be considered as the figures showing the month. And the motion of the moon can be considered as the motion of

the clock hands denoting the respective dates. Thus the sky was considered as a calendar by the ancient Indians. They named the constellations. This is the best example of the fact that the common man in ancient India was being benefited by the astronomical progress, says Ketkar.

3.Grahnakshatra:

Ketkar has given the information about different types of telescope in this book. He insisted that every sky observer or astronomer should use a telescope compulsorily.

He says, 'The best means of travel around the globe are vehicles or ships, similarly the best means of travel around the celestial spheres are the telescopes. With a telescope in hand, you can travel thousands of miles in space.

Distance of the moon from the earth is 2 lakhs 40 thousand miles. But a telescope of general optimization can make us feel this distance as less as 60 miles. Thus we can use small telescopes and observe the polestar, Big dipper, the Orion, Kruttika or the Pleiades stars. We can observe their luminous intensity and colour too.

The book also provides the information about the availability of telescopes and their price range. Ketkar writes, "In France, Société Astronomique de France provides telescopes and their cost ranges from Rs. 30/-, Rs. 40/- and Rs. 60/-."

Isha:- "Very nice information, Grandpa. Ketkar has provided very important and interesting information. From the efforts he took, it can be understood that he wanted to sincerely popularise astronomy in society, and make use of his vast knowledge for the common man.

Grandfather:- "Absolutely. Many scholars of his time have given precious feedback about his efforts and expressed their respect for him.

Renowned marathi writer, Shripad Krishna Kolhatkar writes, "We can say that Ketkar was the 'Ganesh Daivajna' of his times. He has pursued his interest over a single subject and has done consistent efforts like a sage. He has published his book without any profit by spending his own time and money. Ketkar doesn't need to be encouraged by financial support but he needs to be encouraged in terms of recognition.

We need to foster the supreme qualities Ketkar possesses. If his talent gets ignored, it will be an offence conducted by our society. We can benefit from his qualities to get inspiration

to pursue difficult subjects. I will be privileged if my writing benefits him to encourage his research."

12

Some Memories

“Ketkar's students had told some interesting facts about their teacher. When Ketkar used to summon the students for punishment for not completing the homework, they used to tell him, "Sir today we saw a star in the sky. It was reddish and blackish. What is it's name?"

On hearing this, he used to answer, "Was it blackish? Have you observed it properly? It may be Mars." Thus forgetting about the punishment, he used to tell them various facts about planet Mars.

Ketkar's son Dattatraya had also written down his memories. According to him, he used to be completely submerged in the thoughts of his favourite subjects. He would forget to eat, go out in the middle of dinner. He couldn't not sleep at night, thus he used to write till late. The lamp would continue to burn till morning.

Sometimes lost in the trail of his own thoughts, he used to wear different sleepers and go out. He used to walk endlessly wearing only his turban and shirt, and would roam in nearby jungle unknowingly without wearing sleepers and his coat.

He would never bathe on time, thus turning the water cold. He used to be fully engrossed and involved in his research. His wife had to suffer the consequences of his nature.

He continued his correspondence over his books, with the eminent writers and researchers who worked in the field astronomy from Rotterdam, Germany, Paris, New York, Bankura, Bombay, Silon (Sri Lanka). Ketkar penned down books after books. At last he told his son, "I can't write further, my nerves are refusing to write." In 1929, his health problems began to worsen. Eyesight diminished. He experienced dementia, so much so that he started to face

trouble remembering his own name. After asking the name, he used to reply as 'Bapuji'. But despite facing these problems, he remained a staunch supporter of *Citrā* paksha *Ayanamśa*.

Once a doctor asked him out of fun, "Why don't you accept the *Citrā* paksha *Ayanamśa* of the *Pañcāṅga* promotion committee?" He immediately answered, "It is mine, not yours". The doctor replied, "Look at his dedication for his research, he does not commit a mistake over it."

He used to ask his son to read the manuscript of his books again and again. He had become very forgetful.

13

Final Journey

After enduring a year with dementia and illness, on Wednesday, July 30, he said to his son, "Look, now only one, two and three." But no one understood what he meant.

After three days, on Sunday, August 3, 1930 at 10.30 at night, Ketkar breathed his last at Bijapur. He was 77 years old at the time of death.

Venkatesh Bapuji Ketkar worked tirelessly and diligently for 56 consecutive years, turning his back to all worldly pleasures. He wasn't fascinated by any worldly attachments and materialism. There is no doubt that Ketkar served astronomy with constant contemplation, meditation and writing on his favorite subject and enjoyed it more than poetry. He will remain in people's memories for a long time.

Ketkar's elder son Shri. Dattatreya Ketkar had composed a four-line verse in Sanskrit after his father's death.

वर्षे नेत्रशराष्टभूमिशतके मोदाख्यसंवत्सरे
हन्त श्रावणशुक्लपक्षदशमीसंयुक्तभानोर्दिने
सूर्यास्तात् दशनाडिकागतनिशि ज्योतिर्विदग्नेसराः ।
हा हा श्रीयुतव्यंकटेशकृतिनः कैलासवासं ययूः ॥

(Oops, it is very sad that the greatest astronomer shri. Vekateshshastri breathed his last on Sunday night, the '10th tithi' of 'shukla paksha' of 'Śrāvana' month, in 'Śaka 1852' named as 'Moda Sanvatsar'; when it was 4 hours after the sunset.)

It means, 'It is sad that the greatest astronomer of his time, Shri. Venkteshshastri Passed away on Sunday night, on August 3, 1930 AD. (Shak 1852 = 1930 AD)

It is interesting to appreciate the strength of Sanskrit language to convey a lot of details in a terse manner. Present verse uses 'Bhootsankhya' method (भूतसंख्या पद्धती) which has been typically used by the ancient Indian mathematicians and 'jyotirvids'.

वर्षे नेत्रशराष्टभूमिशतके - in the year 1852 = 1930 A.D.

वर्ष - year

नेत्र - eyes (which are 2) = 2

शर - arrows (which are 5 floral arrows of the God of love - 'Madan' described in our ancient sanskrit scriptures) = 5

अष्ट - 8

भूमि - Earth (which is 1) = 1

अष्टभूमिशतके - 18 hundred

सूर्यास्तात दशनाडिकागतनिशि- 4 hours of night passed after the sunset

दश = 10

नाडिका - half 'muhurta' = 24 minutes (1 Muhurta = 48 minutes)

दशनाडिका = 4 hours (10 x 24 = 240 minutes)

After the death of astrologer Shri Ketkar, in Kesari's condolence issue, it was written that, "V B. Ketkar's mastery of astronomy was so irreplaceable, that his death has caused irreparable damage to Aryan Astronomy."

'Venkatesh Samachar', a Mumbai daily, stated that, "Today, the death of Jyotishacharya VB ketkar has given a great shock to the world of astronomy." In the November issue of 'Modern Review', Dr. J. C. Ray wrote, 'Mr. Ketkar was best qualified to show the way. It will be difficult to find another man who has studied the calendars of the different provinces as well as he did. His right place would have been as the head of the department of the Indian Almanac'.

What an eminent personality! Throughout his life, he did not betray his intellect. Through his voluminous research, books written with very few tools available, his example should be taken

by today's new generation. I think everyone should set him as the ideal.

Isha: - "Indeed Grandpa, we feel proud to inherit the legacy of such a great personality from India. But at the same time, it increases our responsibility to foster noble scientific attitudes and pass on the knowledge to society for its benefit."

Suraj: - "Yes, Grandpa. It is our duty to disperse the work of Venkatesh Bapuji Ketkar, the great personality of all the time, in the society. We will definitely pass on the information you have given today, to our friends."

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<https://ketkardnyankosh.com/index.php/2012-09-06-10-04-39/2012-10-01-06-02-19/5637-2013-01-10-07-15-06>

8) **Pañcāṅga and Astronomy**

<https://ketkardnyankosh.com/index.php/%E0%A4%96%E0%A4%82%E0%A4%A1-%E0%A5%AB-%E0%A4%B5%E0%A4%BF%E0%A4%9C%E0%A5%8D%E0%A4%9E%E0%A4%BE%E0%A4%A8%E0%A5%87%E0%A4%A4%E0%A4%BF%E0%A4%B9%E0%A4%BE%E0%A4%B8/2012-10-01-04-26-21/4881-2012-12-28-07-35-15>

9) Transliteration (Sanskrit to English)

Vowels

Devanāgarī	Transcription	Devanāgarī	Transcription	Devanāgarī	Transcription
अ	a A	ऋ	r R	ओ	o O
आ	ā Ā	ॠ	ṛ Ṛ	औ	au Au
इ	i I	ऌ	ḷ Ḹ	ं	m M
ई	ī Ī	ॡ	ṡ Ṣ	ः	h H
उ	u U	ए	e E	ँ	~
ऊ	ū Ū	ऐ	ai Ai	ँ	'

Consonants

क k K	च c C	ट ṭ Ṭ	त t T	प p P
ख kh Kh	छ ch Ch	ठ ṭh Ṭh	थ th Th	फ ph Ph
ग g G	ज j J	ड ḍ Ḍ	द d D	ब b B
घ gh Gh	झ jh Jh	ढ ḍh Ḍh	ध dh Dh	भ bh Bh
ङ ṅ Ṇ	ञ ñ Ñ	ण ṇ Ṇ	न n N	म m M
ह h H	य y Y	र r R	ल l L	व v V
	श ś Ś	ष ṣ Ṣ	स s S	



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