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JAI SINGH, HIS EUROPEAN ASTRONOMERS AND THE COPERNICAN REVOLUTION

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Sawai Jai Singh, the founder of modern Jaipur, built observatories in five different cities of north India in order to update existing astronomical charts. He also had a number of European works on astronomy and mathematics translated into Sanskrit. Although the telescopic sight had been invented and the Copernican revolution had gained a solid footing in several European countries, Jai Singh apparently did not benefit from it. A question is often raised: why did Jai Singh, an enlightened scholar, remain ignorant or choose to ignore the brilliant theoretical and experimental progress of European Astronomy initiated by the Copernican revolution. The question becomes all the more baffling when one discovers that he had a number of European astronomers assisting him at his observatories. From an examination of the religious and social background of his European assistants, the article draws the conclusion that the Europeans, because of their own theological beliefs and prejudices, may not have presented the Copernican revolution to him in its true perspective. And, for the telescopic sight, it is suggested that the news of its invention may not have reached him in time before the observatories were conceived.

I NTRODUCTION

"Sawai Jai Singh (the founder of modern Jaipur) from the first dawning of the reason in his mind and its progress towards maturity was entirely devoted to the study of mathematical science."[1,2] He was born in A.D. 1686. Realizing that the astronomical tables of his times had become outdated and were in need of revision, Jai Singh devised a number of ingenious instruments and built observatories in five different cities of north India.[3] And, with a considerable amount of effort spanning a decade, he had a new set of tables prepared, which were completed around 1730.

Although the telescope had become common by then with European astronomers and had acquired refinements such as the micrometer and crosshair,[4] there is no evidence that Jai Singh benefited from it in his intended goal. His instruments do not use a telescopic sight, and with all their ingenuity of concept and design are no more than, what may be called 'naked eye tools',—somewhat in the tradition of the medieval astronomers such as Ulagh Beg of Samarkand.[5]

The tables of Jai Singh became obsolete even before they were published, as a set of more accurate tables had been completed by the British Royal Astronomer John Flamsteed and his assistants by 1725.[6] Further, Jai Singh also had several European works on mathematics and astronomy translated into Sanskrit. Here again, the efforts of Jai Singh fell far short of his times; his choice in astronomy seemed to have been on an already obsolete book, *The Almagest* of Ptolemy,[7] and not *The Revolution* of Copernicus or *The Principia* of Newton, both of which had been in existence for quite some time.

Jai Singh's labors consequently failed to sow the seeds of modern astronomy in India, and left the country unaware of the Copernican revolution until the advent of the British. His efforts also contributed little if anything at all to the real progress of this science anywhere else in the world.

Copernican Revolution

In 1543, a Polish astronomer-monk Nicholas Copernicus, published his famous book, *On the Revolution of the Heavenly Bodies*, and thereby revolutionized the science of astronomy. Copernicus, breaking away from the traditional system of Ptolemy with its emphasis on geocentric cosmology, worked out a simpler system based on the heliocentric theory of the early Greeks. Copernicus' original ideas were modified and elaborated soon thereafter by Johannes Kepler in the early 17th Century, when he discovered the three basic laws of planetary revolution around the sun. The verification of the Copernician system was, however, provided by a contemporary of Kepler, an Italian professor of mathematics, the celebrated Galileo Galilei. He did it with a telescope of his own making, by reporting in 1611-12, the continuously changing phases of the planet Venus, similar to those of the moon.[8] Finally, Sir Isaac Newton discovered the universal law of gravitation and showed in his famous work, *The Principia*, that a planet's motion around the sun was the consequence of a universal force-gravitation. Newton's '*Principia*' was published in 1687, about a year after Jai Singh was born.

A question is often raised: why did Jai Singh, an enlightened scholar, a man far ahead of his times, remain unaware or choose to ignore the brilliant theoretical and experimental progress of the European astronomy initiated by the Copernican revolution and attempt "to revive the spirit of Ulagh Beg at a time that seems—in retrospect—to have been a century too late?"[9]

The question why Jai Singh remained unaware or ignored the Copernican revolution becomes all the more baffling when one discovers that before commencing work on his observatories he is said to have familiarized himself with the different systems of Astronomy, including the European. A letter from the Mogul Emperor Muhammed Shah quoted in the preface to *Zij Muhammed Shahi* substantiates the fact that prior to erecting the observatories, Jai Singh did indeed assemble "the astro-

nomers and geometricians of the faith of Islam and the Brahmins and *Puṇḍits,* and *the astronomers of Europe*".[10]

From the correspondence of the Jesuit missionaries in India at that time, a number of European names associated with his astronomical enterprises, have come to light. The following table gives a brief summary of these people.

Year	Names	Nationality	Vocation
1728-29	Manuel de Figueredo[11, 12]	Portuguese	Jesuit Priest, led a delegation to Europe
1730	Don Xavier or Pedro de Silva[13, 14]	Portuguese	Physician/Astronomer settled in Jaipur
1734	Frs. Pons and Claude Boudier[15, 16]	French	Jesuit Priest/Astronomer
1740	Anthony Gobelsberger and Andrue Strobl[17, 18]	Bavarian	Jesuit Priest/Astronomer

In addition, Father Joseph Tieffenthaler,[19] a Jesuit from the Austrian Tyrol, arrived from Europe in 1743 supposedly to partake in the observations, but owing to the untimely death of the Raja a few months earlier, he could not do so. The names of Europeans present prior to 1728 are not known, and may very well be buried in the archives of Jaipur or Goa, or lost forever, along with the other Jesuit document which disappeared during a shipment from Goa to Portugal.[20]

Delegation to Europe

Having received information that observatories in Europe were also engaged in the upgrading of the star charts, Jai Singh sent a delegation, led by Padre Manuel,[21] to the king of Portugal, John V to obtain informtion needed to compare his data with European data.[22] The delegation returned in 1728-29 with some books on mathematics,[23] and an astronomical table prepared by the French astronomer de le Hire.[24,25] The Portuguese physician-astronomer, Don Pedro de Silva also came along with the delegation,[26] and after working for a number of years mostly as a liaison between Jai Singh and the Portuguese authorities at Goa, decided to settle permanently in Jaipur.[27] It is reported that Jai Singh contemplated sending a second delegation around 1742-43 to Europe—this time to the Pope and to Kaiser—to establish contacts and perhaps to obtain further material for his pursuits,[28] but his plans could not be put into effect due to his own death in 1743, and also due to subsequent lack of interest in the sciences at the Jaipur court.[29]

In spite of seemingly close contact with European astronomers lasting over decades and with the enormous sums of money invested in a delegation to Europe, why do Jai Singh's endeavors not reflect any influence of the European advances of the preceding century, particularly the influence of the Copernican revolution? Did

he deliberately ignore the expertise of his European advisors and go ahead with the outmoded instruments of his own design for the preparation of tables? On the theoretical side, did he feel uncomfortable with the heliocentric concept as the contemporaries of Galileo had felt before—and thus failed to appreciate the true nature of the theoretical advances led by Copernicus, Kepler and Newton?[30] And is that why he had an already discredited text, *Almajest* of Ptolemy and not the *Principia* of Newton translated into Sanskrit? The answers to some of these questions, strange as it may seem, lie not so much with Jai Singh, but in the religious and cultural environment of the 17th century Europe and in order to understand it, the background of Jai Singh's European contacts should be explored.

The Portuguese

From the very beginning of his project, as the letter of Muhammad Shah indicates, Jai Singh was in contact with Europeans, specifically the Portuguese.[31] But the extent of that initial contact is not known nor is it clear whether he was initially in touch with the Portuguese Jesuits or the Portuguese authorities in Goa.

Having come over to India first in 1498, the Portuguese had been in the country for almost 200 years by then.[32] In fact, by the time of Jai Singh they controlled a 60 mile strip on the western coast between Damao and Bombay, which had the town of Goa as its capital. A viceroy sent from Lisbon and stationed at Goa ruled over their eastern empire which extended all the way from East Africa to modern Sri Lanka. Until 1640, when they were defeated by the Dutch at sea, the Portuguese were the leading power in the Indian ocean. Because of their power at sea and also because of their interest in trade and commerce, emissaries of rank lower than ambassador were frequently exchanged between the rulers of North India and the viceroys at Goa. During the days of Jai Singh, thousands of Portuguese mercenaries, traders and adventurers were found in the country from north to south. The soldiers sought employment mostly in artillery units of the local rulers, and the sailors in the navy of the Moguls. At one time the Mogul fleet in the Bay of Bengal had 923 Portuguese sailors.[33] After replacing the Arab merchants at sea, Portuguese traders directly or indirectly controlled coastal trade in India for a long time. Their own currency, minted at their possessions in India, was accepted by local business people. By the late 17th century, because of their maritime enterprises and trade, the Portuguese language had become the means of international communication. The Dutch, the English, whose influence replaced the Portuguese in later years in the East, or any other European for that matter, had to learn Portuguese in order to be understood by one another or by an interpreter in South-East Asia.[34]

It appears natural, therefore, that desiring to learn about European astronomy, Jai Singh should have turned to the Portuguese. His relations with them, once established, remained unbroken until his death in 1743, and through them he acquired his principal European helpers.

THE JESUITS

Jai Singh's European helpers, working directly under him, were scholars, belonging to a priestly religious order—"The Society of Jesus".[35] The society with its head office at Rome was founded by a Spanish soldier, Ignatius of Loyola, in 1539, on a military pattern, and as such, he demanded an absolute discipline from its members. The members of the society, commonly known as the Jesuits, took a special vow of obedience to the Pope. The society selected its members carefully, and in fact, a recruit to the society went through a long period of rigorous training and apprenticeship—often lasting for a decade or more, during which the ones with shaky faith were weeded out—before being ordained as a full-fledged priest. The careful selection of members, coupled with strict discipline, led to a rapid growth in the power of the society and made the Jesuits one of the most influential orders of the Roman Catholic church. The Jesuits cultivated scholarship among their members from the very beginning, and by the 17th century had quite a few eminent mathematicians and astronomers within their ranks. But as Geymonat has pointed out, this cultivation of scholarship did not imply any open-mindedness towards new ideas.[36] Rather it constituted an intelligent effort to explain new researches according to the established orthodox pattern of their church in order to enhance the prestige and the power of the church. As a matter of fact, during the 17th and 18th centuries the society actively opposed any assimilation of new scientific ideas.

By the time the observations of Jai Singh were planned, the Jesuits were no longer new arrivals on Indian soil. Arriving first in 1542, they had been in the country for almost 200 years.[37] It has been pointed out that they were sent—at least in the beginning—after careful selection and "the average Jesuit missionary in India was a man of culture, observation and judgement, and possessing some knowledge of the languages of the land."[38]

An invitation from the Emperor Akbar introduced them to the Mogul court where, enjoying favorable treatment for a while, they furthered Portuguese national interests while carrying out their priestly duties with their congregations.[39] However, in the reign of Aurangzeb, and during the years following his death, the patronage of the Delhi court ceased, and they looked for its substitute elsewhere. The interest shown by Jai Singh, therefore, in European astronomy, was viewed by them as a golden opportunity to regain some of their former privileges and they participated in his pursuits wholeheartedly.

The participation of Jesuits in Jai Singh's astronomical endeavors, once initiated, continued on and off for several decades until his death in 1743. However, in this participation they were obviously unable to go against the dictates of their beliefs sanctioned by the hierarchy of the Catholic church in unequivocal terms.

THE OPPOSITION OF THE CATHOLIC CHURCH

The Catholic church from the very outset had not looked upon the Heliocentric theory of Copernicus favourably;[40] the theory contradicted the established doctrine of the immovability of the earth and therefore was in disagreement with Catholic dogma. The church's opposition to the theory, beginning on a mild note, became loud and bitter when its spread appeared to get out of hand. The church sought out the adherents of the theory and pronounced harsh punishments on them with the intention of sounding a clear warning to others. Giorduno Bruno was imprisoned in a dungeon and then burned alive in 1600 for proclaiming that the sun and not the earth, was the centre of the heaven and his ashes scattered to the winds.[41] About three decades later, Galileo was forced to stand trial before the Roman Inquisition for supporting the theory with his telescope and upholding it as truth.[42] He was publicly humiliated, forced to recant his beliefs, and convicted to spend the rest of his days under virtual house arrest.[43] It's noteworthy that the Jesuits of Italy had an important hand in bringing the 70-year old ailing scientist to trial before the courts of the Roman Inquisition.[44]

The Catholic church did not stop to rest after punishing Bruno and Galileo however. As a matter of fact, the recantation of Galileo was read throughout Italy at universities and colleges before the professors of mathematics and astronomy and concerted efforts were made to ensure that they did not hold or defend the views regarding the mobility of earth.[45] Further, the works of Galileo were added to the 'Index' of prohibited books which already listed those of Copernicus and Kepler, and the Inquisitors were ordered to deny publication of any writings upholding the views of these three authors. The commissioners of the Inquisition, accordingly, searched public and private libraries, book shops, and foreign vessels at all ports for prohibited and smuggled books, and the smugglers were punished by death.[46] As a consequence, the Copernican revolution withered away completely from the countries where the Catholic church was strong.

It is misleading to assume, however, that the Catholic church was the sole and only organized religious group active in its condemnation of the new astronomy. As a matter of fact, Protestant denominations such as the Lutherans and Calvinists were even more venomous in denouncing Copernicus and Kepler.[47]

One might suppose that in a land far removed from the Catholic Europe, such as Portuguese India, the vigilance of the Inquisition might not have been that intense after all, and that it would have been safer to advance the discoveries of Copernicus, Kepler, Galileo and Newton. But the facts do not seem to suggest this. The authorities of the Inquisition at Goa were even more vigilant and active than their counterparts in Europe.[48, 49] When the stories of the Goan Inquisition trickled back to Europe, they startled even those who were well aware of the horrors committed in the Iberian peninsula.[50]

JESUITS AND THE COPERNICAN REVOLUTION

For future generations of faithful Catholics, 'the truth' had been expounded by the theologians of Rome in 1616:

> "The proposition that the sun is the centre and does not revolve about the earth, is foolish, absurd, false in theology, and heretical, because expressly contrary to Holy Scripture; and that the earth is not the centre but revolves about the sun, is absurd, false in philosophy, and from a theological point of view, at least, opposed to the true faith."[51]

As faithful servants of the church, the Jesuits believed in the above with all their hearts. Their training, absolute discipline and obedience to their superiors had left them hardly capable to think otherwise.[52] It's not surprising therefore that in the letters of the Jesuit Fathers, from their missions in India, there is not a single reference or comment to reflect that there was even a single Copernican among them.[53] It's noteworthy that the Jesuits such as Moduit and de Lane, while arguing with the local Brahmins, criticize Hindu astronomy but do not assail its geocentric feature.[54]

When Jai Singh consulted the Jesuit scholars about the status of the astronomy in Europe, it's unlikely that they ever discussed the Copernican revolution in its true perspective; to them it was heresy, and thus to be shunned at all cost. Moraes' contention that Father Figueredo referred Jai Singh to the discoveries of Copernicus, Kepler and Newton does not sound plausible.[55]

If Jesuits were unable to introduce Jai Singh to the Copernican revolution, what about the other Europeans in the country such as the British and the Dutch? Could they have not introduced him to the revolution? Possibly, they could have. But the evidence, to substantiate that they actually did, has yet to surface.

FAILURE OF THE MISSION TO EUROPE

The relentless war waged by the Church in the aftermath of Galileo's trial had taken its frightful toll. By the time Jai Singh's mission under Father Figueredo arrived in Europe, there was not a single scholar left in the Iberian Peninsula, particularly in Portugal, who could speak about Kepler or Newton. In Portugal, where King John V reigned, the Holy Office of Inquisition had cleansed the institutions of higher learning of all Copernicans decades before. The King himself was not tolerant either. As a matter of fact, the "Most Faithful King" had presided over one of the most vigorous periods of the Inquisition in the history of his country.[56,57]

The mission under Father Figueredo apparently never stepped outside the Catholic world and returned to India with the non-controversial works of authors such as de le Hire of Catholic France and Don Juan Nepier of Portugal, and consequently so

far as neoastronomy was concerned it produced very little. The tables of Flamsteed in the Jaipur palace library appear to be a later acquisition.[58]

Unfortunately, the Raja seemed to have had no alternative but to send a team of foreigners on his fact finding mission to Europe as no high born Hindu of his days would dare 'cross the ocean' and thereby risk 'losing his caste'.

The Question of Telescope

Jai Singh's *Zij Muhammad Shahi* has references to the telescope.[59] Jai Singh had used telescopes for his observations as Ansari has pointed out.[60] The satellites of Jupiter reported in the *Zij* cannot be observed otherwise.[61] Thus it cannot be said that Jai Singh was unaware of the telescope.

Then why are his instruments non-telescopic in nature? In order to explore this question a bit deeper, distinction ought to be made between a general purpose telescope and a "telescopic sight". A telescopic sight is a modified telescope with a cross-hair at its prime focus. The cross-hair enables an observer to align his instrument towards an object with precision, and thus helps measure an angle with greater accuracy. Although, the telescope had become increasingly common with European astronomers following Galileo, the telescopic sight came in much later. It's Jean Picard who introduced it first into astronomy in 1667.[62] However, even with telescopic sights the accuracy of the instruments of 1670's was no better than 1′, a limit easily matched by accomplished observers such as Hevelius with their non-telescopic instruments.[63] Consequently, the acceptance of the telescopic sight was rather slow in the beginning. Eventually, when Flamsteed achieved an unprecedented accuracy of 10″in his star catalogs of 1712 and 1725, the non-telescopic observations became the things of the past.[64]

In the astronomical endeavors of Jai Singh it's not the telescope, but the "telescopic sight" that's missing. His instruments are not designed to incorporate telescopic sights. Perhaps, the invention of the telescopic sight which had come into vogue with European astronomers only a few decades earlier did not reach him in time. His disregard of the telescopic sight does not appear to be intentional but rather rooted in his general ignorance of European instruments and methods. In a letter written to the Father Superior of the Jesuits at Chandernagore, around 1731, long after his Delhi observatory had been in operation, he enquires about the method and the instruments with which the moon's longitude was observed in Europe when the moon was outside the meridian.[65]

In Europe, longitude (right ascension) measurements could have been quite easily inferred from instruments such as an azimuth-quadrant or a sextant. Apparently Jai Singh was not aware of the fact. Possibly, poor communications in the 17-18th century were responsible for his ignorance of the European techniques. His deliberate acquisi-

tion of charts, globes and maps of *phirangis*, his support of Fathers Pons, Boudier and others in later years who made observations with telescopic sights at Jaipur[66], the capital of his kingdom, and his inquiry regarding de le Hire's measurement techniques, do not suggest prejudice against European equipment and particularly against the telescopic sight.

Conclusion

In retrospect, it appears that the Raja relied too much upon and was clearly influenced by his Jesuit assistants who unwittingly erected an invisible shield between him and the so-called heretical new astronomy they avoided. To the end of his days he trusted the expertise of these faithful servants of the Church and made no attempts to consult anyone else from a country such as England or Holland where the Copernican revolution had gained a footing.[67] Evidently, Jai Singh never became aware of Copernican thought in its full scope. It is wrong and unfair to him to conclude, therefore, that he deliberately chose to ignore the theoretical advances of the Copernican revolution because he was more comfortable with geocentric cosmology.

As pointed out earlier, it is not the telescope but the telescopic sight that is missing from Jai Singh's instruments. Perhaps he did not have full opportunity to evaluate European instrumentation, incorporating the telescopic sight, before his own instruments were designed.

The meagerness of the communication facilities played a greater role in Jai Singh's ignorance of the contemporary astronomy of Europe than is generally realized. Communications were still bad in the 17-18th centuries. And an Eastern scholar such as Jai Singh, removed thousands of miles from the scientific circles of Europe, could have easily remained ignorant of researches in contemporary astronomy.

It is a tragic fact that the science of astronomy, despite his great efforts, did not revive in India in Jai Singh's hands. As it turned out, astronomy in India started out on a wrong foot, and withered away soon after his death. On the other hand, asrtoomers such as Fathers Boudier and Strobl, victimized by their own theological belifs and prejudices, also missed out on the unprecedented opportunity of being instrumenal in initiating the Copernican revolution in a land where a scholarly prince had his purse strings wide open for just such an adventure.

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[3] A description of the observatories and their instruments is given by Kaye, G. R., *A Guide to the Old Indian Observatories*, Archeological Survey of India, Calcutta, 1920. The theoretical capabilities of some of the observatory instruments have been calculated by William Blanpied, "Raja Sawai Jai Singh II: An 18th Century Medieval Astronomer", *Am. J. Phys.* **43**, 1025, 1975.

[4] Asimov, Isaac, *Eyes on the Universe*, pp. 48-52 (Houghton Mifflin, Boston, 1975).

[5] Ruler of Central Asia, built an observatory around 1428 A.D.

[6] Flamsteed collected data on planets, moon, sun and some 3000 stars with an accuracy of 10″. His data was published first in 1712 and finally posthumously in 1725 in three volumes under the title of *Historiae Coelestis Brittanica*.

[7] The translation of *Almajest* is known as *Samrāṭ Siddhānt*, National Institute of Science of India, New Delhi, 1966-69.

[8] Ref. 4. p. 28.

[9] Blanpied, Ref. 3, and also Blampied W., "The Astronomical Program of Raja Sawai Jai Singh II and Its Historical Context", *Japanese Studies of Hist. Sci.*. **13**, 87 (1974).

[10] Ref. 2, pp. 182-83. The italics are of the author.

[11] *Letters Edifiantes et Cureuses*, Tome Deuxieme, pp. 772-78 (Paris, 1843).

[12] Figueredo appears to have been primarily a liaison between Jai Singh and the Portuguese authorities at Goa and at Lisbon.

[13] Gracias, Amâncio, "Uma Embaixada Cientifica Portuguesa à Corte dum Rei Indiano no Século XVIII, *O Oriente Português*, **19**, **20**, **21**, 187, 1938.

[14] Hunter reports that de Silva having died in 1780's was survived by a son living at Jaipur while he was visiting the city. Ref. 2.

[15] Ref. 11.

[16] Ibid. pp. 610-11.

[17] Stocklein, Joseph, *Neuve Weltbott*, Nos. 643, 644, Augsburg and Gratz, 1728.

[18] Bernoulli, J., *Description Historique et Geographique de l'Inde*, Tome I, p. 5, Berlin, 1786.

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[20] Correia-Afonso, John, *Jesuit Letters and Indian History*, p. 134, A. M. Coyne, S. F., St. Xavier's College, Bombay, 1955.

[21] Padre Manuel and Manual de Figueredo are apparently the same person.

[22] Ref. 2.

[23] The books on mathematics included Euclid's Elements, treatises of plain and spherical geometry, and a book on construction and use of logarithm. Hunter, Ref. 2.

[24] Ibid.

[25] de le Hire (1640-1718) French astronomer, published astronomical tables in 1687 and 1702.

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[28] *Neuve Weltbott*, No. 643, Ref. 17.

[29] Ibid.

[30] de Santillana, Giorgio, *The Crime of Galileo*, p. 27ff, University of Chicago Press, Chicago, 1955.

[31] Hunter also observes that Jai Singh's European astronomers were mostly the Portuguese. See Ref.2.

[32] de Oliveira, Marques. *History of Portugal*, p. 335ff. Columbia University Press, New York, 1972.

[33] Ibid, p. 340.

[34] Boxer, C. R., *Four Centuries of Portuguese Expansion*, p. 92, University California Press, Berkeley, 1969.

[35] *Encyclopaedia of Science and Religion*, 7, pp. 500-05, (ed.) J. Hastings, Charles Scribner's Sons, New York.

[36] Geymonat, Ludovico; *Galileo Galilei*, p. 74, (McGraw-Hill, New York, 1965).

[37] Boxer, Ref. 34, p. 37.

[38] Correia-Afonso, Ref. 20, p. 59.

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[40] White, A.D., *A History of the Warfare of Science with Theology*, p. 116ff, reprinted by the Free Press, New York, 1965.

[41] Ibid, p. 125.

[42] For a detailed account of the Institution of Inquisition see Lea, H. C., *History of Inquisition of Spain*, 4 Vols. (McMillan, London, 1907). Inquisition was abolished in Europe during the early decades of the 19th century. See Vol. 4, p. 436.

[43] de Santillana, Ref. 30, pp. 237ff.

[44] Geymonat, Ref. 36, pp. 151-52.

[45] Ref. 40, p. 139.

[46] Putnam, G. H., *The Censorship of the Church of Rome*, Vol. 1, pp. 128-29, p. 309ff, Vol. 2, p. 323, pp. 455-59. Benjamin Blom, New York, 1967; also White, Ref. 40, p. 139.

[47] Ref. 40, pp. 122-24.

[48] An Italian traveller, Gemelli Carreri writes, "Inquisition is much respected and dreaded by the Christians at Goa and about it". Carreri, *The Collection of Voyages and Travels*, IV, p. 221, London, 1704 as quoted by Heras, Henry, *The Conversion Policy of the Jesuits in India*, Indian Historical Research Institute, Bombay, 1933.

[49] The Inquisition in Goa was finally abolished in 1812. Hunter, W., *The Indian Empire: Its People, History, and Products*, p. 304ff. W. H. Allen and Co., London, 1893; also Ref. 32, p. 352, and Ref. 42, Vol. 3, p. 310.

[50] In some of the 'autos de fe' (trials) of the Goan Inquisition for which the figures are available, it is revealed that 4,046 persons were sentenced to various kinds of punishment. These punishments included 105 men and 16 women condemned to flames, of whom 57 were actually burned alive and 64 burned in effigy. See Hunter, ref. 49, p. 306.

[51] Ref. 40, p. 132.

[52] Ignatius, the founder of 'The Society of Jesus' desired 'blind' obedience from his members as he wrote: "(members) must endeavor to be resigned interiorly conforming their will and judgement wholly to the superior's will and judgement in which no sin is perceptible." Ref. 35.

[53] For example see: *Lettres edifiantes et curieuses ecrites des mission estrangeres, Nouvelle edition, Memoire de Indes*, Toulouse, 1810. Also Ref. 17, 28, and Ref. 27.

[54] Ref. 11, pp. 307-08, and pp. 401-02.

[55] The author has been unable to verify the reference quoted by Moraes, in which Figueredo allegedly refers Jai Singh to the advancement of astronomy in Europe such as the researches of Copernicus, Kepler and Newton. The reference quoted in his paper is: *Letters Edifiantes et Curieuses*, Vol. XIV, p. 337, 1781. Since this reference does not even mention Figueredo or Jai Singh, there is obviously a misprint. Perhaps, Vol. XV, p. 337 (1781) has been meant, which does talk about Figueredo and Jai Singh. However, the latter reference does not support Moraes' contention. The second reference, in fact, is a letter from Boudier already quoted in this paper. Ref. 11.

[56] The title of "Most Faithful King" was conferred upon John V, the king of Portugal, by Pope Benedict XIV.

[57] Ref. 42, p. 310.

[58] Around 1730, Jai Singh addressed a set of five questions to the Jesuits of Chandernagore. The questions as reported by Fr. Calmette are as follows. Ref. 16.

1. From where comes the difference that he finds between the moon observed and the calculation made on the basis of the tables of M. de le Hire which he has had translated? This difference is nearly one degree; however, the instruments with which he (Jai Singh) made the observations

are large and exact, and the observations have been made with all necessary care. Is this difference also found for the Paris meridian?

2. Are there any tables which give the movements of the moon in perfect conformance with the observations? If there are, who is the author and what astronomical hypothesis does he follow?
3. What is the hypothesis that M. de le Hire followed and in what geometric manner did he make his tables of the movements of the moon?
4. In what manner is the longitude of the moon observed in Europe when it is outside the meridian and with what instruments?
5. On what basis did M. de le Hire establish the third equation of the movements of the moon and in what way could one reduce it hypothetically and calculate it geometrically.

The second question above suggests that Jai Singh at the time did not have in his possession Tables more recent than those of de le Hire's. The Tables of Flamsteed, published after de le Hire's, were apparently a later acquisition.

Ref. 1, leaf nos. 0 and 3.

[59] Ref. 1, folio 189.

[60] Ansari, S. M. R., "The Establishment of Observatories and the Socioeconomic Conditions of Scientific Work in Nineteenth Century India", *Indian J. Hist. Sci.*, 13, 62, No. 1 (1978).

[61] Ref. 59.

[62] Pannekoek, A., *A History of Astronomy*, p. 259, Interscience Publishers, New York, 1961.

[63] Ibid., p. 260.

[64] Ref. 6.

[65] Ref. 58, See the fourth question. In the translation reproduced by Blanpied, Ref. 9, the French word "observer" has been misinterpreted as "to calculate".

[66] Garett, A., and Guleri, C., *The Jaipur Observatory and its Builder*, p. 20, Pioneer Press, Allahabad. 1902, as cited by Kaye, Ref. 3, p. 7; Also Ref. 11.

[67] Ref. 17.