

BETWIXT JESUIT AND ENLIGHTENMENT
HISTORIOGRAPHY:
JEAN-SYLVAIN BAILLY'S HISTORY OF INDIAN
ASTRONOMY

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ABSTRACT. — The crystallization of scientific disciplines in late eighteenth-century Europe was accompanied by the proliferation of specialist histories of science. These histories were framed as much by the imperatives of the astronomy of the times as they were by the compulsions of disciplinary differentiation. This paper attempts to contextualise the engagement with the astronomy of India in the histories of astronomy authored in the eighteenth century by the astronomer Jean-Sylvain Bailly. While Bailly's history of astronomy is not considered very highly among historians of science, the key themes that were to engage the concerns of historians of astronomy working on India for the next century were already in place in Bailly's history. The paper traces the influence of Jesuit historiography of India on the landscape of French Enlightenment historiography – and in particular on Bailly's quaint antediluvian theory of the origins of Indian astronomy. The reception of Bailly's theory of Indian astronomy is also read in context. Consequently, it is argued that in the historiography of Indian astronomy, Bailly's history marks a liminal moment before the binary dichotomies of the history of science framed the history of Oriental astronomy.

RÉSUMÉ. — **ENTRE HISTORIOGRAPHIE JÉSUITTE ET LUMIÈRES: L'HISTOIRE DE L'ASTRONOMIE INDIENNE DE JEAN-SYLVAIN BAILLY.** – Le processus de

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crystallisation des disciplines dans l'Europe de la fin du XVIII^e siècle a été accompagné d'une prolifération d'histoires spéciales des sciences. Celles-ci sont marquées tant par les impératifs des sciences de l'époque que par les contraintes de la différenciation disciplinaire. Le présent article vise à présenter la manière dont l'Inde est traitée dans l'histoire de l'astronomie écrite au XVIII^e siècle par l'astronome Jean-Sylvain Bailly. Alors que l'histoire de Bailly n'est pas très appréciée en histoire des sciences, on constatera que les principaux thèmes, qui allaient susciter au siècle suivant des recherches développées par les historiens de l'astronomie spécialistes de l'Inde, y étaient déjà en place. L'article ébauche l'influence que l'historiographie jésuite a exercée sur celle des Lumières françaises – et en particulier sur la théorie bizarre, élaborée par Bailly, des origines antédiluviennes de l'astronomie indienne. La réception de cette théorie est également étudiée dans son contexte. On peut affirmer que l'histoire de Bailly constitue une étape liminaire dans l'historiographie de l'astronomie indienne, avant que les dichotomies binaires de l'histoire des sciences n'impriment leur empreinte sur l'histoire de l'astronomie orientale.

Pour le mathématicien du XVIII^e siècle, l'histoire constitue une partie, voire un instrument, de la recherche mathématique elle-même. Cette conception de l'histoire et de sa pratique n'est pas l'apanage de Lagrange, mais elle est partagée par d'autres mathématiciens du XVIII^e siècle.

[Rashed, 1988, p. 47]

Between 1775 and 1787 two important French astronomers, Guillaume Le Gentil and Jean-Sylvain Bailly, produced a substantial corpus of writing on the history of mathematics and astronomy of India [Le Gentil 1779, 1781, 1784, 1785, 1785a], [Bailly 1775, 1777, 1787]. This paper examines the factors that shaped Jean-Sylvain Bailly's chronicle on the history of Indian astronomy. His contemporaries, some of whom considered him a charlatan and populist, frequently challenged Bailly's competence as a historian. Yet his *Traité de l'astronomie indienne et orientale* [Bailly 1787] and his *cause célèbre*, the hypothesis concerning the antediluvian origins of Indian astronomy were controversial and animated subsequent scholarship. Bailly's *Traité* was deeply appreciated and discussed among the late eighteenth-century community of British indologists. This positive appreciation of Bailly's work on Indian astronomy by the British orientalists surpassed that of the erudite Jean-Étienne Montucla's *Histoire des Mathématiques*¹ [Montucla 1799–1802], [Raina 2003]. Montucla's *Histoire*

¹ Montucla's history of mathematics is considered the first history of the mathematical sciences, inasmuch as it encompassed "all of the mathematical sciences" when compared

contained a chapter on the history of Indian mathematics, but the discussion was primarily on computational astronomy in ancient India.

The first part of this paper describes and contextualises Bailly's *Traité*. This is followed by a discussion concerning the reception of Bailly's work by the network of *Académiciens* and contemporary mathematicians in France. In order to situate Bailly's historical project, a genealogy of the history of Indian astronomy is traced. It is suggested that Bailly was indebted to Jesuit sources and to the Jesuit historiography of India. This historiography ironically shaped the Enlightenment image of India, and is the fountainhead of Bailly's antediluvian hypothesis. The *Traité* marks a turning point in the histories of Indian astronomy and mathematics compiled by practicing French savants during the Enlightenment. Bailly's work marks the transition from the ethnography of the French Jesuits in India to the historically meticulous writings of Delambre from the post-Enlightenment period.

HISTORIOGRAPHY IN THE GOLDEN AGE OF MATHEMATICS.

One of the earliest accounts of the history of Indian mathematics, a history that even by contemporary accounts is considered a major accomplishment, is to be found in Al-Biruni's tenth-century *Tarikh-i-Hind* [Sachau 1910]. However as a quasi-autonomous discipline the history of mathematics differentiated itself from mathematics and other varieties of history only in the seventeenth century [Struik 1980, cited in Grattan-Guinness 1994, p. 1666]. Montucla inaugurated the history of mathematics in France in the eighteenth century [Grattan-Guinness 1994, p. 1666]. This history was the work of mathematicians who maintained ties with the traditions that preceded them and possibly threw up research problems for their own work. Thus as Peiffer [2000, p. 3] writes: "historical practice was part of scientific practice". While underlining the antiquity of the discipline, these histories provided a legitimising context. An unstated objective may have been to benchmark their work in history.

Bailly's *Histoire* published in 1775 and the *Traité* published in 1787 were programmatic efforts directed towards the compilation of a universal

with works of a similar scale such as Delambre's *Histoire* or Cantor's *Vorlesungen* [Swerdlow 1993, pp. 301–306].

tableau of the history of the sciences. These two books served as the master narrative for historians of astronomy and mathematics writing on the history of Indian astronomy for the next three decades. In the last decades of the eighteenth century, Montucla had discredited Bailly's work. This critical strain was taken up by French astronomer-savants such as Delambre² and Biot in the first decades of the nineteenth century. The investigations of the British orientalists had by this time surpassed the questions raised by Bailly's *Histoire*. But the themes that were first articulated in that work continued to preoccupy later generations of historians. In any case, Bailly's location at this liminal moment in French history makes him and the age fascinating indeed.

Jean-Sylvain Bailly was born in Paris on 15 September, 1736, and guillotined on 12 November, 1793. The spirit of those revolutionary years brought this astronomer into the domain of public affairs, when he was "unanimously proclaimed" first mayor of Paris on 15 July, 1789. The subsequent convolutions of that revolutionary struggle, and his controversial role in the massacre of *Champ de Mars* resulted in his condemnation [Chapin 1980, p. 401]. He had received his scientific training, from "France's greatest observational astronomer" Nicolas de Lacaille,³ and its "greatest theoretical astronomer" Alexis Clairaut [Chapin 1980, p. 401]. Before the Revolution, he succeeded his father as keeper of the king's paintings at the *Louvre* in 1768, where he had previously established an astronomical observatory in 1760. Bailly went on to become a member of the *Académie des sciences* in 1763. After 1771, he turned to literary and historical pursuits that were guided by his scientific training. His four-volume history of astronomy published between 1775 and 1782 earned for him the important honour of membership in France's most important cultural and learned societies, the *Académie française* and the *Académie des inscriptions et belles-lettres* [Chapin 1980, p. 401].

A dominant feature of the historiography of science at the time was its image of the progress of scientific knowledge. The notion of progress enabled the historian to filter and discard ideas that were not causally

² For a discussion of Delambre's criticism of Bailly, see [Raina 2001].

³ Lacaille was professor of mathematics at the University of Paris, in which capacity he taught Lavoisier, Lalande and Bailly. But more importantly, the inconclusive meridional surveys undertaken during the previous century by Cassini I and by Cassini II in the eighteenth century were redone by Lacaille [Gillispie 1980, p. 113].

related to the received version of the reigning scientific theory [Laudan 1993, p. 2]. The historiography of progress facilitated boundary marking. During this early phase of the history of science, savant-historians wrote histories that appealed to scientists and promoted an image of the nature and value of science for the elite. They wrote for their scientist colleagues to persuade them of the value of their vision or of the trajectory created for their discipline.

The glorious decades of French science, it has been suggested, extended over the half-century separating the work of d'Alembert and the death of Laplace. Put another way, the half-century spanning Laplace's career was when French science was pre-eminent and Laplace was its law-giver [Gillispie 1980, p. 40]. This assertion is founded on the supposition that the exact sciences constituted the nucleus of French science. During this era French science dominated world science in a manner unmatched by any other national complex since [Pyenson 1993, p. 4]. French scientists had been the beneficiaries of the French state since the reign of Louis XIV. Hence while French Enlightenment thinkers, as Pyenson writes, "[...] warmed themselves beside state fires", the thinkers embarked on a mission to civilise the world [Pyenson 1993, p. 2–3]. In this nexus between science and state, scientific activity also served political goals. The high science of the savants had traditionally served the French elite, while the sciences associated with deductive reasoning were outside the purview of institutions of elite status and went unrecognised. French scientific learning was fragmented and produced functional and social differentiation [Shinn 1992, p. 64], a system of social selection developed "around obscure mathematics". A pattern emerged in the eighteenth century where social superiority was sought through mathematics education, and the pattern persisted into the nineteenth century [Shinn 1992, p. 64].

Depending on the disciplinary emphasis of the historian, the decades 1780–1820 could be termed either the Laplacian or the Cuvierian era. The ordering of nature, it appeared, was dictated by scientific societies such as the Royal Society in England and the *Académie des sciences* in France [Macleod 1987]. Metropolitan science drew its symbolic capital from three principal projects in the sciences that finalized a picture "determined by Europeans": 1) Geographically, the principal concern was to resolve finally all questions concerning the earth's shape and texture. 2) Astronomically,

the Newtonian picture was to be completed in order to finalize the frame of the world – the objective was the calculation of astronomical units and to determine the meter accurately. 3) Zoologically and botanically, the goal was the systematic confirmation of views of linearity, continuity and the continuous gradation of the species [Macleod 1987, p. 231].

From its very inception, the Academy had consistently supported astronomical and geodesic investigations. On the eve of the French Revolution, humanitarian and reformist sentiment suffused the corridors of the *Académie*. Science came to be emblematic of social progress. This enhanced the stature of the *Académie* and scientists associated with it in the public eye [Gillispie 1980, p. 97]. As a scientific society, the *Académie* required social legitimisation that was provided by the histories it had commissioned. The Baconian framework was one that bestowed historians with a portrait of “disinterested co-operation and theory neutrality” in science [Laudan 1993, p. 4]. This finally was institutionalised as the over-arching framework of the savant-historians.

The highlight of this era of French science was that by the end of the eighteenth century celestial mechanics reached its theoretical zenith. The finalization of this research program under the broader rubric of classical physics, contributed to the installation of mathematics and theoretical astronomy at the top of the pyramid of knowledge. This theory of knowledge propelled by the idea of the inexorable progress of human thought and human history was current among the Encyclopaedists. Models of three stages of historical development were, it appears, circulating among the thinkers of the Enlightenment or were at least present within historical narrative in the late seventeenth and eighteenth centuries. They certainly figured in Vico, and from Bailly’s own circle, Condorcet was known for thinking in triads. There were for him three stages in human history: 1) From the darkness of primitivism to the development of language; 2) From the development of language to the introduction of alphabetic writing; 3) From the classical period to the present [Bentley 1997, pp. 401–402]. Such a theory of the stages of historical development appears to have suffused Enlightenment thinking. Consequently, Condorcet emerges as an “intermediary figure between the Encyclopaedists and the positivists” [Gillispie 1980, p. 37]. For Anne-Robert-Jacques Turgot, the philosophy of history was in a reciprocal relationship

with a theory of scientific development, wherein the successive stages of scientific development were successive stages of historical development [Gillispie 1980, p. 7]. Thus Comte's three-stage analysis was preceded by Bailly's two-stage model. According to the latter model, the first stage entailed the destruction of an existing knowledge system; while the second involved the creation and adoption of a new strategy [Cohen 1985, p. 337]. This process Comte disaggregates into three stages that included the destruction of the old, a resultant state of anarchy, and the establishment of the new. Nineteenth-century positivism may thus be an outcome of the Enlightenment's historical reflection.

This was the institutional and intellectual context shaping Bailly's history of astronomy. In his history of astronomy, Bailly had proposed the thesis that the light of science and philosophy had first descended on a very ancient people, long since forgotten, and who possibly had left no traces behind. This ancient people had inhabited the Northern regions of Asia close to the 50th parallel in an antediluvian past.⁴ A knowledge of the sciences was transmitted to the Indians and the Chaldeans from this source.⁵ The antediluvian thesis may be seen as a precursor to the Aryan model, the full impact of which was only apparent in the next century.⁶

⁴ Cœurdoux had proposed more than two decades earlier that the Brahmins had descended from a people who came from the North and reached India via the Mount Caucasus [Murr 1987, p. 177].

⁵ In his eighth letter to Voltaire dated 14 September, 1776, Bailly again referred to his thesis regarding the 50th parallel, wherein the people living along this latitude were endowed with a knowledge of the sciences, whose light spread over the middle of the earth [Bailly 1777, p. 224]. This light then descended from the northern to the southern regions of Asia, these being India, China, Persia and Chaldea [Bailly 1777, p. 234].

⁶ In a more recent account of the origins of mathematics, van der Waerden suggests that the similarities in the religious and mathematical ideas prevalent in England of the Neolithic Age, Greece, India and China of the Han period indicate the existence of a common mathematical doctrine that was the fount of these ideas. Having pointed that out, he conjectures a place of common origin of this mathematical doctrine. He goes on to suggest that the Indo-European languages were perfectly connected with a decimal counting system. As a number system it constituted an ideal basis for teaching arithmetic and mathematics. Thus he conjectures that: "if we find quite similar ideas about the ritual importance of geometrical constructions in Greece and India, and the set of Pythagorean triangles with ritual applications in England and India, and the same geometrical constructions in Greece and India, the conclusion that these religious and mathematical ideas have a common Indo-European origin is highly probable" [van der Waerden 1983, pp. 33–35]. Ideas such as these prefigure in the Jesuit discourse, and the similarity with Bailly's racial theory is striking.

The second feature worth noting is that the scriptures provided a backdrop for dating and localizing the origin of scientific ideas, and subsequently the source of transmission. Bailly, discussing the antediluvian thesis with Voltaire, commences his letter dated 10 August, 1776 by clarifying that he was acquainted with India and the “light” that shone on the Indian people. But the philosophical systems encountered among the Brahmins were no different from that of the Greeks, evidence for which was amply available in antiquity⁷.

BAILLY’S SOURCES AND THE LEGACY OF JESUIT HISTORIOGRAPHY

The nature of the encounter with other civilisations in the eighteenth century was shaped by a number of motives, among them, colonisation. Equally important were the Enlightenment ambition to produce a universal history, the imperative to extend the frontiers of knowledge, and, with the rise of the new nation states, the need to define French and European identity. The enterprise of historical astronomy was never far from the minds of the eighteenth-century astronomer. With the finalization of celestial mechanics, historical astronomy went into a phase of relative decline [Han Qi 1995], [Raina 1999]. Bailly’s historical excursion into Indian astronomy commences with a remark that is reminiscent of his Persian predecessor Al-Biruni, but could as well have emanated from the less sympathetic Jesuits rebuffed by the insularity of the Brahmins. The Indians were depicted as a proud, indolent and ancient people who were unable to learn from anyone. Nonetheless, Bailly perseveres, for the study of Indian astronomy could transport us to an ancient past and enable us to observe the sky and the changing firmament through the eyes of those who observed it [Bailly 1787, p. ii]. The study of the history of astronomy was evidently relevant to the discipline of astronomy itself.

We now discuss Bailly’s sources and the Jesuit historiography of India that he inherited. This historiography was reworked into the history of science to explain the differences or absences encountered in chronicling

⁷ “De là cette foule de témoignages que l’antiquité fournit en leur faveur. Mais ces lumières étaient-elles nées aux Indes? Ont-elles pu naître également à la Chine & dans la Chaldée? Voilà une grande question qu’il ne me paraît pas impossible de résoudre” [Bailly 1777, p. 16].

the history of Indian astronomy. The sources Bailly worked with in the *Histoire* of 1775 and the *Traité* of 1787 are not substantially different. They did not include primary textual material, but were comprised of proto-ethnographic accounts of the astronomical practices prevalent in communities of astronomers in India with whom the Jesuit astronomers had been in contact in the early eighteenth century. In addition to these Jesuit reports, Bailly had access to Le Gentil's *Voyages* and *Mémoires* based on his expedition to Pondicherry and his travels in Southeast Asia.

The French Jesuits arrived on the Coromandel Coast of India as evangelists. *Pères* Tachard, Fontenay, Bouvet, Gerbillon, Le Comte and Visselou were the first French missionaries to arrive in India. As the eighteenth century commenced there were three large French missions located in southern India. Two of them – the Madurai mission founded by Nobili in 1608 and the Mysore mission that was first run by the Dominicans and later by the Franciscans – left no traces of their work. They were reestablished by the French Jesuits [Bamboate, 1933, p. 85]. The third was the Carnatic mission that commenced at Pondicherry and was founded by members of the Society of Jesus, who landed there after the Jesuits were expelled from Siam during the course of an uprising. The most notable of these Jesuits were Tachard, Mauduit⁸ and Bouchet [Bamboate 1933, p. 85]. Tachard was among the first French missionaries of the Society of Jesus to choose India as the “theatre for their apostolic work”, having been sent by Louis XIV to Siam in 1685;⁹ in 1686 he accompanied the French ambassador to Siam to meet Louis XIV and the Sovereign Pontiff. He returned to Siam in 1687, but two years later following a coup against the King and his minister, he retired to Pondicherry with other missionaries and remained there till 1693 [Bamboate 1933, p.89]. He had a reputation for making accurate astronomical observations that are contained in his diary and letters [Bamboate 1933, pp. 90–91].

Tachard and the French ambassador to Siam, M. de la Loubère visited Louis XIV in Paris in 1687, and carried with them a Sanskrit manuscript from Siam. This manuscript contained rules for the computation of the

⁸ *Père* Mauduit had successfully predicted a lunar eclipse on 23 March 1701, since he possibly had access to the Rudolphine tables and a presumably accurate knowledge of the local longitude [Sharma 1982, pp. 346–347].

⁹ For a more recent study of the French Jesuits who participated in the mission of 1685, see [Hsia 1999].

longitudes of the Sun and the Moon, and served as source material for Le Gentil and Bailly. At the time, Gian-Domenico Cassini, head of the Paris Observatory, deciphered the computational rules contained therein into the language of modern astronomy¹⁰ [Sen 1985, p. 49]. Cassini's computations were presented in the *Mémoires* of the French Royal Academy. Based on the ratio of omitted lunar days to the total number of days, that Cassini took to be 11/703, he calculated the synodic month¹¹ to be 29 days, 12 hours, 44 minutes and 2.39 seconds. Having established that 228 solar months were equivalent to 235 lunar months, Cassini showed that the Indians who had generated these astronomical rules knew about the metonic cycles¹² [Sen 1985, p. 50]. The sun underwent 800 revolutions over a computed period of 292207 days, and thereby Cassini estimated the length of the sidereal year to be 365 days, 6 hours, 12 minutes and 36 seconds. Since this figure agreed with the value obtained in the *Paulisa Siddhanta* of Varahamihira (c.505–c.558 CE), it was much later argued that these computational rules were derived from the latter text [Sen 1985, p. 50].

Père Bouchet opened up a discussion on metempsychosis and comparative philosophy [*Lettres*, 1810, vol. 12, pp. 136–193]. As a Catholic, he was naturally perplexed by the doctrine of the transmigration of the soul, and embarked on a comparative discussion of the soul in Indian, Pythagorean, Platonic and Christian literature [*Lettres*, 1810, vol. 12,

¹⁰ Three chapters of the second volume of this text entitled *Description du royaume de Siam* par M. de la Loubère [*Description*, 1714] deal with astronomy. Pages 113–149 deal with Siamese astronomical rules for calculating the motion of the sun and moon; these were decoded by Cassini, who suggests that these rules clearly suggested an Indian influence. The second chapter, a long one (pp. 150–234), is a reflection on the Indian computation rules; and is based on material obtained on *Père* Tachard's voyage to Siam. Cassini suggests that these rules could be used to fix the Siamese calendar. I am indebted to Jean-Marie Lafont for the details on this text. Lafont suggests that the texts clarify two things: first, that there existed in France an interest in Indian mathematics that pre-dated the Jesuits (evident in the mention of a French traveler named Vincent who spoke of Indians in Surat who solved the magic square) and, second, that Siam in the 1680s was at the intersection of two astronomical traditions, Chinese and Indian, and the Jesuits picked up both at that location.

¹¹ A synodic month or a lunar month is the time between successive new or full moons.

¹² A period of 235 lunar months, or about 19 years in the Julian calendar, at the end of which the phases of the moon recur in the same order and on the same days as in the preceding cycle.

pp. 145–153]. He was most preoccupied with eschatology, Indian cosmology, the theory of the beginning and the end of the world, and the Indian book of Genesis [*Lettres*, 1810, vol. 12, p. 155]. This interest persists into the secular history of astronomy produced by non-Jesuit French savants, and is possibly the signature of the eighteenth-century fascination with the origins of the universe and the commencement of human history. This exposition moves along a fluid boundary between the scriptural and the scientific, and is a secular discourse on Biblical chronology.

Chronology was not only about the unfolding of time and human history. For those nurtured in Christian doctrine, human time, like history, began after the Deluge. Consequently, the search for analogues of the Noahic Deluge figures in their reading of other scriptural traditions, as if the Deluge were a mythopoeic universal that informed our meditations on celestial time [*Lettres*, 1810, vol. 12, p. 157]. In terms of the scientific interpretation of the Bible, as the history of science moved towards becoming a secular discipline, the chronology of the Dispersion of Nations and the Deluge were to be fixed. These preoccupations were not specific to *Père* Antoine Gaubil, for whom answering these questions required the study of the history of astronomy in China [Diény 1995, p. 504]; they also concerned the Jesuits in India.

Two of three important sources for the history of astronomy in India appearing in Jean-Sylvain Bailly's *Traité de l'astronomie indienne et orientale* [Bailly 1787] were based on two texts. *Père* Patouillet sent one of them from India to the astronomer Joseph de Lisle in 1750. This was a copy of the *Pancanga Siromani*. The manuscript may have come from Masoulipatnam or Narsapur, but Bailly felt that it had come from Benaras, which has the same meridian as Narasimhapur. In any case, its provenance was questionable [Bailly 1787, p. iii], [Sen 1985, p. 50]. The manuscript of *Père* Xavier Duchamp, or the Xavier manuscript as Sen calls it, could be a copy of a treatise on Hindu astronomy authored by Duchamp, that he had mailed to Gaubil in Beijing [Bailly 1787, p. iii], [Sharma 1982, p. 348]. Duchamp's manuscripts extant at the Jesuit Archives at Vanves and the *Observatoire de Paris* [Duchamp 1733, 1734] are not Sanskrit manuscripts, but accounts of Indian astronomical practices – calculations of eclipses based on the explication of the procedure followed by Tamil astronomers at Pondicherry – that contain a glossary

of astronomical terms employed in Sanskrit and Tamil [Duchamp 1733]. Both the Patöuillet and the Duchamp manuscripts were the focus of much discussion.

Drawing upon these sources, Bailly informs his readers of the two divisions of the Indian zodiac, the one consisting of twelve equal signs, each of thirty degrees, and the other of 27 asterisms each of $13^{\circ} 20'$. The latter were designated by stars that had no relation to the twelve signs. They were seen merely as a device for calculations that generated the positions of the astral bodies in these twelve signs. The zodiac of 27 asterisms, he suggests, is the true zodiac for the Indians. This, in turn, suggested that lunar astronomy took precedence over solar astronomy [Bailly 1787, pp. iii–iv].

In his book's sixth chapter, Bailly offers a comparison of Indian astronomy with that of the Greeks in Alexandria as well as of that of neighbouring peoples. In order to establish his antediluvian hypothesis concerning the origins of Indian astronomy, Bailly first seeks to establish that the Indians had borrowed nothing from other peoples in comparative perspective. This task is undertaken sequentially through the elimination of various sources of influence, and thereby illustrates where Indian astronomy differed from the others [Bailly 1787, p. 154]. Bailly also computes the length of the sidereal year and the equation of the sun and the moon. From the Duchamp manuscript, he obtains the tables and Siddhantic rules and computes the lunar eclipse of 29 July, 1730 and the solar eclipse of July 1731; these were found to be in good agreement with the observed values. From the Patöuillet manuscript, he computes the length of the sidereal year to be 365d 6h 12m 30s, and the greatest equations of centre for the sun and moon $20^{\circ} 10' 34''$ and $5^{\circ} 2' 26''$ [Bailly 1787, pp. 155–159].

The originality and antiquity of Indian astronomy, for Bailly, resided in the accuracy and diversity of most of the methods. In addition to the sidereal year, the duration of the tropical year was 365d 5h 50m 35s, a figure that, according to the modern calculations of Lacaille, was 365d 5h 48m 59s [Bailly 1787, p. 159]. These features of Indian astronomy so enamoured Bailly that he felt the evidence was sufficient to suggest that Indian astronomy was not plagiarized. Furthermore, he agreed with Le Gentil that the finer points of their mathematical rules were evidence

of the superiority of their methods [Bailly 1787, p. 159].

Two themes of the Jesuit "*discours sur l'Inde*" reappear in Bailly's history of science albeit in a different form. These we could refer to as the trope of disfigurement and a trope of forgetting. Both are found in the eighteenth-century writing of *Père Cœurdoux*, a French Jesuit stationed in Pondicherry who wrote extensively on the traditions and customs of the Indians [Murr 1987]. The more important issue is that Cœurdoux was in touch with De Lisle in Paris until the astronomer Le Gentil arrived there in 1760; it is highly unlikely that Le Gentil was unaware of the writings of Cœurdoux [Murr 1983, p. 244]. This is not merely a conjecture when we encounter tropes of disfigurement and forgetting in Cœurdoux, Le Gentil and Bailly, although Cœurdoux and Bailly apply the tropes to different knowledge domains. Cœurdoux's formulation, it may be suggested, was the generic form of the theory that was refurbished for the history of astronomy.

I shall very briefly summarise Sylvia Murr's remarkable book on Cœurdoux's indology, drawing on those parts of the book that have an immediate bearing to the present problematic. Since the end of the eighteenth century, Jesuit astronomers in India had discussed the Indian calendar that referred to a deluge in remote antiquity. The Jesuits equated this deluge with the "universal deluge" of the Bible and struggled to establish that the Indian and Biblical deluges were not incompatible. The crucial difficulty was to accommodate ancient peoples such as the Indian and Chinese within Christian chronology, when confronted with the possibility that there could exist civilisations that predated Christian civilisation. Consequently, the Jesuits sought to arrive at the date of the Indian deluge from that mentioned in the Bible [Murr 1987, pp. 174–175]. By rendering the Indian chronology compatible with that of the Book of Genesis, the Jesuits were bridging the gulf separating the Indian and the Biblical worlds and integrating the former within Judeo-Christian historiography [Murr 1987, p. 173].

The Jesuits produced a version of the antediluvian hypothesis in order to integrate these other civilisations and their knowledge forms within Christian cosmology. Jesuits like Cœurdoux were also combating Voltaire, who argued that there never was a deluge, since classical antiquity never mentioned it [Murr 1987, p. 175]. Voltaire evoked the Chinese and the

Brahmins in order to frame the idea that all religions shared a universal core, and that the religion of the Brahmins and Chinese was purer and more reasonable than Christianity. Cœurdoux, in contradistinction, was more concerned with comprehending the passage of the Indians from true religion to idolatory. Murr [1987, p. 179] summarises his position in four evaluative judgments:

1.1. All the descendants of Noah had the same monotheist religion.

1.2. Christendom had inherited the tradition of true religion from the Jews.

1.3. The Indians were the recipients of the same heritage from Noah as were the Jews.

1.4. But contrary to the Jews, the Indians lost the true religion and tumbled into idolatory.

Within the secular discourse of the history of astronomy, this idea of a moral disfigurement, I shall argue, is reformulated as an intellectual or cognitive disfigurement. Cœurdoux's evaluative posture requires that he finally assign the responsibility for the fall of the Indians into idolatory to the Brahmins. The latter were finally held responsible for forgetting the "*belles connoissances*" that they had inherited from the Noahic people [Murr 1787, p. 181].

	<i>Trope of forgetting</i>	<i>Trope of disfigurement</i>	<i>Historiography</i>
<i>Jesuit savants</i>	The Brahmins had forgotten the original, true Noahic religion from which they had descended and fallen into idolatory	The religion of the Brahmins had been disfigured over the centuries as they had tumbled into idolatory and superstition	Jesuit historiography of India
<i>Astronomer savants of the French Enlightenment</i>	The Brahmins had forgotten the astronomical methods that had been their legacy from an ancient people	The Brahmins had disfigured the core of an ancient science that they had inherited from a people living close to the 50th parallel	Enlightenment historiography of astronomy

The historian of astronomy, Sen, remarks that Bailly believed in the antiquity of Indian astronomy, and that it was this astronomy that was

transmitted to the Chaldeans and the Greeks¹³ [Sen 1985, p. 51]. But this positive reading of Bailly arises from a literal reading of his history in as much as it accords priority to the origins of Indian astronomy. This might possibly also be one of the many reasons behind the outright rejection of his history by his astronomer colleagues in France. Present-day Indian historians of astronomy who read Bailly approvingly do so because they have ignored Bailly's exchange with Voltaire and have not closely scrutinized the racial theory disguised behind his history of antediluvian astronomy.

THE ANTEDILUVIAN ORIGINS OF INDIAN ASTRONOMY

Diderot, Voltaire and the Encyclopaedists recognized the possibility that the missionary zeal of the French Jesuits could influence their descriptions of Indian society and its knowledge forms, and their primary intention was to combat the pretension of the church to be exclusively in possession of the truth. They wished to show that there existed other revelations, that other peoples were endowed with religious sentiments of value more or less equal to that of the Christians. This interest in India was not entirely pure [Biés 1974, p. 57]. According to Biés, Voltaire, the author of *Essai sur les mœurs et l'esprit des nations*, took great pleasure in describing the civilisations of Asia that differed in all respects from Europe. India was the home of the number system, the game of chess, spices, metempsychosis, vegetarianism, and the horror of violence. Why, then, Voltaire asked rhetorically, does Europe neglect the spirit of these nations? As he declared in the *Avant-propos* of the *Essai*, the Orient was the “*berceau de tous les arts*” that were transmitted to the Occident [quoted in Biés 1974, p. 58]. The remarkable feature was that Voltaire did not see the Orient as the cradle of the sciences. His utopian

¹³ “[...] *les Indiens semblent avoir connu le véritable mouvement des étoiles dans la même précision que nous observons aujourd’hui, & de l’autre, que M. Edouard Bernard attribue aux prêtres Egyptiens la connaissance de ce véritable mouvement des fixes, c’est une raison de croire que les Chaldéens, placés entre les Indiens & les Egyptiens, ont pu avoir cette même connoissance*” [Bailly 1787, p. 271]. From here he goes on to suggest that: “*Il paroît donc que Ptolémée a eu un commerce indirect de connoissances avec l’Inde par le moyen des Chaldéens; mais on peut croire encore que les Grecs d’Alexandrie ont eu une connoissance plus particulière des observations & des méthodes indiennes*” [Bailly 1787, p. 278].

metaphorical allusions to India, however, deal with what Bloch has called an “inauthentic Utopia”, that is, one that is here and now, but at some geographical distance from Europe. The authentic Utopia is the not-yet.¹⁴ Where then was the cradle of the sciences?

The antediluvian theory about the origins of astronomical knowledge proposed by Bailly was a cultural attempt to engage with other civilizations.¹⁵ Nevertheless this attempt was located well within the coordinates of Europe and modern science. The possibility of scientifically sanctioning the scriptures through the history of science was an unviable endeavour in the eyes of Enlightenment savants such as Voltaire. For one thing, Voltaire’s God was not the God of the Judeo-Christian tradition. Two intellectual traditions were cogently reflected in the Voltairean corpus. One derived from the scientific and political writings of the English free-thinkers, and one of Voltaire’s major scientific works on the *Éléments de la philosophie de Newton* (1738) was designed to acquaint the French with Newton’s system. The other incorporated more traditional French sources “congenial to his intellect and temperament” [Redman 1979, pp. 14–15]. The *Essai sur les mœurs et l’esprit des nations* was ready in 1744, and a definitive edition appeared in 1769. In and around 1744, when the *Essai*, one of the first universal histories of man, was completed, Voltaire was appointed royal historiographer [Redman 1979, p. 22]. So strong was the influence of Newton’s system on Voltaire that he believed that history one day would be written like physics. The combined influence of Newton and Bacon focused historical investigation on the social causation of change and on the prognosis of the progress of civilisations. The latter was propelled by the belief that reason could indefinitely guide the progress of

¹⁴ For a discussion of Bloch on Utopia, see [Nowotny 1984]. In fact, the idea of the authentic Utopia as the not-yet is borrowed from Nowotny.

¹⁵ Another Enlightenment savant who proposed an antediluvian theory of the origins of science in India was Georges Cuvier (1789–1832). Laudan has tried to understand why this hard-headed scientist espoused a “decidedly odd-theory”. What is clear in his work is a coalescence of his interests in natural history, history of science and Orientalism [Laudan 1988, p. 19]. There were two theories of the origins of science and mankind circulating within this network. According to the one espoused by Cuvier, men belonged to a single species, from which followed his idea that science had a single origin. Cuvier’s single origin hypothesis was consistent with his idea that geographical and social factors, as opposed to innate intelligence, advanced or retarded the growth of science. Laudan suggests that Cuvier did not distinguish the origins of mankind from those of civilization [Laudan 1988, pp. 21–22].

the arts and sciences [Crombie 1994, III, pp. 1606–1167].

One of the raging disputes in Voltaire's day was between the so-called ancients and moderns. Voltaire offers a definition of progress: "There are [...] spheres in which the moderns are far superior to the ancients, and others, very few in number, in which we are their inferiors. It is to this that the whole dispute is reduced" [Voltaire 1979a, p. 65]. This battle between the ancients and the moderns had its historical precedent in the seventeenth century, when the crucial concern related to the method of writing history. The turning point appears to have been Benedictine Jean Mabillon's (1632–1707) *De re diplomatica* (1681) published towards the end of the seventeenth century, which provided historians with the principles of historical criticism [Peiffer 2000, p. 4]. The idea of progress had metamorphosed a key element of Christian eschatology concerning the end of the world into an open-ended future; thus the new age from ages past was envisioned as the movement towards "unending improvement"¹⁶ [Nowotny 1984, p. 3]. The certainty of the past was to be discounted for the uncertain and infinite future. The age of modernity reversed the temporality of early history wherein the "silver age" would succeed the "golden age", thereby turning skeptically to mankind's hitherto held belief that the past was better than the present [Voltaire 1979a, p. 61]. This unending improvement was reflected in the recent history of sciences, and interestingly all the advances listed by Voltaire were in the area of astronomy: the discovery of the satellites of Jupiter, the five moons and rings of Saturn, the calculated position of three thousand stars, the laws of Kepler and Newton for calculating the orbits of the heavenly bodies, the cause of the precession of the equinoxes [Voltaire 1979a, p. 63].

The new humanism, stemming from a universalist theory of history, sought to break with earlier histories that were elaborate narratives of massacres. This humanist aspiration to amend all previously written history¹⁷ is even encountered in the *Histoire des mathématiques* of Jean-

¹⁶ Condorcet's *Esquisse d'un tableau historique des progrès de l'esprit humain* propagated this image of the infinite perfectibility of society. Furthermore, it epitomised the progress of the human mind. True to the genre of Enlightenment history, the history of science was integrated within a broader cultural history.

¹⁷ Voltaire and other Enlightenment figures were prone to ignore periods of history that were "distasteful". Since the Middle Ages were considered coarse, they were sidelined in Paris [Bentley 1997, p. 401].

Étienne Montucla (1799–1802). Those ages and periods of quiet scholarly work were not as carefully recorded by history as was carnage and disaster [Voltaire 1979b, p. 547]. Previously written history was nothing more than an account of the succession of cruelties, and any revolution (here Voltaire uses the term revolution in the sense of a social upheaval) would bury the memory of these disputes and “fraudulent treatises” that were the cause of misery [Voltaire 1979b, p. 549]. The colossal weight of the memory of carnage in history impeded further progress towards a better future. The difference between cultures resided in the differential propensity that each of them had for war. Voltaire thought that the Orientals were better citizens of society, but their docility was the cause of their subsequent enslavement [Voltaire 1979b, p. 553].

The idea of a universal history needs a brief mention. Voltaire visualized his *Essai* as a sketch of a universal history that differed little from one end of the universe to the other. Peoples differed in their customs or by chance. But custom, whose dominion was immense, influenced nature, manners and usage, and hence introduced variety in the universe. Nature was the instrument for establishing unity, and culture was the source of variety [Voltaire 1979b, p. 555]. Voltaire had attempted to integrate the history of science, medicine and the technical arts into his analysis of different periods of European history. The divine hand of providence in history was replaced by the more secular comparative history of civilisations where natural causes explained the progress and decline of civilisations [Crombie 1994, III, p. 1604]. Bailly is in dialogue with the Voltairean corpus and we shall discuss his response to Voltaire as the historiographic background to his astronomy of India.

BAILLY’S RESPONSE TO VOLTAIRE’S *ESSAI*

The foregoing discussion has only summarily highlighted important elements of the Voltairean oeuvre because there is such a large body of existent scholarship on his work and context. The subsequent discussion attempts to address Bailly in his – and Voltaire’s – Enlightenment milieu and to explain how this milieu, given its internal diversity and heterogeneity, conditions the production of the former’s history of astronomy of India. Elements of this milieu can be recovered from the letters – written in the form of extended essays – Bailly addressed to Voltaire between

August 1776 and November 1776 [Bailly 1777]. The controversy was possibly provoked as a backlash. Voltaire was initially predisposed to the antediluvian thesis, but Rachel Laudan remarks that Bailly's obsessiveness finally provoked a reactive commentary from Voltaire¹⁸ [Laudan 1993, p. 11]. It could as well be conjectured that Voltaire recognised that Bailly's antediluvian hypothesis was premised on a Christian chronology, the very foundations of which Voltaire had rejected.

The theory of scientific discovery and the origins of science

Bailly's letter to Voltaire dated 13 August, 1776 [Bailly 1777, p. 41–90] addresses the stagnation of the many sciences practiced in India. Bailly's evaluative judgements of the sciences of ancient India can be summed up in two principal postulates. First, it was an appraisal informed by the epistemology of modern science. Second, it denied Indian science certification on the grounds of the closure of its cognitive horizons, a view arising from the construction of India as “the eternally unchanging”. The table below presents the two sets of appraisals concerning this knowledge form. In either case, we note that they disclose two features: the state of the evolution of science in Europe in the eighteenth century, and the fact that comparative studies were still largely based on Europe's ignorance of much of the non-European world.

<i>Epistemological reconstruction</i>	<i>Comparative conclusions</i>
The Indians assert that there are five hundred veins in the human body, but they have no idea of anatomy since dissection is prohibited amongst them.	They have no knowledge of chemistry
Their conception of botany is that of the peasants.	All their science is in the Vedas
They have been under the influence of Aristote for long.	Medical practice dating back to the early centuries of this era [Bailly 1777, p. 74].

¹⁸ In the *Traité* he writes: “*Les Indiens existent en corps de peuple depuis un grand nombre de siècles: ils en ont conservé les traditions; & ce peuple peut être regardé comme le possesseur des plus précieux restes de l'antiquité. Ces restes sont d'ailleurs aussi puis qu'ils sont antiques; car dans son indolence il possède sans acquérir, & son orgueil l'empêche de rien adopter: Il est encore aujourd'hui ce qu'ont été ses premiers auteurs qui ont tout institué*” [Bailly 1787, p. i].

This assessment of the closure of the cognitive horizons was itself the product of Bailly's ignorance of the knowledge systems of India. A substantial history of chemistry in French, taking into account the contributions of several civilisations was first published by the renowned chemist Marcelin Berthelot, and even for him the source was the work of the Indian chemist and historian of science, P.C. Ray [Berthelot 1885, 1893], [Roşu 1986], [Raina 1997]. Similarly, it was not until the 1850s that a substantial scholarly account of the history of medicine in India emerged [Liétard and Cordier 1989]. In like manner, it was not until recently that Richard Grove pointed out that the Dutch work of Henrik van Reede, *Hortus Malabaricus* published in the seventeenth century and presenting the plant classification of the Ezhavas living on the Malabar coast, was adopted by Linnaeus in 1740 to establish 240 entirely new species [Grove 1995, p. 90].¹⁹ The comparative appraisal of the sciences in the French Enlightenment, with the sole exception of the science of astronomy, rested on pillars of ignorance. The assessment itself sought to answer the question, was there a science in India in the first place? It concluded that there was a science but that it had not changed in a millennium and was in a state of disfigurement.

Could Enlightenment historiography anticipate the polygenesis of scientific ideas, or were transmission models of the period fixated with monogenetic sources of scientific development? A related issue is the underlying epistemology of science. Was science considered a cultural universal, and was this science epistemologically homologous with modern science? If this was so, then logically all other scientific systems that were distinct from modern science would be seen as disfigurements of an original template of science, the origins of which were possibly in some antediluvian past. This is one course of argumentation that may possibly lead to Bailly's question: were these enlightened people of pre-antiquity born in India, or could they have been born in China or Chaldea? In either case, he felt that the issue was difficult to resolve [Bailly 1777, p. 16]. But why does Bailly have to pose this question at all? Is there some central astronomical idea that does not fit in with the tradition of astronomy in India, or is it that the Indians were incapable of such contributions?

¹⁹ See the entire chapter on the significance of South-West India for Portuguese and Dutch constructions of tropical nature.

Bailly returns resolutely to the hypothesis that the Indians inherited an older tradition of science and astronomy that was far from perfect. This astronomical knowledge was based on observations made in the higher latitudes of Asia. He then “conjectures” that the astronomical sciences were born in these very northern latitudes, and later descended towards the equator and “enlightened” the Indians and Chinese [Bailly 1777, pp. 18–19]. The crucial question for Bailly was whether the people of India, China and Chaldea were capable of invention? [Bailly 1777, p. 20]. His antediluvian hypothesis may retrospectively be seen as an attempt to divest non-European peoples of the invention of “science”, albeit even a different kind of science.²⁰ An interesting feature is that the strategy is self-validating, for even if Bailly could have reckoned with a different kind of science, the hypothesis concerning the genealogy of Western science stood unchallenged. In order to elucidate whether these non-European peoples were capable of invention required stipulating a theory of the origins of science. This theory was a racial one, inasmuch as it evoked races as either originators or transmitters of science. The quality of the science was determined in part by the climate, as it was for Cuvier. Bailly did not accord serendipity an important role either in the origins of science or in scientific discovery or invention. While chance did play a role, Bailly felt that this possibility was remote [Bailly 1777, p. 20].

Bailly's theory of the origins of science was framed by the history of scientific discovery in Europe of the seventeenth and eighteenth centuries. There were five propositions, I argue, in this theory of the origins of science:

Proposition 1. — Scientific theories or inventions were the products of research, and without sustained efforts in research the former were not

²⁰ It was in the writings of Roger Bacon that the germ of the idea of an antediluvian theory emerges, as he turned to the recovery of a wiser past as a step “toward a happier future”. He held that the plenitude of wisdom had been revealed by God to Hebrew patriarchs and prophets, and that this wisdom had been lost in ages of sin. The developments of the twelfth century were seen as the product of the recovery of ancient texts and the discovery of their meaning. The Renaissance perspective accorded importance to the belief that ancient wisdom was to be rediscovered from texts that anticipated Christian doctrine and scientific knowledge [Crombie 1994, I, p. 26]. This, in fact, was accepted by the Jesuits as well, who embarked on a programme of discovering ancient texts. The growth of knowledge appeared to have provided a stimulus for the search for ancient models, and hence the historical division into periods extended beyond mere chronology [Crombie 1994, I, p. 27].

possible [Bailly 1777, p. 21].

At first glance, there is no allusion to race in this postulate. In fact, it is an expression of the ongoing institutionalisation that marked the growth of scientific ideas in eighteenth-century Europe. The racial aspect becomes explicit in the manner in which he qualifies the proposition. What we have called Proposition 2 appears as its corollary. The engine driving the process of invention is the uneasiness of the spirit that incites researchers into overcoming obstacles, transporting them into the world and the dominion of nature [Bailly 1777, p. 21]. Read in reverse, Bailly is evoking the European stereotype of the docile, lethargic Oriental resigned to his fate, contrasted with the dynamism of the European savant.

Proposition 2. — Scientific and artistic inventions are stimulated by uneasiness of the spirit, which in turn results in progress [Bailly 1777, p. 23].

Bailly proceeds to qualify that this uneasiness of the spirit is not detected among those who live by habit, hence the arts and sciences have not developed as much among these people. This leads to the third proposition that again follows from Proposition 2.

Proposition 3. — The languor and inertia that characterizes the ancient people obstructs the progress of the sciences among them [Bailly 1777, p. 23].

This proposition enables Bailly to pronounce upon Chinese astronomy in his day: the absence of progress in Chinese astronomy was attributable to the fact that the ancient Chinese and their counterparts shared the same character and genius. Since their genius had not evolved, neither had their astronomy [Bailly 1777, p. 23]. The stereotype of the unchanging, stagnant Oriental entered explanations and assessments of non-European science.

Ancient civilizations such as those in Chaldea, India and China were very similar [Bailly 1777, p. 91]. The Chaldeans and the Chinese had observed the night skies for millennia but had no new results to offer. A similar constancy of purpose, devoid of insight, was also observed among the Indians, whose philosophical opinions were “disfigured and degenerate” [Bailly 1777, p. 91]. This was a direct rebuff of Voltaire’s metaphorical evocation of India as a Utopia-here. Bailly evokes the heat spells that characterize the equatorial region as the cause of the indolence

of these people [Bailly 1777, p. 92]. This was the incarnate form of secular interpretation. The climatological metaphor was evoked to argue for the paucity of scientific thinking among the Indians: in the eighteenth century, the hot climate was held responsible for adversely affecting the development and maturation of scientific thought.²¹ The inability of scientific thought to develop further was to be taken as a sign that its development was arrested by a hot climate [Bailly 1777, p. 194]. This could be formalized as another proposition in Bailly's logic of scientific discovery:

Proposition 4. — A salubrious climate plays a determining role in the development of scientific ideas.

In this way, the exclusion of the non-West from the history of scientific ideas could be legitimated and explained. The climatological metaphor is extrapolated further, this time as a biotic one, to suggest a mechanism for tracing the direction of transmission of scientific ideas. Bailly suggests that an idea that has no precedent, or that lacked a genealogy, within a cultural system was possibly transplanted from a more advanced nation [Bailly 1777, p. 194]. This is the classical diffusionist theory of transmission that could be reformulated in the words of Shapin:

Proposition 5. — Knowledge flows from regions of high truth concentration to regions of low truth concentration [Shapin 1983, p. 161].

The implicit assumption was that the encounter with non-Western knowledge forms was established on the platform of the exact sciences in the era of the Enlightenment. Secondly, in the ocularcentric vision

²¹ Drawing upon the tradition of Bodin, it was Montesquieu, who proposed a climatological theory for the growth and decay of civilizations. Mobilizing both the climate and geography, Montesquieu proceeded inductively from the fall of Rome to demonstrate that physical climate affected the emotional, moral and intellectual dispositions of peoples. In this scheme, the world was intellectually and climatologically partitioned in two [Crombie 1994, III, p.1606].

	<i>Orient</i>	<i>Occident</i>
<i>Climate</i>	Hot and Torrid	Temperate
<i>Intellectual predisposition</i>	Indolent and speculatively passive	Intellectually rigorous and innovative
<i>Political orientation</i>	Despotism; and resistant to change	Free societies

of the Enlightenment²² the home of scientific truth was Europe, while the non-West was the vast continent of darkness and superstition. These propositions, either together, or in various combinations succeeded in reducing Asia to a mere depository of scientific ideas and deprived it of the modernist attribute of being inventive or innovative.

The discounting of time, as mentioned earlier, and the core dispute between the ancients and the moderns, centred on the rejection of the metaphor of the “golden age”. Bailly discussed the difference between the idea of the deluge found in the Old Testament of the Bible and that of the “golden age” in Hindu mythology. The golden age was nothing but a tableau that the imagination embellished once created. The deluge, on the other hand, was a historical fact preserved by tradition. The secular interpretation of the Bible and the search of other chronologies in order to confirm the epoch of the deluge resulted in the dismissal of the idea of a past golden age as the mythology of the ancient civilizations. As Bailly put it, progress dispelled the idea of the golden age [Bailly 1777, pp. 98–99]. The Enlightenment recruited science and the idea of natural law to develop an ideal social order; and, as this social order acquired the likeness of the natural order, it was rendered more ideal: “Utopia is the moment of maximum equivalence” [Winter 1984, p. 87]. This is the moment when there is parity between natural and social order.

Bailly’s thesis concerning the wisdom of an ancient people whose ideas diffused to various parts of the globe came to be considered a myth by his Enlightenment compatriots who much preferred centring the origins of science in ancient Greece. The quixotic Bailly quizzed the irascible Voltaire: was not the civilization from which the sciences issued the same as that of Atlantis [Bailly 1784, p.119]. Why, after three thousand years, was the same memory prevalent in Athens and Beijing: the memory of an island swallowed by the ocean, of a lost continent once inhabited by humans. The Noahic world-view that had so preoccupied French savants, astronomer-savants, and the early French Jesuits in India was now mobilised differently in composing the history of astronomy. This took the

²² Cartesian thought provided warrant to rationalist and sensationalist philosophies and encouraged speculative and empirical concepts of vision. The central Lockean idea of the mind as camera obscura, of sight as the noblest of the senses, provided the linkage between lucidity and rationality and gave the Enlightenment its name [Jay 1993, pp. 80–85].

form of legitimating a history of transmission in terms of an interpretation of Biblical chronology produced by the Jesuits after their encounter with non-Western chronologies. This inaugurated another gradual shift in the history of science proper. By the end of the eighteenth century, the pursuit of Sanskrit for the savants was no longer important because verifying the assertions of the Bible or returning to its antiquity was no longer important. The chronology proposed by Bailly ceased to be taken seriously [Biés 1974, p. 81].

Furthermore, in an anticipatory gesture, Bailly argued that not only a new politics and commerce but also a scientific revolution had illuminated all the peoples of Europe and united them in a network of communications and circulation of peoples and ideas.²³ The relations between the citizens were such that they all considered themselves Europeans, and as a result, they established an important confederation with a uniform population [Bailly 1777, p.162]. Non-Europe figured in the definition of European identity at two levels. The first, psychological, involved the projection of the darker side or the undesirable aspect of European culture onto the "Other". This aspect was labelled either Asiatic or Oriental [Ambjörnsson 1995, p. 102]. Secondly, for the Enlightenment savants, the idea of the nation was "in a paradoxical way connected to the idea of Europe [...] The gigantic Asiatic empires are not considered nations in that sense of the word" [Ambjörnsson 1995, p. 103]. In articulating the likely formation of this confederation of nations called Europe, Bailly's scientific vision converged with Enlightenment utopian thinking.

The ancient, unchanging nations had passed their youth and frittered away their genius; and though reason persisted even with the onset of age, the Indians had been reading the same book of science for almost fourteen centuries [Bailly 1777, p. 76]. This preoccupation with the knowledge of antiquity precipitated in their passage from the age of reason to that of madness [Bailly 1777, p. 77]. This state of madness was recognized in the reign of religious doctrine. And it is here that Bailly proposes theological,

²³ For a discussion of the powerful ideology of circulation in the eighteenth century, see [Williams 1993]. Bailly: "*Cependant la politique, le commerce & la lumière des sciences ont établi entre tous les peuples de l'Europe une communication très-libre. Les relations sont telles, que tous ces peuples pourraient être considérés comme un seul peuple sous le nom d'Européens: car on doit faire entrer ici une considération importante, c'est la population uniforme & partout rapprochée*" [Bailly 1777, p. 162].

linguistic and epistemological reasons for the absence of progress in the sciences in India.

He argues that for the Indians to pursue science it was essential to reject their religious doctrines. This effectively meant that the gods of the Hindu pantheon be deposed according to the precepts of monotheistic religion [Bailly 1777, p. 80], for without the pure idea of god, it would be difficult to discover scientific ideas. Fables and mythology proved inadequate to address the reality of the natural world [Bailly 1777, p. 88]. The Brahmins, Indian equivalents of the French clergy, were the repositories of religion and science [Bailly 1777, pp. 80–81]. For the sciences to advance they would have to be disempowered. Secondly, Bailly was still a few years away from the discoveries of the Orientalists, for he writes that Sanskrit was a primitive language [Bailly 1777, p. 88]. But this remark must be read in terms of the Enlightenment view of the role of the spoken vernacular as the medium of scientific instruction and its catalytic role in the development of science. Bailly sees Sanskrit as a rich language that was reserved for a few and in which the treasures of philosophy and science were expressed. The argument then reverts to his critique of the Brahmins as throttling the growth and spread of scientific ideas. The third point re-emphasises the epistemological appraisal: any theory about physical reality must be founded on experience and reason, the two central elements of Enlightenment epistemology.

But the representation of the Orient as constant, unchanging, passive, degenerate and disfigured in contrast to a Europe that was changing, dynamic, progressive and authentic framed the European reading of the past. In this age of Enlightenment, two diverse systems of thought simultaneously sprang forth, that of modern science and that of modern utopia. Both were optimistic and progressive and intimately shaped each other [Davis 1994, p. 21]. As with Voltaire and the Encyclopaedists, the Orient became a point of contrast to reaffirm European identity. The past was rewritten, as Fuller writes, as “an anticipation of the present” state of Europe that had witnessed the rise of science [Fuller 1997, p. 95]. Thus, any excursion in the history of the past should have finally led to Enlightenment Europe.

The Chronology of Oriental Astronomy

As a trained astronomer writing on the history of astronomy, Bailly

was on more solid ground than in his reflections about civilisations and pre-history. The astronomical knowledge of India, however limited in its own time, gave cause for wonderment, and supported Bailly's conviction that the sciences and above all astronomy was the common object of research among all peoples [Bailly 1777, p. 134]. The discursive pattern of his presentation indicates that the encounter with the Other is such that the object revealed is the Selfsame [Young 1990, p. 2]. The Orient is collapsed into one category, since the nations comprising it have made the same progress in astronomy [Bailly 1777, p. 135]. The revolutions of the sun and the moon were divided into twelve months or moons, and the zodiac divided into twelve equal portions [Bailly 1777, p. 138]. Bailly was indeed surprised to find that the zodiac divided into twelve equal portions or that 28 lunar mansions were found among the peoples of Asia as well as among the Egyptians, the Egyptians and Chinese being separated by a distance of 3000 leagues. Further, all these people had a week consisting of seven days; and the Chinese, Indians and Egyptians named the days of the week after the planets that appeared in some arbitrary order. Such agreements in ideas and concepts across time and space could not have been the product of chance [Bailly 1777, p. 151]. But this is not sufficient for Bailly to infer an influence. Influence can only be inferred if these different astronomical measurements bear an exact and determined relationship between themselves. In other words, an astronomical measure in one astronomical system must be some multiple of a unit measure in another astronomical system. This unit measure was the grand cubit preserved at Cairo, and the issue to be settled was how this was communicated to several regions of the globe [Bailly 1777, pp. 149–151].

The historical record revealed traces of astronomy practiced in Asia about 3000 years before the Christian era. Bailly concluded that the astronomical tables he possessed from India belonged to the epoch²⁴ 3102 BC.

²⁴ Underlying this interest in chronology were also some of the leftover concerns of historical astronomy. Bailly argues that if the Indian epoch commencing 3102 is real, and the longitudes on which this calculation is based is admitted, then these numbers could be used to verify the mean motion and confirm the results of our theories. However, he goes on that if the epoch of 3102 is fixed astronomically, this would be "*d'une grande utilité pour éclaircir la chronologie des Indes en particulier, & en général celle de l'Asie*" [Bailly 1787, p. 306].

But these tables were neither of Indian nor of Asian origin. Some people foreign to the Indians, Chinese and Persians clarified the astronomical tables for these Asian peoples at this time [Bailly 1777, p. 200]. He harks back to his quaint theory of these lost enlightened and ancient people, who, he clarifies though possibly similar to those of Europe, were comprised of many nations and languages [Bailly 1777, p. 201]. The signature of these people is seen in Asian nations that, in the present age, offered nothing but the debris of a forgotten astronomy, a physics that had degenerated to fable, a philosophy surrounded in absurdity. Most importantly, their inventions were everywhere characterised by an absence of progress [Bailly 1777, p. 204]. This constancy was manifest in their cyclical theory of time: the present generation was merely the reflection of the past generation. This construction of a timeless people draws Bailly sarcastically to deflect Voltaire's pugnacious onslaught on Europe's celebration of itself. He concludes one of his letters to Voltaire with the remark that "*vos amis*", your friends, the Indians were merely the inheritors of the intellectual legacy of a more powerful and enlightened nation [Bailly 1777, p. 204].

Bailly's theory of the origins of science along the 50th parallel appears, in our own time, as one of the origin myths of science, particularly during an age when science was seeking its own origin myths for legitimisation within the space both of religion and the secular nation. The fact that these ideas were dismissed as quaint in their own time indicates that they did not measure up to the theory of history proposed by members of the circle of the Enlightenment. Interestingly, each of these theories about history and society were presented, argued and validated differently. Furthermore, this was a way of doing boundary work as well; it involved acquiring authority for the map proposed by linking it with the cartographic efforts of earlier authorities [Gieryn 1994, p. 431].

In order to accord his theory the status of scientificity, Bailly, within his circle of secular savants, introduces elements of Buffon's work in the area of geology. A theory from another scientific discipline is enlisted in order to endow the claims with a measure of authority. The underlying theory of transmission was that the movement of knowledge in pre-antiquity was associated with the movement of people. What prompted these ancient and enlightened people to migrate? Bailly suggests that the "*refroidissement du globe*", or the cooling of the earth with the onset of

the last glaciation forced the migration of these people to the southern regions of the earth. A scientific theory is called upon to authorise a historical thesis. Two more letters to Voltaire are devoted to a review of the geological theory of the cooling of the earth. This shifts the very criteria for refuting his theory. The theory could not have been refuted solely by the new criteria he had proposed. Bailly concludes his letters by prodding Voltaire that the former spoke in the name of truth. He thereby sought to justify his theory in a rhetorical manner as if Buffon the geologist, in person, were in dialogue with an Indian philosopher²⁵ [Bailly 1777, p. 345]. There was not a better metaphor to deceive the philosopher pre-occupied with Europe's Other, even though the Other was conceived in the image of the Selfsame. But Buffon was also important for Bailly because Buffon's theory of the cooling of the earth fixed an age of the earth that was orders of magnitude different from that of Biblical chronology, but that coincided purely in orders of magnitude with that of Hindu chronology. This was then another position from which to argue for his antediluvian theory.

The specific contributions of Chinese and Indian astronomers were to be interpreted in terms of this historiography. The Chinese were aware of the inequalities in the motion of the sun and the moon, the duration of revolution, the slow motion of stars along the ecliptic. But this knowledge of the Chinese astronomers and instrument makers was insulated from the populace and lost to subsequent generations, who, in turn, could not profit from the progress of knowledge [Bailly 1777, p. 30]. For similar reasons, Bailly concludes that the Brahmins, who were the repositories of astronomical knowledge in India, carried this knowledge and a language with them to India. They were not the inventors of this knowledge, but were considered superior within their societies on account of it [Bailly 1777, p. 89]. As discussed earlier, the Jesuits, Le Gentil, and the French colonialists had adopted an adversarial position towards the Brahmins in their accounts. The Christian evangelists felt that the Brahmins arrested the spread of the Christian faith. The savants inherited the missionary critique but for different reasons. If they were worthy of any praise, it was on account of the knowledge of astronomy that had been deposited with

²⁵ Bailly's candidacy to the *Académie des inscriptions et belles-lettres* has been widely attributed to his "shameless flattery of Buffon" [Gillispie 1980, p. 102].

them over the centuries, and that had now become available to the West. In an incipient form, this was another device for divesting non-European civilisations of their creative histories. It involved labelling a civilisation as a depository rather than as an innovator of knowledge. This is precisely the manner in which the history of science of the Arab-speaking world was drafted in the second half of the nineteenth century and possibly even earlier [Montgomery 2000].

Situating Bailly's Histoire

Bailly's literary and historical career commenced when he was almost forty and living at his father's house in Chaillot. Between 1775 and 1782, he wrote his four-volume history of astronomy and, in so doing, revised many of the opinions he had expressed in his polemic with Voltaire.²⁶ Voltaire's oeuvre approaches science as just one constitutive element in the history of culture. This genre of writing became marginal in the nineteenth century and was resurrected in the twentieth century [Cohen 1994, p. 24]. The sciences and the *belles lettres*, in this scheme, were allies and could not be separated at the base, for it was "*les lettres qui ont donné aux sciences l'éclat dont elles brillent aujourd'hui. Sans les sciences la nation la plus lettrée deviendrait faible et bientôt esclave; sans les lettres la nation la plus savante retomberait dans la barbarie*" [Biot 1803, p. 77].

Bernard Cohen suggests that Bailly and Montucla were among the inaugurators of the discourse on scientific revolutions. The researches of Copernicus and Newton, according to Bailly, were the two exemplars of the Scientific Revolution. Copernicus, for one, had undermined the authority of the older system and established a better system in its place [Cohen 1985, p. 495]. The political metaphor is evident in his suggestion that it was Copernicus' seditious mind that had dethroned Ptolemy. Similarly, the key in Newton's hands unlocked the secrets of the skies

²⁶ Bailly's metamorphosis of Le Gentil's ethnography into history could also be seen as a programme driven by two external imperatives. On the one hand, history as discourse was to mark the progress from the interpretive flexibility of ethnography to the certainty of Cartesian discourse. On the other hand, the institutionalisation of science and the emergence of disciplinary identities required specialised histories, and Bailly's was one of them. However, it was a history that was to be of general appeal as well, for he reminded Voltaire that the latter could not ignore the history of sciences, if he was interested in the diversity of ancient and modern history. This history of the progress of the mind was littered with obstacles and impediments that were overcome with courage and industry [Crombie 1994, III, p. 1600].

through mathematics or, to be more precise, geometry [Cohen 1985, p. 170].

Bailly proposed a two-stage theory of revolutions. Existing systems and concepts are destroyed in the first stage, and in the second stage the new system is established. This incorporates both the older concept of cyclical revolutionary change and the newer notion of revolutionary change as a gestalt switch [Cohen 1985, p. 222]. Within this framework, Bailly reasons that neither Galileo nor Kepler set up a revolution. The sublime idea of reducing the laws of celestial motion to those of the motion of terrestrial bodies is a modern one, the credit for which should go to Descartes²⁷ [Cohen 1985, p. 222]. This is subsequently employed in his investigations in the history of astronomy in India and the non-West. The concept of the Scientific Revolution situated eighteenth-century science with reference to the science that went before it, including that of the non-West. In a generic sense, the term “scientific revolution” connoted the idea that “scientific discovery generally proceeds in a convulsive sort of way” [Bailly, 1777, p. 21]. “Scientific Revolution” when used in a specific sense, however, connoted a “historical idea about one episode in the past of science” [Bailly 1777, p. 21]. The history of science during this period was integrated as one element of a broader cultural history. The ebb and flow of astronomical science followed the rise and fall of civilisations. Bailly saw the astronomy of the Chaldeans, Indians and Chinese as the debris of a science of an older civilisation, the greater part of which was lost: “They were destroyed by a great revolution [...] which destroyed the men, the towns, the knowledge, and left only debris. Everything concurs in proving

²⁷ The remark possibly betrays a strain of pre-Duhemian nationalism in the history of science. While Duhem’s philosophy of science rejects tenets of inductivism, his nationalism was a more complex issue. He was a Roman Catholic and sought to combine Aristotelianism with commitment to science. His key contribution to the history of science, was his demonstration that a thinker’s ideas may be indebted to those of a previous opponent. When turned around on Duhem, it is only nationalism that could explain his refusal to acknowledge his debt to Whewell [Agassi 1963, pp. 31–32]. This raises a rather interesting problem concerning the universality of science. Both Duhem and Voltaire contrasted the different cognitive predispositions of the British and French minds. This issue of the distinctiveness of the two mathematical styles prompted Rouse Ball to suggest much later that it could be possible to write a history of the influence of race in the selection of mathematical theories in the eighteenth and nineteenth centuries [Richards 1991, pp. 297–298]. Thus to propose that Bailly had a racial theory of the origins of science is not too farfetched.

that this revolution took place on the earth” [Bailly, quoted in Cohen 1985, p. 223]. The idea of convulsive and periodic change extends both a political metaphor and one of geological cataclysmic change.

At this liminal juncture, Bailly’s views were themselves changing rather rapidly. The *Histoire* reveals a Bailly whose views differ, although not radically, from those of the Bailly engaged in a polemic with Voltaire. True to the vision of Montucla and Voltaire, Bailly was committed to the project of writing the history of science for science. This history did not have to do “with mankind’s slaughtering sprees, but of its steady progress [...] in invention and discovery, marked above all by the mathematical sciences with their built-in-certainty” [Cohen 1985, p. 23]. The history of science informed us that Newton had brought about revolutionary change by milder and fairer means than those employed by those who usurped thrones in Asia. These usurpers wished to wipe the slate of history clean, so that all future history would begin with them [Cohen 1985, p. 474]. The reader, today, is struck by the irony of Bailly’s remarks as well as by the age’s blindness to what was gradually and slowly being unleashed in Asia. This lack of reflexivity could be imputed to the self-confidence of the Enlightenment; it had embarked on a civilizing mission as much in Europe as in Asia.

The first volume of Bailly’s work on the history of ancient astronomy appeared in 1775 and covered the history of astronomy from its origins, almost in antiquity, to the school of Alexandria [Bailly 1775]. At the very outset, Bailly makes clear that his interest in the history of astronomy is more or less ordained by contemporary concerns. This utilitarian exigency is reflected in the agenda for the history of astronomy and may be schematised as follows:

<i>Function (of astronomy)</i>	<i>Justification</i>
Confronting superstition	Enlightenment
Opposing astrology	Catholicism
Informing agriculture and the preparation of the calendar	Utilitarianism
Informing chronology	Validation of the Bible
Informing geography and navigation	Exploration

The first column in the table summarizes the reasons proposed by Bailly for pursuing investigations in astronomy [Bailly 1775, pp. xi–xii]. The second proposes a context for Bailly's justification. While the overriding secular considerations are attributable to the rise and spread of Enlightenment thought, the gradual stabilisation of a utilitarian mentality as the new age of capital was beginning to announce itself as well as the rise of colonialism provided the impetus for this expansion of knowledge. On the other hand, Catholicism and the church also had a secular interest in the sciences for reasons both scriptural and doctrinal.

Bailly's book opens with an account of the inventors of astronomy, and the antiquity of the discipline. Ancient civilizations like the Indian, Chinese, Chaldean, and Egyptian had studied the skies, and this astronomical knowledge was passed on from one generation to the next, from one people to the other. They thus must be counted among the inventors of science [Bailly 1775, pp. 3–4]. Furthermore, the West's indebtedness cannot be overlooked for it is from the Egyptians and Phoenicians that the Greeks acquired their arts, sciences and Gods [Bailly 1775, p. 7]. Even toward the end of the eighteenth century, spaces existed that were relatively wanting in continental essentialism. The phase is then the transient historiographic zone between the reign of the ancient Greek model and its substitution by the Aryan model [Bernal 1987]. Within the framework of the convulsive growth of scientific ideas, Bailly proffers a Noahic theory of the lost people of Atlantis, citing Plato as the source of these advanced scientific ideas. But the theory was still Eurocentric: the Egyptians were dislodged from the centre of the universe of scientific ideas, for it was argued that the lost people of Atlantis predated the Egyptians [Bailly 1775, p. 7].

Two historiographic propositions enabled Bailly to construct these connections:

Proposition 1a. — Knowledge embedded in the ancient traditions should be systematically collected, and each of the constituent elements of one should be weighed and clarified with the corresponding elements of the other.

The comparative method is reflected here, but the proposition fails to specify how corresponding elements from different knowledge systems were to be identified. This inability permits a great deal of latitude in interpretation and an arbitrariness that allows the historian or analyst to

push his or her pet version through the interstices of uncertainty.

Proposition 2a. — In order to arrive at the origins of astronomy, dates are to be assigned and validated.

These are to be compared with the state of development of a civilisation, and the genius of a people before the merit of invention is awarded to them [Bailly 1775, p. 3]. The first part of this proposition bears directly upon empirical historical method, while the second part again allows for a degree of arbitrariness, in that it could easily self-validate the history of Western civilisation. In fact, it is obvious how this proposition structures the historical reading of the astronomy of the non-West. By allowing the astronomer the interpretive flexibility to assess the state of genius of a people, the historian intervenes in divesting the civilisation and situating the origins elsewhere.

Furthermore, an examination of the science of the Indians, Chaldeans, and Chinese would unveil the debris of a science rather than the elements of one.

Proposition 3a. — The astronomy of the Indians, Chinese and Chaldeans incorporate sufficiently exact methods for calculating eclipses, but these sciences are blind for they lack any theoretical foundation, methods or a theory of the cause of phenomena [Bailly 1775, p. 18].

Bailly's reading suggests that these knowledge systems are essentially of an instrumental nature, comprising elements that are known with a sufficient degree of specificity, while the more essential were apprehended simply within their framework of knowledge. Other elements were either entirely unknown or grossly determined, and these were followed by a series of astronomical observations that, over the centuries, had neither utility nor results to offer [Bailly 1775, p. 18]. We could remark that most of the elements in the discursive distinction drawn between modern and Oriental science were available in an incipient form by the end of the eighteenth century.

Bailly's history transforms Le Gentil's ethnographic accounts from India, while keeping the latter's aperçus concerning the computational nature of Indian astronomy and the absence of a formal deductive theory. Furthermore, it posits a conceptual relationship between invention and progress in the sciences. Progress is not just a consequence of invention but also a sign of inventiveness. The Indians and other ancient peoples

were inheritors of an ancient wisdom that was destroyed “by a great revolution”. Despite this major discontinuity with the past, computational methods were dispersed by individuals, whose vague and confused notions derived from the attempt to construct a knowledge oriented to certain end-uses rather than one preoccupied with first principles [Bailly 1775, p. 19].

THE RECEPTION OF BAILLY'S HISTORY

How was Bailly's work received in his own time? On this front, it would be interesting to explore the impact of Bailly's work on two prominent intellectuals of the French Enlightenment, Pierre-Simon Laplace and Étienne Montucla. Laplace was a mathematician and theoretical physicist, whose persona was emblematic of the revolutionary times and the epitome of a phase in the history of physics that would also come to an end with his unprecedented contributions. Montucla was a contemporary historian of mathematics, and it would be an engaging task to compare his contributions with those of Bailly.

Montucla's Specialist History of Mathematics

Montucla with Bailly could be counted among the pioneers of the specialist histories that appeared in France in the eighteenth century.²⁸ Like Fontenelle and the Encyclopaedists before him, Montucla had a conception of the history of science premised on Baconian inductivism. This meant chronicling the development of the human mind and the different branches of knowledge as well as contributing to the progress of science itself, since historical knowledge of discoveries and facts directs contemporary work and avoids retracing paths that have already been traversed. This was the kind of mathematical history Montucla set out to produce [Crombie 1994 , III, p. 1599–1600].

And yet we must venture three possible reasons why Montucla's *Histoire des Mathématiques* is not so extensively discussed when it comes to the history of astronomy and mathematics in India. While Montucla

²⁸ Montucla's *Histoire* was received by his contemporaries with accolades. Addressing its success, Laudan points out that it drew upon two intellectual traditions. 1) Montucla inherited a tradition of history of science, and the available secondary literature helped him clear a lot of ground. 2) He organised his mathematical narrative to conform to the vision of science as mathematical and progressive then current in France [Laudan 1993, p. 6].

(1725–1799) himself occupied the post of the royal astronomer for some time, Montucla was the first of the group who started off as a historian of mathematics. He was also part of a literary circle that included D'Alembert, Diderot and Lalande [Vogel 1980, p. 500]. But Le Gentil, Bailly, Laplace, Delambre and Biot were the principal actors and initiators of a discourse on the astronomy and mathematics of the Orient. They were bound together by their profession as practicing astronomers, their membership in the *Académie des sciences* and the expeditions they either headed or undertook with the *Bureau des longitudes*.

In short, they belonged to an invisible college, and although Montucla was by far the more rigorous historian when compared to Bailly, it was Bailly whose history was discussed more seriously in this circle. Bailly's history was also more provocative and challenged some of the founding precepts concerning the central place of European identity, albeit in a fashion that continued to deny the ancient civilisations of the Orient any privileged place in the world of science. This provocative thesis captivated his audience, and controversy surrounded his work for at least three decades. Finally, Le Gentil, Bailly, and after them Delambre, Biot, Chasles and Sédillot wrote extensively about the history of mathematics and astronomy of India, whereas Montucla had one small chapter on this topic in his history of mathematics.

The reception of Montucla's work on India was thus dependent on the volume of his output on India and not on the rigor of the work under consideration. This was possibly the primary consideration in Montucla's absence in the polemic. All the others, with the exception of Laplace, had authored at least one book on the subject of the history of astronomy of India. In biographical terms, however, there was a point wherein the lives of Montucla and Bailly intersected. Prior to the French Revolution both had occupied high office in the French state. Until the Reign of Terror began, Bailly benefited following the Revolution. While Bailly later paid with his life, Montucla lost his position and his wealth [Vogel 1980, p. 500]. It was during these years that he commenced revising the *Histoire*. The first edition had appeared in 1752, when Le Gentil's work was not yet available. The first two volumes of the second edition were published in 1799, and Montucla draws upon Le Gentil's *Mémoires*. The third and fourth volumes were completed by Jérôme Lalande and Silvestre Lacroix

between 1799 and 1802. This encyclopaedic work elaborates upon mixed mathematics, since the differentiation between physics and mathematics was not realised when he began work on the first edition. Separate chapters were devoted to the ancient mathematicians, and he relied on Latin sources for his exposition of Arabic mathematics [Grattan-Guinness, cited in Peiffer 2000, p. 9].

For Montucla, mathematics was an empirical discipline and mathematical progress was catalysed by the application of the faculty of reason to the phenomena of the natural world [Laudan 1993, p. 6]. The Enlightenment history of the arts and sciences drew upon oriental studies and the comparative cultural study of civilisations. These were in turn underpinned by the ideal of inductivist science [Peiffer 2000, p. 1]. Montucla's chapter on India,²⁹ presumably revised or written for the first time in the years just after the French Revolution, departs from the ambivalence that marked the century that was just coming to a close. Montucla commences by challenging the belief that India was the first cradle of the human species and the source of ideas on the sciences and the arts, in particular [Montucla 1799, p. 423]. In the absence of any textual evidence, and on the basis of a few fragmentary inscriptions, it was impossible to determine when and from where this science penetrated into India. The proto-ethnographic accounts of Le Gentil and the impressionistic history of Bailly, embellished by mysticism, was not enough to infer that astronomy reached India from a more ancient people. He rejects en route the ideas of "*quelques savans célèbres*" [Montucla 1799, p. 424], an oblique reference to Bailly's antediluvian origins of astronomy and its advent in India. This interpretative difference cannot be ascribed to the rivalry between the two historians. In a sense, however, it is prompted by their different semantic and methodological approaches to history. Bailly was transforming the proto-ethnographic accounts of the astronomical practices of India as history. Montucla was preoccupied with the textual grounds for ascribing a date to the origin of a tradition or a theory. Some of the astronomical tables sent from India at the time were based on the conjunctions of stars that dated back to the 9th century AD. Hence was it not likely that the Indians

²⁹ Montucla's sources were not radically different from those of our interlocutors. They were those of Bailly, which included the writings of Le Gentil, the letters of the Jesuits, Pons, Boudier, Gabelsperger and Strohl on the Jaipur expedition, Anquetil Duperron on the chronology of the Hindus and Tiffenthaler on the geography of India.

had received their astronomy from the Arabs, who, in turn, had received it from the Greeks? Since the extent of the exchange between the Indian and Greek worlds before Christendom and the medieval Arab contacts were not definitely known in the eighteenth century, the Arabs were seen as the vectors of Greek knowledge. The French Orientalist de Guignes did the groundwork to establish the relationship between the Greeks and the Mauryan Empire in 1772. This provided information for the first time on ancient India's chronology [Pouchepadass 1991, p. 52]. It appears that neither Montucla nor Bailly were aware of this work.

Montucla, like Le Gentil, was confronted by the difference of Oriental knowledge, recognizing that the astronomical practices and methods employed were ingenuous and easy to employ. These methods were transmitted by a small number of adepts through an oral tradition. How could the Indians have invented them at all? Montucla faced a methodological dilemma, for he had commenced his career in the history of mathematics with a history of the quadrature problem [Vogel 1980, p. 500]. The dilemma could be phrased as follows: how was this knowledge tradition to be transcribed in historical terms. Since he found it difficult to adopt a middle position between the antediluvian and the Indian origins of astronomy, he left it to the reader to decide on the basis of evidence offered³⁰ [Montucla 1799, p. 424].

This is not the place to go into a detailed discussion of Montucla's chapter on the "*Histoire des Mathématiques chez les Indiens*". The crucial discussion of Montucla's account relates to the chronology of the Indians, their yugams, the origins of this chronology, the origins of the zodiac, the likelihood that the Indians invented an astronomical tradition. The Noahic deluge serves as a border demarcating antiquity from the ancient world. The other priority disputes relating to the invention of zero, the place-value system, and the representation of numbers did not appear in this account. In fact, they were not very important in France in

³⁰ In our own times, historical discourse has been fractured by the polemic of the internal and external. Historian of mathematics, Joan Richards, posits that the creative history of mathematics "lies on the fractal boundary between internalism and externalism". She sees in Montucla's *Histoire* the exemplar for a possible transcendence of this dichotomy, since for Montucla and his times the history of mathematics was the history of human intelligence. The difficulty is that this exemplar would have to be divested of the eighteenth-century definition of the "human and rational guiding of our understanding" [Richards 1995, pp. 134–135].

the eighteenth century.

The history of astronomy in Laplace's Exposition

“C'est dans l'Exposition du Système du monde que les personnes étrangères aux mathématiques puiseront une idée exacte et suffisante de l'esprit des méthodes auxquelles l'astronomie physique est redevable de ses étonnants progrès. Cet ouvrage, écrit avec une simplicité, une exquise propriété d'expression, une correction scrupuleuse, est terminé par un abrégé de l'histoire de l'astronomie, classé aujourd'hui, d'un sentiment unanime, parmi les beaux monuments de la langue française. On a souvent exprimé le regret que César, dans ses immortels Commentaires, se soit borné à raconter ses propres campagnes: les commentaires astronomiques de Laplace remontent jusqu'à l'origine des sociétés” [Arago 1855, p. 512] (emphasis added)

The Laplacian finalization of the Newtonian system announced more or less the end of an age of physics. In the discussion of the inequalities of planetary motion or the theory of chance, Laplace brought to the discipline a richness of mathematical insight and epistemological nuance. The differentiation between a deterministic view of nature and a probabilistic view of knowledge revealed the incompleteness of knowledge [Gillispie 1980, p. 43]. The issue of concern here is Laplace's philosophy of history. During the Ancien Régime, astronomers and orientalists collaborated, but this was formally promoted during the Napoleonic era, in particular after the Egyptian campaign. The Académie des Sciences constituted a committee that included Delambre and Laplace, among others, to oversee the translation of a work of the tenth-century Arabic astronomer Ibn Yunus [Peiffer 2000, p. 15]. There was a feeling within the Bureau des Longitudes that it would benefit by drawing upon the astronomical knowledge of the Persians and Arabs. Consequently, an assistantship was created in the history of Oriental astronomy, the first of which was awarded to Jean-Jacques Sédillot (1777–1832), father of Louis-Amélie Sédillot (1808–1875). The translations produced by the elder Sédillot were reflected in Laplace's *Exposition* and Delambre's *Histoire*. Peiffer suggests that this rather weak brand of Orientalism of the two Sédillots went too far. Consequently, Laplace or Delambre and the others found it simpler to oppose their findings [Peiffer 2000, p. 15].

The fifth book of Laplace's magnum opus *Exposition du système du monde* contains a brief summary of the history of astronomy [Laplace 1813]. The book lays out a genealogy for celestial mechanics from antiquity to the theory of gravitation. There is a section covering the history of

ancient astronomy from antiquity to the foundation of the school of Alexandria [Laplace 1813, p. 560]. This is more or less the way Bailly had framed his history of astronomy—there is a concordance between the title of Bailly’s book and the title of the chapter in Laplace [Bailly 1775]. This is followed by a discussion of the schools of astronomy in the Arab-speaking world [Laplace 1813, p. 572]. The third chapter covers the evolution of astronomy from Ptolemy to its renewal in Europe [Laplace 1813, p. 586]. The book closes with a discussion of astronomy in modern Europe and the discovery of universal gravitation.

The perfected state of astronomy discussed by Laplace did not descend overnight from the skies. It was realised through the comparison and deduction of the laws of celestial motion and the causes of their inequalities obtained in turn from the ensemble of ancient and modern observations. The two pillars of this science were mechanics and analysis, but both of these branches were perfected with astronomy. The state of development of mechanics and analysis necessarily influenced astronomical theories [Laplace 1813, p. 558]. The search for this perfected state of astronomy could be attained through the incorporation of an extensive array of astronomical data: this was partially provided through the efforts in historical astronomy. Laplace computed that the Indian value of the apparent and mean annual motion of Saturn $12^{\circ} 13' 13''$ at the beginning of the *kali yuga*—that Bailly had dated as 3102 BC—closely agreed with the value determined by modern methods— $12^{\circ} 13' 14''$ [Laplace 1787, p. 80]. This concordance may be visualized as some sort of double validation. In the first instance, it endowed the modern observation with an aura of certitude. But since it was the past that was to be discounted with respect to the present, the modern observation validated the correctness of the computational rule of the past. It was the correctness of such computational rules that had enchanted Le Gentil, and later Bailly. This explains the need to invent an ancient people who were repositories of wisdom later transmitted to the Indians, who in turn transmitted it to the Chaldeans and Greeks. Unwittingly, though it may appear, Laplace validated Bailly’s chronology and thus provided legitimacy to the Christian/Biblical chronology.

Laplace proposed a cyclical evolution of astronomy. For many centuries

astronomy had been in a quiescent state, and then it erupted in the school of Alexandria (first revolution). This was followed by another stationary period until Arabic science emerged and their works perfected the discipline. Astronomy abandoned its home in Africa and India where it was born and came to be established in Europe. Over the next three centuries, it reached the height it had attained by the end of the eighteenth century [Laplace 1813, p. 559]. The theory of scientific revolutions, as elaborated by Bailly and Montucla, provided Laplace a grid on which to plot the “*progrès de la plus sublime des sciences naturelles*”, a science that was constantly growing even amid revolutions that befell empires [Laplace 1813, p. 559]. This cyclical and convulsive evolution of astronomy progressed towards celestial mechanics.

Furthermore, he accepts a number of insights of Bailly and differs from him on many counts. But his appreciation of the history of the discipline is related, as it is in the case of most scientists' history, to his own project in the sciences. Astronomy does not consist in merely making gross observations about the seasons and the rising and setting of stars; it is the search for the laws of motion of celestial bodies. The object of investigation of ancient astronomy could be the motion of the moon, its phases and eclipses, knowledge of the planets and the duration of their revolutions, the sphericity of the earth and its measurement [Laplace 1813, p. 360]. The geodetic activity of the astronomers for Laplace no longer belonged to the domain of the new astronomy.

Returning to the metaphor of political upheavals, Laplace argues that the origins of astronomy in India and Persia have been lost during the gloomy periods of their history. The Indian tables suggested that Indian astronomy was sufficiently advanced, but it was not very ancient. He elaborated upon the opinion of his dear and unfortunate friend, Bailly, a victim, he says, of the inconstant memory of the masses whose idol he once was [Laplace 1813, pp. 566–567]. Bailly had suggested from a scrutiny of the Indian tables that there were two Indian epochs, one that commenced in 3102 BC and another in 1491 AD. These tables were linked with the motion of the sun, moon and the planets. Bailly had sought to establish that the first of these epochs was obtained from observations. However, Laplace was of the opinion that Bailly had imagined it in order to inscribe within the zodiac a common origin for the movement of the

celestial bodies. Further, by comparing the theory with a large number of observations, the astronomical tables were considerably perfected. This examination also revealed that there was no conjunction of the stars as admitted in the Indian tables. In fact, some of the elements of Indian astronomy lacked the grandeur that Bailly had assigned it [Laplace 1813, p. 567].

In Indian astronomy, the annual equation of the moon is added to the equation of the centre of the sun. Many of the elements, such as the equations of the centre of Jupiter and Mars, were very different in the Indian tables. Laplace inferred that, from the collection of tables, it was evident that the general conjunction of the planets at the beginning of the *kali-yuga* was an impossibility, which proved that they were constructed or at least modified in the recent past [Laplace 1813, p. 367]. Laplace, applying the “theory of disturbing forces”, was able to converge upon the conclusion that the tables belonged to a period 3000 years before the Christian era. This discovery, Playfair³¹ points out, required “the perfection to which astronomy is, at this day brought in Europe, but all that which the sciences of motion and of extension have likewise attained” [Playfair 1790, pp. 170–175]. In other words, Laplace was evaluating the antiquity of Indian astronomy and deciphering its computational rules from the standpoint of the mechanics that had been invented over the last hundred years.

But modern science was indebted to the ingenuity of its computational procedures and the originality in writing numbers that facilitated calculations, namely, the place-value system. In the process, while acknowledging this indebtedness, Laplace had opened the window for priority disputes in

³¹ The British mathematician, John Playfair (1748–1819), was a contemporary of the network of Academicians discussed in this paper and publicized the corpus of writing of Bailly and Le Gentil to the community of English mathematicians and astronomers [Playfair 1790]. Discussing Bailly’s *Traité*, Playfair wrote: “I entered on the study of that work, not without a portion of the skepticism, which whatever is new and extraordinary in science ought always to excite, and set about verifying the calculations and examining the reasonings in it, with the most scrupulous attention. The result was, an entire conviction of the accuracy of one and of the solidity of the other” [Playfair 1790, pp. 137–138]. He played a crucial role in setting the research agenda for British Indologists, such as Colebroke, researching the history of mathematics and astronomy in ancient India. I shall, however, refrain from discussing Playfair’s work here. For a brief discussion on Bailly’s influence on Playfair, see [Raina 2002].

the history of science. Were the Indians really the inventors of the number system? Who invented zero? Etc. This was to be taken up by the next generation of astronomers-physicists. In all these cases, the master narrative was that of Bailly. However, Laplace's historical excursion was one section in a popular exposition of Newtonian mechanics. The problem that confronted Laplace, however, was that the history of astronomy as he reconstructed it revealed that it did not develop along Baconian lines [Agassi 1963, pp. 10–11].

In the Baconian scheme, the history of science was an integral part of the science itself. Science developed by climbing the "ladder of axioms", without skipping a single rung. Less general theories preceded those more general. Laplace attempted to reconstruct the evolution of the Newtonian system carefully on such Baconian lines and finally admitted that this was the history of astronomy as it might have occurred and not as it possibly did [Agassi 1963, p. 12]. How was he to explain the deviation of hypothetical history from actual history? Laplace encountered a great deal of speculation in the work of Copernicus, Descartes and Bacon and was forced to abandon the Baconian idea that prejudiced people could not develop science. Agassi suggests that Laplace did not push the realisation that prejudices could be useful, in which case "they were not as black as Bacon and others painted them", and thus missed the opportunity to shrug off the cloak of inductivism [Agassi 1963, pp. 12–13]. Agassi's remarks are driven by his attempt to comprehend Laplace's "confidently scornful" remarks about the ideas of Brahe. But it may well be that the same skepticism about inductivist history prompted Laplace's positive reception of Bailly's history.³²

Besides, it was at this time that India came to be represented as an algorithmic civilization, setting it up in opposition to the geometric West. During this period, there was ambiguity about contrasting the algebraic with the geometric traditions. The positive reception of the history of Indian astronomy and mathematics within this network could be situated in the contemporaneous commitments of Laplace, Lagrange and

³² Can an inductivist do good history of science? While Agassi presents an extensive critique of inductivism, the Laplace problem for him illustrates how we can obtain a positive response to the question. The metatheoretical condition for a good inductivist history of science, although it presupposes a vision of that history, is to ask whether this theory itself fits the facts [Agassi 1963, p. 14].

the other mathematicians of the time who had contributed substantially to the study of approximations. This involved the development of useful approximation methods to solve algebraic and differential equations. As Grabiner points out, the underlying paradox was that the results they obtained were most accurate when the methods were the most approximate³³ [Grabiner 1985, p. 209]. Consequently, there may have been an element of surprise and admiration in their observation of the accuracy of some of the Indian computational procedures that, in turn, also invoked approximations. This affinity possibly explains the positive characterisation of this section of the history of Indian astronomy at that juncture in the history of the Enlightenment.

INDIAN ASTRONOMY IN THE HISTORY OF ASTRONOMY

Historians of physical sciences and historians of mathematics from the end of the eighteenth and the nineteenth centuries embraced the disciplinary differentiation that physics and mathematics underwent towards the last decades of the eighteenth and early decades of the nineteenth century. Historians of the physical sciences avoid the mathematics of physics, and historians of mathematics emphasise the technical aspects of mathematics and ignore physical contexts [Greenberg 1995, p. 621]. The exact sciences in the age of revolutions were witness to accelerated change over a century and a half, and the signs of this acceleration had been visible since the seventeenth century. For some historians, the closure of the Laplacian phase marked its twilight. The end of the eighteenth century is seen by some as the end of the era of classical science, which had reigned supreme for the preceding eight to nine centuries [Rashed 1988, p. 5]. The historiography of modern science thus projects the science of the revolutionary era as concluding the engagements of the previous eight centuries, thereby reaffirming the premises of modern science. This modernity is presented

³³ The introduction of new methods of approximation in physical astronomy and celestial mechanics is traceable to the work of d'Alembert on the three-body problem within the framework of a universal theory of gravitation, the problem of the shape of the earth and the irregularities in its motion. While d'Alembert inherited these problems from Newton, Euler and Clairaut, he, along with Laplace and Lagrange, continued the tradition [Paty 1998, p. 26].

as a conquest that entailed a totally reconfigured science in terms of scientific rationality, the social organisation of science, and the advent of history itself as an autonomous discipline [Rashed 1988, p. 5].

In Laplace's oeuvre a phase of Newtonian physics – that of celestial mechanics – had come to an end. This had resulted not merely from developments in theory and the invention of new mathematics but from a process of retrospective incorporation of astronomical observations from diverse regions of the earth into modern astronomy. The late-seventeenth-century and eighteenth-century project of historical astronomy was one of the formations informing this finalization. By the end of the eighteenth century, interest in historical astronomy gradually declined. If interest in historical astronomy was motivated by scientific imperatives, it was also motivated by scriptural ones. This had to do with validating Biblical chronology.³⁴ Validating the chronology of the deluge, offered the possibility of integrating other civilisations and their histories within Biblical time and chronology. This facilitated the writing of a universal history.

The swelling revolutionary mood in Europe produced another kind of secularisation of the discipline of history, though the authors of this history might have retained their Christian preoccupations from the past. Revolutionary times, however, were mirrored in the birth of a metanarrative of revolutionary change. Latour points out that we see two kinds of modern history emerging in the nineteenth century, one dealing with universal and necessary things and focussed on epistemological breaks, and the other relating to the contingent universe of suffering humans [Latour 1993, pp. 70–71]. The historiography of scientific revolutions is premised upon the postulation of a rupture, a convulsive departure from the past.

Bailly and Montucla were the inaugurators of the theory of scientific revolutions that has, over the last two hundred years, played a pivotal

³⁴ On the 23rd September 1783 the founder of British Indology, William Jones arrived in Calcutta with his bride and a detailed plan of study. Of the sixteen subjects of study mentioned, items 4 and 7 are germane: "4. Traditions concerning the Deluge, &c. and 7: Arithmetic and Geometry, and mixed Sciences of Asiatics" [Jones, cited in Raj 1999, p. 22]. This commonality of concerns reflects the mental landscape of science and religion in the eighteenth century, and how science was often drawn in to vindicate the Bible. However, Raj argues that Jones's project was different from that of Voltaire and Bailly. For Jones, the issue was not one of Biblical chronology but of Biblical ethnology. For the philologist, the Bible would be vindicated by establishing the affinity of nations through the affinity of languages [Raj 1999, p. 29].

conceptual role in the theories of scientific revolution and the history of science. During this period, allusions to political revolutions often connoted a theoretical or paradigmatic break with the past of science.³⁵ This theory of the convulsive growth of scientific ideas provided a grid for mapping not just the growth of the history of astronomical ideas in Europe, but the history of astronomy across civilizations from antiquity to the birth of modernity.³⁶

The uncertainty of the times was also reflected in how the Enlightenment philosophers constructed the Orient. The century is marked by its ambivalence about the Orient. By the end of the century, as the modern nation state came into being, the stereotypes of the Orient begin to stabilise. The ethnographic phase of the history of astronomy came to an end. This closure was marked as much by a decline of interest in historical astronomy as by the emergence of a very different theory of history premised this time on the idea that only textually inscribed knowledge could count as evidence in the court of historical reason. Bailly's history thus marks the inauguration of a phase in more than one way.

Three trends are noticeable in the histories produced in the second half of the eighteenth century. Laudan suggests that the histories of specialist disciplines, such as those of mathematics and astronomy, served to mark disciplinary boundaries and to legitimate fields. The second trend comprised overviews that sought to contribute to the development of the

³⁵ This is reflected in Bailly's allusion to the Copernican revolution: "[...] this revolution did not come about all at once. The celestial light is not instantaneous, the light of the mind, which is dispersed unequally and meets obstacles, needs time to overcome them and to spread [...] At each new domicile science was subjected to a new examination: the knowledge transmitted was verified; but in that period a great revolution came about which changed everything. The genius of Europe revealed and announced itself in Copernicus" [Bailly quoted in Crombie 1994, III, pp. 1600–1601].

³⁶ The prevalence of the notion of the revolutionary advance of science is reflected in Biot's *Essai* on science during the French Revolution. It is relevant to indicate that the idea of convulsive political upheavals that alter the course of nations was imported into the discourse of science. Thus, Biot wrote: "[...] *mon but n'a pas été de suivre la marche tranquille des sciences, lors qu'elles s'avancent sous un ciel sans nuage, éclairées par la douce lumière de la paix. Ce n'est pas le calme que j'ai dû peindre, mais la tempête; j'ai voulu montrer les Sciences luttant avec toutes leurs forces contre la plus violente des révolutions, lorsque tout était conjuré pour les détruire, qu'elles étaient proscrites, persécutées et qu'au milieu de cette persécution même, elles tiraient encore de leur propre sein le salut de la patrie [...]*" [Biot 1803, p. 80]. While Biot himself had his reservations about the French Revolution, he alludes to the revolutionary character of science and its contribution to the prestige of the nation.

respective disciplines. The third trend explored the religious, political and economic conditions of scientific progress and the comparative study of science in nations outside the purview of the "West" [Laudan 1993, p. 3]. The comparative method produced explorations of the phenomena of the emergence of science in the West and the related issue of non-emergence in the non-West. It is no coincidence that just while Bailly's history was being drafted, William Jones was creating afresh another stream of Indology. Despite the first flush of excitement over Bailly's history of Indian astronomy, however, his thesis concerning the antediluvian origins of ancient astronomy was a strategy for devalorising the contributions of Indian astronomy in order to re-signify modern European science.³⁷ In order to rationalise this thesis within the framework of a universal history so dear to the philosophes, Bailly proposed a theory of the origins of science, which might retrospectively be considered a racial (not racist) theory of the origins of science. As far as the history of the astronomy of India was concerned two crucial tropes, that of forgetting and disfigurement, framed this history.

This theory of origins of science was founded on the idea of the inherent progress of scientific ideas that was reflected in the progress of nations. As Adas has pointed out, the yardstick for the assertion of European superiority had changed with the secularisation in the domain of knowledge and institutions [Adas 1990]. In the previous century, European superiority was argued for on religious grounds, but by the second half of the eighteenth century, the reasons offered were scientific. Historical presentism enabled the production of a self-validating theory of scientific and, by implication, national progress. This is evident in how differences between scientific traditions or scientific styles came to be typecast as civilisational dichotomies. The proposition that different civilizations embarked on the task of knowledge production along different lines would have been easily accommodated within Enlightenment anthropology.

In mathematical and astronomical terms, the ingenuity of the computational rules of Indian astronomy was recognized. It was also recognized

³⁷ This history of science inspired by Bacon, came to be seen as a constitutive element of European historical consciousness, that simultaneously, again in the spirit of Bacon, illuminated the evolution of science while promoting it [Crombie 1994, III, p. 1601].

that what the tradition lacked in terms of observational accuracy was compensated for by its computational methods. However, as these astronomers desperately searched for a theory that underpinned Indian astronomy, the greater was their disappointment. This disappointment was expressed in the diminution of the value of Indian astronomy as science. Different civilizational signatures were imputed to distinct mathematical styles. This was the period when India began to be invented as an algebraic civilization, since it offered a series of effective, efficient computational rules. What was missing was a theoretical edifice that was the hallmark of Western science.

In the dispute between the ancients and moderns, the philosophes and the savants had discounted the value of past knowledge with respect to the present. The sciences had reached their contemporary status through contributions from ages past, each of which had witnessed eruptions both in the realm of politics and knowledge. But it was only over the last two hundred years that the progress of the sciences had been substantial. In this discounting of the past, the knowledge emanating from the Oriental civilizations was ancient. The ancient was reduced to the childhood of human civilization, and the ancient civilizations were conceived of as the cradle of the human species. Modern civilization had reached maturity in Europe, and this was conspicuous in the state of perfection of astronomy and the exact sciences in Europe.

French overseas interests were often reflected in the writings of these functionaries on other civilisations. The astronomers and the astronomer-historians formed an invisible college whose influence was to last well in to the last years of the Third Republic. It becomes apparent that a new stage in the history of science had been inaugurated. Bailly's own work on India marked the end of the ethnographic stage in the discourse on India, its end having in a sense been prompted by his own historiography and the times that produced it. While Bailly was composing the history of astronomy, in far away India British administrators were rediscovering the mathematics of India, but this time in actual mathematical texts. Bailly's successor astronomer-savants, those who agreed with him as well as those who opposed him in France, would engage in another polemic with their European rivals across the channel over Indian mathematics.

BIBLIOGRAPHY

Primary sources

- ARAGO (François)
- [1854] *Œuvres complètes de François Arago*, t. 2, Paris: Gide et J. Baudry, 1854.
 - [1855] *Œuvres complètes de François Arago*, t. 3, Paris: Gide et J. Baudry, 1855.
- BAILLY (Jean-Sylvain)
- [1775–1782] *Histoire de l'astronomie ancienne depuis son origine jusqu'à l'établissement de l'école d'Alexandrie*, 4 vols., Paris: chez les Frères Delire, 1775–1782.
 - [1777] *Lettre sur l'origine des sciences et sur celles des peuples de l'Asie*, Paris: chez les Frères Delire, 1777.
 - [1787] *Traité de l'astronomie indienne et orientale*, Paris: chez Debure, Libraire de la Bibliothèque du roi et de l'Académie des inscriptions et belles-lettres, 1787.
- BERTHELOT (Marcelin)
- [1885] *Les origines de l'alchimie*, Paris: Georges Steinheil, 1885.
 - [1893] *Histoire des sciences. La chimie au Moyen Âge*, t. 3, Paris, 1893.
- BIOT (Jean-Baptiste)
- [1803] *Essai sur l'histoire générale des sciences pendant la Révolution française*, Paris: chez Duprat, Quai des Augustins, An 11.
 - [1714] *Description du royaume de Siam par M. de la Loubère, envoyé extraordinaire du Roy auprès du Roy de Siam*, Amsterdam, 1714.
- DUCHAMP (Xavier)
- [1733] *Lettre du P. Duchamp au P. Souciet, reçue en 1733*, Archives françaises de la Compagnie de Jésus, Vanves, vol. 83, 83GBro 083, p. 7; ff 166–169.
 - [~1734] *Sur le calcul des planètes selon la méthode de Graha Chendrika; pour calculer les éclipses, calculs divers*, Archives françaises de la Compagnie de Jésus, Vanves, vol. 83, 83GBro 083 71p, ff. 119–155.
- LAPLACE (Pierre Siméon)
- [1787] *Esprit des journaux*, November, cited in [Sen 1985, p. 51].
 - [1813] *Exposition du système du monde*, Paris: Courcier, 1813.
- LE GENTIL (Guillaume)
- [1779–1781] *Voyage dans les mers de l'Inde (1760–1771), fait par ordre du Roi, à l'occasion du passage de Vénus, sur le disque du soleil, le 6 juin 1761, & le 3 du même mois 1769*, 2 vols., Paris: Imprimerie royale, 1779–1781.
 - [1784] Remarques et observations sur l'astronomie des Indiens et sur l'ancienneté de cette astronomie, in *Mémoires de M. Le Gentil de l'Académie des sciences royales*, publié dans le volume de cette Académie pour les années 1784 et 1785, Paris: 1787, pp. 482–501.
 - [1785] Mémoires sur l'origine du zodiaque, in *Mémoires de M. Le Gentil de l'Académie des sciences royales*, publié dans le volume de cette Académie pour les années 1784 et 1785, Paris: 1787, pp. 9–16.
 - [1785] Du Zodiaque indien, des transactions philosophiques, année 1772, avec celui que l'on voit au bas d'une tour de Notre-Dame de Paris, avec des réflexions sur ces deux monumens, in *Mémoires de M. Le Gentil de l'Académie des sciences royales*, publié dans le volume de cette Académie pour les années 1784 et 1785, Paris: 1787, pp. 17–23.
 - [1810] *Lettres édifiantes et curieuses: mémoires de l'Inde*, t. 11–15, Toulouse: Noël-Étienne Sens, imprimeur libraire, 1810.

MONTUCLA (Jean-Étienne)

- [1799–1802] *Histoire des mathématiques*, nlle éd. compl. par Jérôme de Lalande, 4 vols, Paris: Henri Agasse, 1799–1802; republished by Albert Blanchard, Paris 1960.

PLAYFAIR (John)

- [1790] Remarks on the Astronomy of the Brahmins, *Transactions of the Royal Society of Edinburgh*, II, I, 1790, pp. 135–192.

Secondary sources

ADAS (Michael)

- [1990] *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance*, New Delhi: Oxford University Press, 1990.

AGASSI (Joseph)

- [1963] Towards an Historiography of Science, *History and Theory*, 1963, Beiheft 2, pp. 1–117.

AMBJÖRNSSON (Ronny)

- [1995] East and West: On the Construction of a European Identity, *VEST* (a Swedish journal of science studies published from Göteborg), 8 (1995), pp. 97–111.

BAMBOAT (Zenobia)

- [1933] *Les voyageurs français aux Indes aux XVII^e et XVIII^e siècles*, Paris: Jouve & C^{ie}, 1933.

BENTLEY (Michael)

- [1997] Introduction: Approaches to Modernity: Western Historiography since the Enlightenment, in Bentley (Michael), ed., *Companion to Historiography*, Routledge: London and New York, 1997, pp. 395–506.

BERNAL (Martin)

- [1987] *Black Athena: The Afroasiatic Roots of Classical Civilization*, London: Free Association Books, 1987.

BIÉS (Jean)

- [1974] *Littérature française et pensée hindoue des origines à 1950*, Paris: Librairie C. Klincksieck, 1974.

CHAPIN (Seymour L.)

- [1980] Jean-Sylvain Bailly, in Gillispie (Charles C.), ed., *Dictionary of Scientific Biography*, vol. 1–2, Charles Scribner's Sons: New York, 1980, pp. 400–402.

COHEN (H. Floris)

- [1994] *The Scientific Revolution: A Historiographical Inquiry*, Chicago: University of Chicago Press, 1994.

COHEN (I. Bernard)

- [1985] *Revolution in Science*, Cambridge (Massachusetts) and London: Belknap Press of Harvard University Press, 1985.

CROMBIE (A.C.)

- [1994] *Styles of Scientific Thinking in the European Tradition: The History of Argument and Explanation especially in the Mathematical and Biomedical Sciences and Arts*, vol. I and III, Duckworth, 1994.

DAVIS (J.C.)

- [1984] Science and Utopia: The History of a Dilemma, in Mendelsohn (Everett) and Nowotny (Helga), eds., *Nineteen Eighty-Four: Science between Utopia and Dystopia. Sociology of Sciences*, vol. VIII., Dordrecht: D. Reidel Publishing Company, 1984, pp. 21–48.

- DIÉNY (Colette)
 [1995] Knowledge and Appreciation of Chinese Astronomy and History in Eighteenth Century Europe According to the Writings of Antoine Gaubil S.J. (1689–1759), in Hashimoto (Keizô), Jami (Catherine) and Skar (Lowell), eds., *East Asian Science: Tradition and Beyond*, Osaka: Kansai University Press, 1995, pp. 501–505.
- FULLER (Steve)
 [1997] *Science: Concepts in the Social Sciences*, Maidenhead: Open University Press, 1997.
- GIERYN (Thomas F.)
 [1994] Boundaries of Science, in Jasanoff (Sheila), Markle (Gerald E.), Petersen (James C.) and Pinch (Trevor), eds., *Handbook of Science and Technology Studies*, Sage Publications, 1994, pp. 393–443.
- GILLISPIE (Charles C.)
 [1980] *Science and Polity in France at the End of the Old Regime*, Princeton: Princeton University Press, 1980.
- GRABINER (Judith V.)
 [1985] Is Mathematical Truth Time-Dependent, in Tymoczko (Thomas), ed., *New Directions in the Philosophy of Mathematics*, Boston: Birkhäuser, 1985, pp. 201–214.
- GRATTAN-GUINNESS (Ivor)
 [1994] Tailpiece: The History of Mathematics and its own History, in Grattan-Guinness (Ivor), ed., *Companion Encyclopedia of the History and Philosophy of Mathematics*, vol. 2, London and New York: Routledge, 1994, pp. 1665–1675.
- GREENBERG (John L.)
 [1995] *The Problem of the Earth's Shape from Newton to Clairaut: The Rise of Mathematical Science in Eighteenth Century Paris and the Fall of 'Normal' Science*, Cambridge: Cambridge University Press, 1995.
- GROVE (Richard H.)
 [1995] *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism*, Dehli: Oxford University Press, 1995.
- HAN (Qi)
 [1995] The Role of French Jesuits in China and the *Académie Royale des Sciences* in the Development of the Seventeenth–and Eighteenth–Century European Science, in Hashimoto (Keizô), Jami (Catherine) and Skar (Lowell), eds., *East Asian Science: Tradition and Beyond*, Osaka: Kansai University Press, 1995, pp. 489–492.
- HSIA (Florence)
 [1999] *French Jesuits and the Mission to China: Science, History and Religion*, Ph. D. Dissertation, University of Chicago, 1999, UMI number: 9934067.
- JAY (Martin)
 [1993] *Downcast Eyes: The Denigration of Vision in Twentieth Century French Thought*, Berkeley: University of California Press, 1993.
- LATOUR (Bruno)
 [1993] *We Have Never Been Modern*, translated by Catherine Potter, Harvester-Wheatsheat, 1993.
- LAUDAN (Rachel)
 [1988] Georges Cuvier on the Oriental Origins of Science, *Nineteenth Century French Studies*, 17 (1988), pp. 19–29.

- [1993] Histories of the Sciences and their Uses: A Review to 1913, *History of Science*, xxxi (1993), pp. 1–34.
- LIÉTARD (Gustave), CORDIER (Plamyr)
- [1989] *Travaux sur l'histoire de la médecine indienne: documents réunis et présentés par Arion Roşu*, Paris: Collège de France, 1989.
- MACLEOD (Roy)
- [1987] On the Moving Metropolis: Reflections on the Architecture of Imperial Science, in Rheingold (Nathan) and Rothenberg (Marc), eds., *Scientific Colonialism: A Cross-Cultural Comparison*, Washington D.C., 1987, pp. 217–247.
- MONTGOMERY (Scott L.)
- [2000] *Science in Translation: Movements of Knowledge through Cultures and Time*, Chicago and London: University of Chicago Press, 2000.
- MURR (Sylvia)
- [1983] Les conditions d'émergence du discours sur l'Inde au Siècle des lumières, *Collection Purusartha*, 7 (1983), pp. 233–284.
- [1987] *L'indologie du Père Cœurdoux: stratégies, apologétique et scientificité*, Paris: École française d'Extrême-Orient, 1987.
- NOWOTNY (Helga)
- [1984] Science and Utopia: On the Social Ordering of the Future, in Mendelsohn (Everett) and Nowotony (Helga), eds., *Nineteen Eighty-Four: Science between Utopia and Dystopia. Sociology of Sciences*, vol. VIII, Dordrecht: D. Reidel Publishing Company, 1984, pp. 3–18.
- PATY (Michel)
- [1998] *D'Alembert ou la raison physico-mathématique au Siècle des lumières*, Paris: Les Belles Lettres, 1998.
- PEIFFER (Jeanne)
- [2000] France, in Dauben (Joseph W.) and Scriba (Christophe J.), eds., *Writing the History of Mathematics: its Historical Development*, Basel: Birkhäuser, 2002, pp. 3–43.
- POUCHEPADASS (Jacques)
- [1991] L'Inde au miroir de l'histoire et des sciences du temps présent, in Gros (F.), ed., *Passeurs d'Orient/Encounters between India and France*, Paris: Ministry of Foreign Affairs, 1991, pp. 52–57.
- PYENSON (Lewis)
- [1993] *Civilizing Mission: Exact Sciences and French Expansion, 1830–1940*, Baltimore and London: The John Hopkins University Press, 1993.
- RAINA (Dhruv)
- [1997] The Young P.C. Ray and the Inauguration of the Social History of Science in India, *Science, Technology & Society*, 2 (1997), pp. 1–40.
- [1999] French Jesuit Scientists in India: Historical Astronomy in the Discourse on India (1670–1770), *Economic and Political Weekly*, XXXIV (1999), pp. 30–38.
- [2001] Disciplinary Boundaries and Civilisational Encounter: the Mathematics and Astronomy of India in Delambre's *Histoire* (1800–1820), *Studies in History*, 17, 2, 2001.
- [forthcoming] The Pre-history of the History of Proof in the Indian Mathematical tradition: From French Proto-ethnography to British Textual Studies, forthcoming.

- RAJ (Kapil)
 [1999] *Refashioning Civilities, Engineering Trust: William Jones, Indian Intermediaries and the production of reliable legal knowledge in late 18th-century Bengal*, Preprint, 1999, pp. 40.
- RASHED (Roshdi)
 [1988] Lagrange, lecture de Diophante, in Rashed (Roshdi), ed., *Sciences à l'époque de la révolution française: recherches historiques*, Paris: Albert Blanchard, 1988, pp. 39–83.
 [1994] *The Development of Arabic Mathematics; Between Arithmetic and Algebra*, Dordrecht, Boston and London: Kluwer, 1994.
- REDMAN (Ben Ray)
 [1979] Editor's Introduction, in Redman (Ben Ray), ed., *The Portable Voltaire*, Penguin Books, 1979.
- RICHARDS (Joan L.)
 [1991] Rigor and Clarity: Foundations of Mathematics in France and England, 1800–1840, *Science in Context*, 4, (1991), pp. 297–319.
- ROŞU (Arion)
 [1986] Marcelin Berthelot et l'alchimie indienne, *Bulletin de l'École française de l'Extrême-Orient*, LXXV (1986), pp. 67–78.
- SACHAU (Edward C.), ed.
 [1910] *Al-Beruni's India: An Account of the Religion, Philosophy, Literature, Geography, Chronology, Astronomy, Customs, Laws and Astrology of India about 1030 AD, with notes and indices by the editor*, reprinted in 1993 by Low Price Publications, Delhi.
- SEN (S.N.)
 [1985] Survey of Studies in European Languages, in Sen (S.N.) and Shukla (K.S.), eds., *History of Astronomy in India*, New Delhi: INSA, pp. 49–121.
- SHAPIN (Steven)
 [1983] Nibbling at the Teats of Science: Edinburgh and the Diffusion of Science in the 1830s', in Inkster (Ian) and Morrel (Jack), eds., *Metropolis and Province: Science in British Culture: 1780–1850*, London: Hutchinson, 1983, pp. 151–178.
- SHARMA (Virendra Nath)
 [1982] The Impact of Eighteenth Century Jesuit Astronomers on the Astronomy of India and China, *Indian Journal of History of Science*, 17 (1982), pp. 345–352.
- SHINN (Terry)
 [1992] Science, Tocqueville, and the State: The Organization of Knowledge in Modern France, in Jacob (Margaret C.), ed., *The Politics of Western Science, 1640–1990*, Humanities Press, pp. 47–101.
- SWERDLOW (N.M.)
 [1993] Montucla's Legacy: The History of the Exact Sciences, *Journal of the History of Ideas*, 54 (1993), pp. 299–328.
- VAN DER WAERDEN (Bartel)
 [1983] *Geometry and Algebra in Ancient Civilizations*, Berlin: Springer-Verlag, 1983.
- VOGEL (Kurt)
 [1974] Montucla, Jean Étienne, in Gillispie (Charles C.), eds., *Dictionary of Scientific Biography*, vol. IX, New York: Charles Scribner's Sons, 1974, pp. 500–501.

VOLTAIRE

[1979a] Selections from Philosophical Dictionary, in Redman (Ben Ray), ed., *The Portable Voltaire*, Penguin Books, 1979.

[1979b] Essay on the Manner and Spirit of Nations, in Redman (Ben Ray), ed., *The Portable Voltaire*, Penguin Books, 1979.

WILLIAMS (Rosalind)

[1993] Cultural Origins and Environmental Implications of Large Technological Systems, *Science in Context*, 6 (1993), pp. 377–403.

WINTER (Michael)

[1984] The Explosion of the Circle: Science and Negative Utopia, in Mendelsohn (Everett) and Nowotny (Helga), eds., *Nineteen Eighty-Four: Science between Utopia and Dystopia. Sociology of Sciences*, vol. VIII, Dordrecht: D. Reidel Publishing Company, pp. 73–90.