Journal of Astronomical History and Heritage, 21(1), 29–36 (2018).

WHITE SUPREMACISM AND ISLAMIC ASTRONOMY IN HISTORY OF ASTRONOMY TEXTS FROM THE EIGHTEENTH CENTURY TO THE PRESENT DAY

Joe Lockard
English Department, Arizona State University, P.O. Box 871401, Tempe, AZ 85287-1401, USA.
Email: Joe.Lockard@asu.edu

Abstract: This paper reviews manifestations of racism in European and American histories of Arab and Persian astronomy from the eighteenth century to the present day. Its first section discusses representation of Islamic astronomy from Adam Smith to late Victorian writers, particularly tracing ideas of Arab unoriginality and scientific incapacity. The second section first relates the appearance of scientific racism in the early twentieth-century historiography of astronomy, then how the rise of scientifically and linguistically competent scholarship in the latter twentieth century provided much-improved information on Islamic achievements in astronomy. The paper's conclusion underlines the importance of avoiding ethnic supremacism and integrating research on Islamic astronomy into teaching and publishing on the history of astronomy.

Keywords: Islamic astronomy, history of astronomy, astronomy textbooks, astronomy education, racism

1 ARABIC ASTRONOMY IN EIGHTEENTH- AND NINETEENTH-CENTURY EUROPEAN THOUGHT

The disappearance of astronomical knowledge from Europe, its preservation in Arabic and Persian-speaking domains, and the eventual recovery of Ptolmaic science through re-translated manuscripts are standard points of contemporary scientific history (Pingree, 1973). In British and American histories of astronomy published from the eighteenth century forward this story often remains obscure. When the English cleric and antiquarian George Costard (1710–1782) published *A Letter to Martin Folkes* in 1746, he derived an historical line for astronomical knowledge that included Egyptians, Babylonians, Hebrews, Greeks and Romans, with the Greeks being most important. More recent science conducted in Arab lands remained un-mentioned and absent. Costard, one of the earlier English-language writers on astronomical history, spoke for an older non-observational school where the Bible remained a crucial text for astronomy and where scientific evidence of the Earth's age was rejected. Costard's combination of biblicism and Hellenophilia (Pingree, 1992) could not stand up against the flow of atlases, codices and scientific manuscripts of every sort flowing into European libraries from Asia, Africa and the Americas as a result of colonial empire-building.

The noted Scottish scholar Adam Smith (1723–1790) wrote from this newer school of Enlightenment-fostered empirical thought. In his lengthy philosophical inquiry and scientific survey "The History of Astronomy", apparently completed prior to 1758 (Ross, 1995: 100) and only published post-humously, Smith (1795: 68) recited received opinion. He stated that Arabs bowed to the superiority of Greek philosophers

> … above the rude essays which their own nation had yet had time to produce and which were such, we may suppose, as arise every where in the first infancy of science, necessarily determined them to embrace their systems, particularly that of Astronomy: neither were they ever afterwards able to throw off their authority.

Arabs were, according to Smith (1795: 69), "… too much enslaved to those [Greek] systems, to dare to depart from them …" Like nearly all European intellectuals of this period, Smith offered these suppositions despite having no personal acquaintance with the Arabic language and its literature. Rather than the empiricism that Smith professed as method, his words represented the transmission of received opinion through the prism of European cultural superiority.

Linguistic incapacity similarly characterized the well-known French astronomer-revolutionary Jean Sylvain Bailly (1736–1793) in his frequently-cited 1787 *Traité de l'Astronomie Indienne et Orientale* that explored Asian astronomy. To adequately address the topics covered in his treatise, a knowledge of Arabic, Persian, Sanskrit, Chinese, Cambodian and Vietnamese would have been necessary.[1] However, Bailly had no command of any of these languages. Instead he relied on second-hand European reports, particularly those of the famous Italian founding-Director of Paris Observatory Giovanni Domenico Cassini (1625–1712)—who also spoke no Asian language. Unfamiliarity with non-European languages remained the norm among Western historians of astronomy until after WWII.

By the late eighteenth century intellectual tides were shifting away from religious astronomy, although astronomical texts continued to exercise magnetic effect over theologians seeking biblical proofs. Yet this more extensive understanding of astronomical history had a limited effect. A more modern text such as *History of*

Astronomy by R.W. Rothman (1829: 32–35) provides a brief history of Arab astronomy in an appreciative and objective fashion, although he acknowledges passing over much history. Meanwhile, in his *Mahometanism Unveiled*, which was generally dedicated to a condemnation of Islam as heresy, the British cleric Reverend Charles Forster (1787–1871) nonetheless took time to review at length—and praise—Islamic sciences. In terms of astronomy, Forster (1829: 267) wrote:

> The progress made by the Saracens, in their scientific researches, is to be measured, not so much by the amount of their actual discoveries, as by the suprizing reach of their conjectural anticipations, while criticizing the now-exploded systems of the ancients.

Forster, an Orientalist (and grandfather of novelist E.M. Forster), had dubious competence in Semitic languages—he claimed to read Egyptian hieroglyphs in Hebrew characters—and none at all in astronomy.

In 1852 the Scottish astronomer Robert Grant (1814–1892) published his influential volume, *History of Physical Astronomy from the Earliest Ages to the Middle of Nineteenth Century,* but despite its comprehensive title this book largely ignores Chinese, Persian and Arab astronomy prior to Newton.

This contrasts with the extensive treatment that Paris Observatory Director Jean Baptiste Joseph Delambre (1749–1822) provided on Arab and Asian astronomy in his magisterial *Histoire de l'Astronomie du Moyen Age*, where he wisely began discussion with the following disclaimer: "We have very imperfect knowledge of the astronomical works composed by the Arabs." (Delambre, 1819: 1; our English translation).

This point is important. Throughout much of the twentieth century, histories of astronomy failed to heed Delambre's caution. Islamic astronomy generally received exceedingly brief mention in basic astronomy texts, and not much more in longer treatments of the history of astronomy. In Seeds' *Foundations of Astronomy*, for example, we read: "For 1000 years Arab astronomers studied and preserved Ptolemy's work, but they made no significant improvement in his theory." (Seeds, 1990: 70). Since archeoastronomy and Greek astronomy receive much more attention from Seeds, his college-level readers might conclude from this one-paragraph reference that Islamic astronomy was negligible, deserving mention only for its alleged storehouse function.[2] Rarely does one encounter one thousand years of intellectual history so blithely dismissed.

Seeds' version does not differ greatly from a lengthy chain of Western representations of this branch of Arab culture, as they seldom venture beyond a summary account of the *Almagest*. Although the transmission history of the *Almagest* via Arabic was well-known (Haskins, 1924: 103–110), nineteenth-century popular texts tended to reduce coverage to a dismissive minimum. For example, an 1873 high-school book boiled it down to a single sentence:

> During the Dark Ages, Astronomy was cultivated chiefly by the Arabians, who made no advance as regards theory, but were diligent observers, and devised some improvements in instruments and methods of calculation. (Lockyer, 1873: 17).

Such views are the residua of a long tradition that apprehended exact sciences as incompatible with fundamental elements of an historic 'Oriental' character. In *History of Astronomy* the British academic and astronomical historian Arthur Berry (1862–1929) states:

> … a remarkable development of science had taken place in the East during the 7th century. The descendants of the wild Arabs who had carried the banner of Mahomet … soon began to feel the civilizing influence of the civilization of the peoples whom they had subjugated. (Berry, 1898: 76).

Beyond an ill-informed and reductionist understanding of Arab history and its formative forces, we read here the exclusive consignment of 'civilization' and its attributes to more sedentary societies. In such accounts, the study of astronomy marks a transition from brutishness to a higher civilizational stage. In *Elements of Astronomy*, Alfred Picquot writes of the Arab tribes:

> At first rude and illiterate, despising every book but the Koran, and impelled by the irresistible enthusiasm of fanatic zeal, they rushed on like a destructive torrent, carrying along with them desolation and ruin … But no sooner did they enjoy the sweets of peace, amidst the repose of conquest, than they bent their ardent minds upon scientific pursuits, and devoted themselves particularly to the study of astronomy. (Picquot, 1828: x).

In this historiography the impulses that drove conquest were turned to observation and measurement of celestial bodies. Similar praise of astronomy as representing evidence of civilization accomplishment can be found in antebellum United States astronomy instruction books that commended Egyptian, Chaldean and Arab astronomy (e.g. see Vose, 1832: 2–3; Olmsted, 1952: 1–2), although without displaying distinct knowledge of the particular accomplishments.

For such nineteenth-century writers astronomy constituted a measure of human intelligence and its development represented a generational emergence into civil maturity and learning. As Berry (1898: 82) notes in a gratuitous adjectival opinion:

> Ulugh Begh (born 1394), a grandson of the savage Tartar Tamerlane, developed a person-

> al interest in astronomy, and built about 1430 an observatory in Samarcand where he worked with assistants.

The scientific product of recently-settled wildmen and grandchildren of savages was, as might be anticipated, of negligible character. Berry (ibid.) concludes:

> No great original idea can be attributed to any of the Arab or other astronomers whose work we have sketched. They had, however, a remarkable aptitude for absorbing foreign ideas and carrying them slightly further.

This historical account reserves originality to the deduction of primary physical principles in the mode of Newton or Kepler, failing to appreciate the range of creativity and observational prowess embodied in other than European traditions. From Adam Smith's dismissal of 'rude' Arab knowledge to Berry's contempt for a 'savage' and unoriginal culture, we can trace a century and a half of Western ignorance of Islamic scientific achievement.

2 RACISM IN TRANSIT: THE TWENTIETH CENTURY

By the twentieth century racial ideas had become commonplace in descriptions of medieval Arab and Persian progress in astronomy. William Walter Bryant (1865–1923), a staff member at the Greenwich Observatory, displayed a similar penchant for sweeping cultural generalizations. In his *History of Astronomy*, Bryant (1907: 26) wrote:

> The Arabs excelled in methodical accuracy. We owe them an immense debt for the introduction of the decimal notation, instead of the cumbersome numerical systems of the Greeks and Romans, though even this system they adopted from India. But like other Oriental nations they failed in the direction of speculative philosophy, and devoted their analysis rather to astrology than to astronomy.

Bryant extols Arab astronomy's accuracy while backhanding it as methodical, as if there were a contradiction. He then attributes Arab civilization with the mathematical genius to create the decimal system, only to slap it for intellectual plagiarism. Finally, he dismisses a collectivized 'Oriental' world for a supposed preference for anti-empirical speculation and predilection for fortune-telling. Yet the Arab world accepted the doctrine of a spherical world for most of a millennium before European mapmakers came to the same conclusion and ceased drawing sea monsters at the edge of a flat world. Caliph al-Mamun in eighth-century Syria produced better estimates of the Earth's equatorial circumference than did Christopher Columbus. Saliba (1979) makes a contested claim that the school of astronomers at the famed Maragha Observatory (est. 1259) was developing non-Ptolemaic astronomical models by the thirteenth century. Whatever the merits of this claim, Islamic astronomy and its observatories, although still not heliocentric, had left pre-Copernican Europe well in arrears (Starr, 2013: 9, 461–463). Late twentieth and twenty-first century historians of astronomy have debated for decades whether Copernicus derived his discoveries from Greek translations of Arabic texts from the Maragha school (see Saliba, 1994; Swerdlow and Neugebauer 1984).[3]

Bryant's early twentieth-century scientific historiography resonated with the white supremacist racialism of Houston Chamberlain, Lothrop Stoddard and others on both sides of the Atlantic. In his masterwork on racialism, *Foundations of the Nineteenth Century*, first published in German in 1899, British-born Chamberlain (1855–1927) repeatedly attacks the notion of Arab contribution to scientific progress and in a splenetic footnote asserts "This whole Arabian science and philosophy was nothing but a wretched translation of Hellenic thought and knowledge." (1911: 399). The American Stoddard (1883–1950), writing a decade after Chamberlain, contrasts an alleged Arab cultural decrepitude, lethargy, and ignorance with a progressive Western civilization that "… grasped the talisman of science, and strode into the light of modern times." (Stoddard, 1921: 22). Both Chamberlain and Stoddard attributed an irrationalism to the Oriental 'race-soul' that prevented genuine scientific progress, and supposedly limited Arabs and other non-whites to an imitative use of Western science and technology. These formulations provided a basis for dividing the world between white intellectualism that shaped modernity and a 'colored world' that provided labor but constituted anti-modernism.

Such claims presented historiographic problems: how could the centuries-long predominance of sciences in the Arab world be explained? The Swiss-American scholar Florian Cajori (1859–1930) earlier grappled with this conundrum in his 1893 *History of Mathematics*, a foundational text in the field. He complimented Arab mathematicians and astronomers for their efforts but claimed that the Persian astronomer Abū al-Wafā Būzhjānī was "… an important exception to the unprogressive spirit of Arabic scientists …" (Cajori, 1893: 110) and that there was no "… important principle of mathematics brought forth by the Arabic mind." (Cajori, 1893: 116). Further, "The Arabic mind did not possess that penetrative insight and invention by which the mathematicians in Europe afterwards revolutionised the science." (Cajori, 1893: 117). So, according to Cajori, who in later life was to hold a Mathematics Chair at the University of California-Berkeley, a "… Semitic race was, during the Dark Ages, the custodian of the Aryan intellect-

ual possessions." (ibid.). Thus, a white supremacist history of science could understand Islamic astronomy and mathematics as having provided a temporary home to Aryan scientific knowledge during an eclipse of the white race-soul.

In the writing of the Royal Greenwich Observatory astronomer Walter William Bryant (1865–1923) we can locate an early recitation of this 'preservation thesis,' that is, a claim that the historic role of Arab and Islamic civilization had been to store and imitate Western scientific knowledge. Any improvement was merely iterative. Bryant (1907: 27) claimed that

> … the Arabs for many centuries kept the flame of astronomy alive, and by steady improvement in accurate observation, increased the value of each successive set of tables and constants.

Perhaps Bryant had learned the lessons of Arab imitation a little too well, for turning to the earlier 1905 work of his famed Danish-born colleague, John Louis Emil Dreyer (1852–1926), long-time Director of Armagh Observatory, one finds remarkably similar language. Dreyer (1905: 249) wrote

> Though Europe owes a debt of gratitude to the Arabs for keeping alive the flame of science for many centuries and for taking observations, some of which are still of value, it cannot be denied that they left astronomy pretty much as they found it.

The point to note here is not so much the borrowed language but rather the formation of a prevailing orthodoxy in science historiography, one where the transmission of Eurocentric and dismissive assessments relies upon an enduring human faculty for uncritical and unevidenced restatement. By contrast, the work of Arab astronomers in reworking and overhauling the Ptolemaic inheritance appears positively advanced in its insistence on empirical evidence. This is a variation of Hellenophilia that Pingree (1992: 555) identifies as "… the false claim that medieval Islam only preserved Greek science and transmitted it as Muslims had received it to the eager West." In fact, as Pingree points out, Arab scientists heavily transformed Greek mathematical and astronomical knowledge and made them Islamic sciences before Europe rediscovered Greek thought. In the early twentieth century the typical treatment of this transformation and transferal appears in the one paragraph that the British astronomer-engineer George Forbes (1849–1936) devotes to Arab and Persian astronomy in *History of Astronomy* (see Forbes, 1909, 19).

Dreyer was substantially more expert and scholarly in his knowledge of Arab astronomy than Bryant and other Edwardian writers, recognizing a wide diversity of historic Arab astronomers and opinion instead of treating them as an undistinguished whole. The chapter on 'Oriental Astronomers' is much more comprehensive and informative than that found in other general astronomy history texts of the period or since. David King, an outstanding contemporary historian of astronomy, suggests that there has never been a more developed successor to this work and that its cumulative effects have verged into the pernicious:

> As a branch of the history of astronomy in general, Islamic astronomy has not yet gained its rightful place. Historians of astronomy still tend to see the Muslim astronomers as preservers and transmitters of classical astronomy to Europe. In fact, in the literature on the history of science (as distinct from Islamic studies), there has been no improvement yet on the chapter 'Oriental Astronomers' in J.L.E. Dreyer's history of astronomy first published about 1900. (King, 1986: 4).

In short, by 1986, despite the passage of nearly a century of radical scientific advance, no more accurate general history of Arab astronomy had been achieved than was developed in the waning years of the Victorian era. Michael Seeds' assessment of Arab astronomy, which appears in equivalent university texts, is a left-over cultural artifact of Victorianism rather than a validated historico-scientific determination.

In fact, the vast bulk of topical evidence remains unexamined. As King (1974: 38) stated near the beginning of his labors in the field,

> The manuscript libraries of the Near East, Europe, and North America, contain thousands of Islamic astronomical manuscripts, the contents of which demand a complete reappraisal of the Muslim achievement in the exact sciences.

Most of these manuscripts consist of works that were not transmitted to Europe and represent astronomical research activity from the period 750–1500 Common Era. Some of the classes of tables they represent include trigonometric tables concerning the solar arc; spherical astronomical tables; tables for Muslim prayer times according to solar longitude; tables displaying the azimuth of Mecca by latitude and longitude; tables for marking sundials, astrolabes and quadrants and planetary equation tables (King, 1974: 41-50). Evaluation of this material requires a combination of astronomical, mathematical and language skills that is in scarce supply, a situation that goes far towards explaining the dearth of research in the field.

Unsubstantiated interpretations surrounding this lacuna in science history continued through much of the twentieth century. Dreyer operated within the context of the massive European development of academic orientalism distinguished by its colonialist discourse and prejudiced cultural

epistemologies. It supplied the authority to substantiate stereotypical characterizations of mentality, cultural contributions, originality or its absence, and other 'oriental' phenomena.

The heavy presence of that discourse appears in the *History of Astronomy* by the Dutch Marxist astronomer Antonie Pannekoek (1873–1960). Pannekoek (1961: 170) concludes an appreciative chapter-long survey of 'Arabian Astronomy' with an observation that

> The importance of Arabian astronomy lay in the fact that it preserved the science of antiquity in translations, commentaries, interpretations and new observations and handed it down to the Christian world.

The reason for the decline of Arab science, according to Pannekoek (ibid.), was that "An impulse towards continual progress was lacking; minds were dominated by a quiet fatalism." One catches here an inflection of Marxist teleology applied to astronomy, for Pannekoek was as well-known a left Marxist theorist as an astronomer (see Tai, 2017). Yet if impulses towards progress were substantially lacking, then the evolution of a millennial tradition of increasingly refined astronomical observation would be at complete variance with such an alleged cultural incapacity. Imputing fatalism to non-European societies incorporates the same perceptions that sought to justify European colonial rule as a means of progress. The terms of Pannekoek's analysis depict Arab astronomy as the servant of the Christian world rather than, more plausibly, as a 'European' (noting that Greek astronomy was pan-Mediterranean more than the late-constructed Europeanization of Greece) foundation for a flowering of Arab culture. Such terms underline how Pannekoek's account consumes and re-transmits cultural and historical stereotypes.

Such attitudes can lead to contradictions from one paragraph to the next, or even within a single sentence, as an author attempts to accomplish a simultaneous representation of great achievement and lack of scientific consequence. In his *History of Astronomy* the well-known Italian astronomer Giorgio Abetti (1882–1982) presents one such contradicted, near-nonsensical example: Ulugh Begh published a star catalog where

> … for the first time the stellar coordinates, celestial latitude and longitude, were given not only in degrees but also in minutes.
>
> Although no important discoveries were made in the East, the accumulation of observations was sizeable and important, as was the development of mathematical methods and the invention of our present system of counting, which greatly simplified arithmetic. (Abetti, 1952: 51).

Abetti literally trips over his own historiographic feet, caught between opposing denotations of importance. Grant's *History of Physical Astronomy*, written a century earlier, has much the same representational problem despite its attempted objective tone:

> The Arabian astronomers do not appear to have effected any essential improvements in the methods of observation. Their instruments, however, were generally larger and better constructed than those of the Greek astronomers, and they appear to have taken greater precaution to ensure the accuracy of their results. (Grant, 1852: 441).

More important than the contradictions found in such histories is the point that such problems arise in the context of a narrative of cultural deficiency and decline.

Ideas of scientific stasis or incremental improvement upon European sources, common fare in nineteenth-century European histories of astronomy, retained authority. For example, in *Elements of the History of Philosophy and Science* … the British cleric, the Reverend Thomas Morell (1703–1784), states:

> From the time of Ptolemy, who may be considered as the last of the ancient astronomers, this sublime science, so far from having advanced in any part of Europe or Asia, evidently retrograded and almost disappeared, till nearly the close of the eighth century, when a partial revival of literature and science in general, but especially of astronomy, took place under the auspices of several of the Saracenic Kaliphs … (Morell, 1827: 254).

Morell, who provides an otherwise positive treatment of the work of Islamic astronomy, frames it as a descendant of European science whereas it was in fact largely independent. Even in an appreciative and relatively deep treatment of Islamic astronomy *Historical Account of the Progress of Astronomy* by the British astronomer John Narrien (1782–1860), we encounter condescending lines such as

> … like children who destroy the things they possess and then weep over their loss, the Arabs came to seek the light of knowledge at Alexandria, where they had endeavoured to extinguish it; and removed the ashes which remained, that they might collect what the fire and their barbarism had spared. (Narrien, 1833: 294).

Narrien addresses 'the Arabs', treated as a socially unified group, as the destroyers of knowledge whose modest contribution lay in its reconstruction under the patronage of the caliphate.

By contrast, the latter decades of the twentieth century witnessed erosion in the prevalence of dismissive or culturally condescending Victorian approaches to Arab astronomy. The post-

war period saw publication by the American scholar Edward Stewart Kennedy (1912–2009) of his important catalog of Islamic astronomy manuscripts (Kennedy, 1956). By the 1970s, researchers with a substantive record in the field still constituted a small group counted on one or two hands at most. In a 1980 review of the state of research, David King described a situation of a substantial supply of Arabic and Persian-language astronomical manuscripts, limited access to original sources, and a minute number of researchers with the necessary scientific and linguistic qualifications to interpret them and advance research. King, Julio Samsó, and fellow scholars have made substantial historiographic progress since then, aided in part by the emergence of a number of universities in Europe, North America and Australia that have attracted graduate students, and history of astronomy conferences solely about, or including dedicated sessions on, Islamic and/or Arab astronomy. As a result, the last three decades have witnessed an increasing number of scholarly publications on aspects of Arabic astronomy by astronomers from nations such as Australia, China, England, Germany, India, Indonesia, Iran, Japan, Lebanon, Malaysia, South Korea, South Africa, Spain and the United States.

Meanwhile, general historians of astronomy, aware of emergent specialist scholarship on Islamic, Asian, African, and New World astronomy, have become far more judicious in their descriptions. For example, O'Neil's *Early Astronomy from Babylonia to Copernicus* (1986) recognizes and delineates the ethnic, religious, and geographic diversity of Arab astronomy; presents a chronological overview of developments; and eschews value judgments concerning the scientific culture and racial proclivities of Arabs. O'Neil wisely qualified his non-specialist knowledge with the observation

> It seems to me that there may be a great deal of Arabic astronomical material which has not been located, or if located not adequately interpreted; these are only hunches based on the remarks of the scholars looking into these matters. (O'Neil, 1986: 119).

A sense of empirical caution prevails in such disclaimers.

More recently, popular works such as *Brief Introduction to the Astronomy of the Middle East* by the well-known British astronomical historian John Steele (2008) have sought to draw together the specialist knowledge published over recent decades. Meanwhile, in his *Solar System Maps from Antiquity to the Space Age* the American scholar Nick Kanas provides extensive coverage of non-European astronomy (Kanas, 2014: 39–86). A major survey such as John North's brilliant *Cosmos* (2008) provides an integrated narrative of astronomy's development in Asia, North Africa, and Europe. Some writers have reversed historical emphasis entirely, attributing European progress largely to the inspiration of Arab and Persian astronomers. Henri Hugonnard-Roche (1996: 284) adopts this view where he writes:

> … the contribution of Arab science was essential to the birth and subsequent developpment of astronomy in the Latin West. Prior to this contribution there was indeed no astronomy of any advanced level in these countries. What was understood as astronomy was scarcely more than a collection of imprecise cosmological ideas …

Such a shift in narrative perspective emphasizes how dramatically the historiographic field has changed. In terms of introductory astronomy texts for classrooms, these generally have moved away from attempts at cultural history and periodization. There is much stricter focus on the science at hand than in astronomy texts of a century and more past.

3 CONCLUSION

While racial characterizations of astronomical progress largely have disappeared from overt view, the question arises of whether they now lie implicit in marginalized and nominally color-blind treatments of Arab and other astronomies. An astronomy textbook that skips from Ptolemy to Copernicus, Newton, Kepler and Herschel still misses major bodies of astronomical research—Chinese, Indian, and Mayan, for example—and eliminates non-Western societies and their knowledge from discussion. To use contemporary scientific utility as a sole criterion for inclusion on grounds of immediate relevance repeats the dominance of Western scientific paradigms. For example, Haque and Sharma (2016) have described the resulting Eurocentric biases and exclusion of Indian astronomical history from contemporary university syllabi and textbooks.

To summarize the argument made here: for nineteenth-century European scientific historians the achievement of Islamic astronomy derived principally from recognition of the greatness of Greek thought and its translation since Arab culture, to their minds, remained insufficient to support real scientific achievement. White racial supremacism was either overt or covert in terms of historical argument that negated Islamic astronomy. Early- to mid- twentieth century histories of astronomy provided little more than retrograde repetitions of their eighteenth and nineteenth-century predecessors in their treatment of these topics. Such slow or absent progress in the historiography of astronomy contrasts markedly with the astonishing development in astronomy itself. Problems of detail, care and caution remain in some classroom texts due to their failure to address Arabic, Persian, Chinese,

Indian, African, New World, Australian, Pacific island, and other bodies of astronomical knowledge.

Historical and cultural inclusiveness represents only one element of a pedagogy for public astronomy. The American scholar Professor George Saliba argues persuasively that the framing of astronomy's history through cultural separation and periodization instead of commonalities has been part of the problem. He questions how

> … we are to distinguish what was Arabic in the science of the European Renaissance or what was Greek in Arabic science. When there are such intimate connections between scientific traditions it becomes almost meaningless to speak of a Greek, Arabic or European science as if each had a character of its own. (Saliba, 2002: 367).

A practical conclusion becomes that we can teach popular astronomy better as an endeavor pursued by a wide range of human cultures engaged in empirical observations of the skies.

4 NOTES

1. Bailly's work on Asian astronomy remained a heavily-cited reference source throughout the following century: see, for example, Lalande (1792: 134–138); Biot, 1862: 170–172; Moigno (1877: 1528–1531). On the other hand, Jean Baptiste Joseph Delambre (1817: 400–441), the most authoritative French astronomer of his day, spent considerable effort challenging Bailly.
2. *Foundations of Astronomy*, one of the most successful and long-lived college-level introductory astronomy texts in the United States, is now in a 13th edition (2015) edited by Seeds and Dana Backman. The 1990 edition's characterization of Arab astronomy has disappeared but reference to non-European astronomy is even less than nearly three decades ago.
3. For a general survey of this question, see Freely, 2011: 162–180; Steele, 2008: 135–138.

5 ACKNOWLEDGEMENTS

The author wishes to thank Professors Raza Ansari, Jarita Holbrook, Laura Kay, Wayne Orchiston and John Steele for their useful suggestions and comments. Nonetheless, all errors remain those of the author.

6 REFERENCES

Abetti, G., 1952. *The History of Astronomy*. New York, Abelard-Schuman.

Bailly, J.S., 1787. *Traité de l'Astronomie Indienne et Orientale*. Paris, Debure l'Aîné (in French).

Berry, A., 1898. *A Short History of Astronomy*. London, John Murray.

Biot, J.-B., 1862. *Études sur l'Astronomie Indienne et sur l'Astronomie Chinoise.* Paris, Michel Lévy Fréres (in French).

Blake, S.P., 2016. *Astronomy and Astrology in the Islamic World.* Edinburgh, Edinburgh University Press.

Bryant, W., 1907. *A History of Astronomy*. London, Methuen.

Cajori, F., 1893. *A History of Mathematics*. New York, Macmillan.

Chamberlain, H.S., 1911. *The Foundations of the Nineteenth Century*. *Volume 1*. London, Bodley Head.

Costard, G., 1746. *A Letter to Martin Folkes, Esq., President of the Royal Society, Concerning the Rise and Progress of Astronomy among the Antients*. London, Ilive.

Delambre, J.B.J., 1817. *Histoire de l'Astronomie Ancienne*. Volume 1. Paris, Courcier (in French).

Delambre, J.B.J., 1819. *Histoire de l'Astronomie du Moyen Age*. Paris, Courcier (in French).

Dreyer, J.L.E., 1953. *A History of Astronomy from Thales to Kepler*. *Second Edition*. New York, Dover [originally published as *History of the Planetary Systems from Thales to Kepler*. Cambridge, Cambridge University Press, 1905].

Freely, J., 2011. *Light from the East: How the Science of Islam Helped to Shape the Modern World*. London, Tauris.

Forbes, G., 1909. *History of Astronomy*. London, Watts and Co.

Forster, C., 1829. *Mahometanism Unveiled: An Inquiry, in which that Arch-heresy, its Diffusion and Continuance, are Examined on a New Principle, Tending to Confirm the Evidences, and Aid the Propagation, of the Christian Faith*. *Volume 2*. London, J. Cochran.

Gibbs, S., and Saliba, G., 1984. *Planispheric Astrolabes from the National Museum of American History*. Washington (DC), Smithsonian Institution Press.

Grant, R., 1852. *History of Physical Astronomy from the Earliest Ages to the Middle of Nineteenth Century*. London, Robert Baldwin.

Haskins, C.H., 1924. *Studies in the History of Mediaeval Science*. Cambridge (Mass.), Harvard University Press.

Haque, S., and Deva, S., 2016. Indian astronomy: the missing link in Eurocentric history of astronomy. *Cultural Studies of Science Education*, 11, 515–526.

Hugonnard-Roche, H., 1996. The influence of Arabic astronomy in the Medieval West. In Rashed, R. (ed.). *Encyclopedia of the History of Arabic Science, Volume 1*. New York, Routledge. Pp. 284–304.

Ilyas, M., 1988. *Astronomy of Islamic Times for the Twenty-First Century*. London, Mansell.

Kanas, N., 2014. *Solar System Maps from Antiquity to the Space Age*. New York, Springer.

Kennedy, E.S., 1956. A survey of Islamic astronomical tables. *Transactions of the American Philosophical Society*, 46(2).

King, D., 1980. The exact sciences in Medieval Islam: some remarks on the present state of research. *Middle East Studies Association Bulletin*, 14, 10–26.

King, D., 1986. *Islamic Mathematical Astronomy*. London, Variorum Reprints.

Lalande, J., 1792. *Astronomie par Jerôme Le Français*. *Third Edition. Volume 1*. Paris, P. Didot L'Aine (in French).

Lockyer, J.N., 1873. *Elements of Astronomy*. New York, Appleton.
Moigno, F.N.M., 1877. *Les Splendeurs de la Foi: Accord Parfait de la Révélation et de la Science de la Foi et de la Raison*. *Volume 3.* Paris, Librairie des Mondes (in French).
Morell, T., 1827. *Elements of the History of Philosophy and Science, from the Earliest Authentic Records to the Commencement of the Eighteenth Century*. London, Holdsworth.
Morrison, R., 2013. Islamic astronomy. In Lindberg, D., and Shank, M. (eds.). *The Cambridge History of Science*. Cambridge, Cambridge University Press. Pp. 109–138.
Narrien, J., 1833. *An Historical Account of the Origin and Progress of Astronomy*. London, Baldwin and Cradock.
North, J., 2008. *Cosmos: An Illustrated History of Astronomy and Cosmology*. *Revised Edition*. Chicago, University of Chicago Press.
O'Neil, W.M., 1986. *Early Astronomy from Babylonia to Copernicus*. Sydney, Sydney University Press.
Olmsted, D., 1952. *A Compendium of Astronomy; Containing the Elements of Science, Familiarly Explained and Illustrated, with the Latest Developments*. New York, Collins.
Pannekoek, A., 1961. *A History of Astronomy*. London, Allen and Unwin.
Pingree, D., 1973. The Greek influence on early Islamic mathematical astronomy. *Journal of the American Oriental Society*, 93, 32–43.
Pingree, D., 1992. Hellenophilia versus the history of science. *Isis*, 83, 554–563.
Picquot, A., 1828. *Elements of Astronomy*. Second Edition. London, Poynton.
Ross, I.S., 1995. *The Life of Adam Smith*. New York, Oxford University Press.
Rothman, R.W., 1829. *History of Astronomy*. London, Baldwin and Cradock.
Saliba, G., 1979. The first non-Ptolemaic astronomy at the Maraghah School. *Isis*, 70, 571–576.
Saliba, G., 1994. *A History of Arabic Astronomy: Planetary Theories during the Golden Age*. New York, New York University Press.
Saliba, G., 2002. Greek astronomy and the Medieval Arabic tradition. *American Scientist*, 90, 360–367.
Savage-Smith, E., 1985. *Islamicate Celestial Globes: Their History, Construction and Use*. Washington (DC), Smithsonian Institution Press.
Seeds, M., 1990. *Foundations of Astronomy*. Belmont (CA), Wadsworth.
Smith, A., 1795. *Essays on Philosophical Subjects*. Dublin, Wogan, Byrne, J. Moore, Colbert, Rice, W. Jones, Porter, and Folingsby.
Starr, S.F., 2013. *Lost Enlightenment*. Princeton, Princeton University Press.
Steele, J.M., 2008. *A Brief Introduction to the Astronomy of the Middle East*. London, Saqi.
Stoddard, L., 1921. *The New World of Islam*. New York, Charles Scribners.
Swarup, G, Bag, A.K., and Shukla, K.S. (eds.), 1987. *History of Oriental Astronomy*. Cambridge, Cambridge University Press.
Swerdlow, N.M., and Neugebauer, O., 1984. *Mathematical Astronomy in Copernicus's De Revolutionibus*. Berlin, Springer.
Tai, C., 2017. Left radicalism and the Milky Way: connecting the scientific and socialist virtues of Anton Pannekock. *Historical Studies in the Natural Sciences*, 47, 200–254.
Vose, J., 1832. *A Compendium of Astronomy; Intended to Simplify and Illustrate the Principles of the Science, and Give a Concise View of the Motions and Aspects of the Great Heavenly Luminaries*. Boston, Carer, Hendee and Co.

Dr Joe Lockard is an Associate Professor of English at Arizona State University in Tempe, Arizona. He specializes in nineteenth-century American literature, with particular focus on issues of race and slavery. His research and teaching also deal with prison literature; for the past decade he has led a weekly poetry workshop in Florence State Prison. He has forthcoming co-edited volumes of critical studies on Native American writer Louis Owens and writing pedagogies in prisons.