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JOSEPH HENRY AND ASTRONOMY

Marc Rothenberg
Smithsonian Institution Archives, MRC 507, P.O. Box 37012, Washington, D.C. 20013-7012, USA.
E-mail: Josephhenr@aol.com

Abstract: Although best known for his research on electromagnetic induction, Joseph Henry, the first Secretary of the Smithsonian Institution, was also very interested in astronomy, and particularly the application of physics to astronomical research. This paper explores Henry's interest and his failure to make a greater impact on astronomy.

Keywords: Joseph Henry; solar temperature; New Astronomy.

1 INTRODUCTION

It gives me great pleasure to recognize the illustrious career of my friend and colleague David DeVorkin by contributing to this collection. I have known DeVorkin ever since he became a curator at the National Air and Space Museum. As fellow Smithsonians we have often interacted, but our research has gone in different directions. As a curator at the National Air and Space Museum, DeVorkin has focused on the history of twentieth-century astronomy, while I, as Editor of the Joseph Henry Papers Project, have focused on the nineteenth-century. An example of this is our work on astronomy at the Smithsonian. Among DeVorkin's outstanding contributions to our understanding of the history of twentieth-century astronomy is his *Fred Whipple's Empire: The Smithsonian Astrophysical Observatory, 1955–1973* (DeVorkin, 2018). In contrast, I am interested in what might be called the prehistory of the Smithsonian Astrophysical Observatory: astronomy at the Smithsonian when it was the empire of Joseph Henry, the first Smithsonian Secretary.

Joseph Henry (1797–1878; Figure 1),[1] Secretary of the Smithsonian from 1846 to 1878, was the most honored American scientist in the last quarter of the nineteenth century (Moyer, 1992). Renowned for his work in electromagnetic induction and his role in the inventtion of the electromagnetic telegraph and the telephone, he received international recognition at the 1893 International Congress of Electricians, where the unit of inductance was named the *henry.* In the United States, the ultimate acknowledgement of his status in nineteenth-century America can be seen on the balustrade of the Main Reading Room of the Library of Congress in Washington, D.C. There are sixteen statues, erected in 1899, representing eight areas of human accomplishment. Homer, Beethoven, Shakespeare, Plato and Michelangelo are among the sixteen. Henry (Figure 2) is one of two representatives of the sciences (the other being Isaac Newton). In his hand is a magnet, symbolic of his career as a physicist.

But like many nineteenth-century scientists, Henry had broad interests, in particular, astronomy. He taught the subject, conducted research, and as Secretary (Director) of the Smithsonian, facilitated astronomical research in the United States and international cooperation in astronomy. What separated him especially from many of his contemporaries was his recognition of the power of merging physics and astronomy. Not only was he a pioneer researcher in the 'New Astronomy', but he repeatedly attempted to persuade American patrons of astronomy that the best path for astronomy in this country should be the pursuit of astrophysics. He thought that the United States could make a more significant contribution to science by striking out on a less travelled path rather than competing with the older and more established observatories of Europe.



Figure 1: Professor Joseph Henry, Prints and Photographs Collection, Library of Congress (afterTaylor, 1880: between 374 and 375).



Figure 2: Statue of Joseph Henry, Main Reading Room, Library of Congress, photographed by C.M. Highsmith, (www.loc.gov/item/20076874402/).

This paper will be divided into four sections. I will begin by looking at Henry as a teacher of astronomy. This is a phase of his career that began in 1826 and continued until his return from his first trip to Europe in 1837. I will highlight his efforts during that 1837 trip to learn the nuts and bolts of constructing and running an observatory. The second section will discuss his pioneer work in astrophysics in the mid-1840s, pioneer work which his contemporaries generally ignored. The third section will be a discussion of Henry as Smithsonian Secretary, touching on his support of astronomical research and his role in the international communication of astronomical discoveries. The final section will consider Henry's efforts in the 1870s to make the United States the center of the 'New Astronomy'.

2 HENRY'S ACADEMIC CAREER AND EARLY ASTRONOMICAL RESEARCH

Henry came to science as a teenager after reading a popular science text (Gregory, 1808).[2] His only formal education beyond primary school was three years (1819–1822) as a part-time student at the Albany Academy in Albany,

New York. At the time Henry was a good decade older than his fellow students and he later downplayed the significance of this education, describing himself as essentially self-educated. But the connection with the Albany Academy eventually resulted in Henry becoming a member of the faculty of the Albany Academy in 1826. He taught a broad range of mathematical and scientific subjects at the Academy, including astronomy.

Although his course lecture notes no longer exist, we do have his inaugural lecture as a faculty member, given on 11 September 1826 (Reingold et al., 1972: 163–179). This was not a lecture to students but a public presentation providing his vision of science to the leadership of the Albany Academy and to the Albany community. In that lecture, Henry defended the study of astronomy, in particular the study of the "… position & magnitude …" of the stars against doubters who might reject it as simply "… a work of curious speculation." His argument was rather commonplace: astronomy is important for navigation (Reingold, et al., 1972: 172). He then went on to discuss planetary orbits and the power of what we would now call celestial mechanics. In his praise of astronomy he acknowledged the contributions of both observational and mathematical astronomers, but clearly thought the latter more important, recognizing by name Isaac Newton (1642–1727), Leonhard Euler (1707–1783), and Joseph-Louise Lagrange (1736–1813) (Reingold, et al., 1972: 173), and concluding that the work of Pierre-Simon Laplace (1749–1827), which

> … marks undoubtedly the highest point to which man has yet ascended in the scale of intellectual attainment. (Reingold et al., 1972: 174).

Albany is where Henry made his first great experiments in electromagnetism, but it is also where he made his first astronomical observations. We also date Henry's first 'publication' in astronomy to Albany. His observations of the 12 February 1831 partial solar eclipse appeared in the Albany newspaper *Argus* of 15 February. Henry remained fascinated with eclipses his entire life, but his interest was somewhat different from many astronomers. For example, one of the questions that haunted him was whether solar light was polarized during an eclipse. Unfortunately, he was never in a position to do the necessary observations (Reingold et al., 1972: 379).

Henry left Albany in 1832 to become Professor of Natural Philosophy at the College of New Jersey, now known as Princeton University. Again, his responsibilities included the course in astronomy. Unfortunately, in contrast to his teaching of physics or even geology, where we have extensive knowledge of the content of his lectures, neither his lecture notes, his students' notebooks, nor his choice of textbook have survived. However, if he followed the model of his natural philosophy course, he would have utilized an approach familiar to students even today: introductory historical lectures demonstrating the progressive nature of science, and then thematic lectures on specific topics (Weiner, 1965).

His major astronomical research activity during his first years at Princeton was his participation in the debate over the nature of meteors. Henry had observed the meteor shower of 13 November 1833. This is the famous Leonid shower (Littmann, 1998). The fundamental scientific issue debated at the time among American astronomers was whether the meteors ultimately originated above the atmosphere or were of atmospheric origin. The key observational data were the existence and location of the radiant and whether the shower was periodic, repeating in November 1834 and 1835. The protagonists were Denison Olmsted (1791–1859) of Yale and Alexander Dallas Bache (1806–1867), Henry's best scientific friend, from the University of Pennsylvania. Henry carefully charted the meteors he observed and concluded (Reingold et al., 1975: 117) that the meteors were all descending parallel to each other and that the appearance of a radiant was an optical illusion. In his sketch *a* was the origin of the meteor and *b* the point of termination. He concluded that the paths were parallel but appeared to come from a radiant because "… we viewed only their projection on the celestial vault." (Figure 3). This observation, which was incorrect, supported Bache's contention of that meteors were ultimately an atmospheric phenomenon (Reingold et al., 1975: 116–119, 477–482).

2.1 Henry Goes to Europe

As Professor of Natural Philosophy, responsible for the Astronomy course, one of Henry's concerns was the possibility of an observatory for Princeton. When Henry went to Europe in 1837, there was only one 'observatory' in the United States. Yale College had a 5-inch Dollond refractor, with a focal length of ten feet on an altitude and azimuth mount. The legs had casters so that the telescope could be rolled around the observatory—which was the converted steeple of a College building. One had to observe through low windows which concealed from view any object higher than thirty degrees above the horizon (Musto, 1968). So,

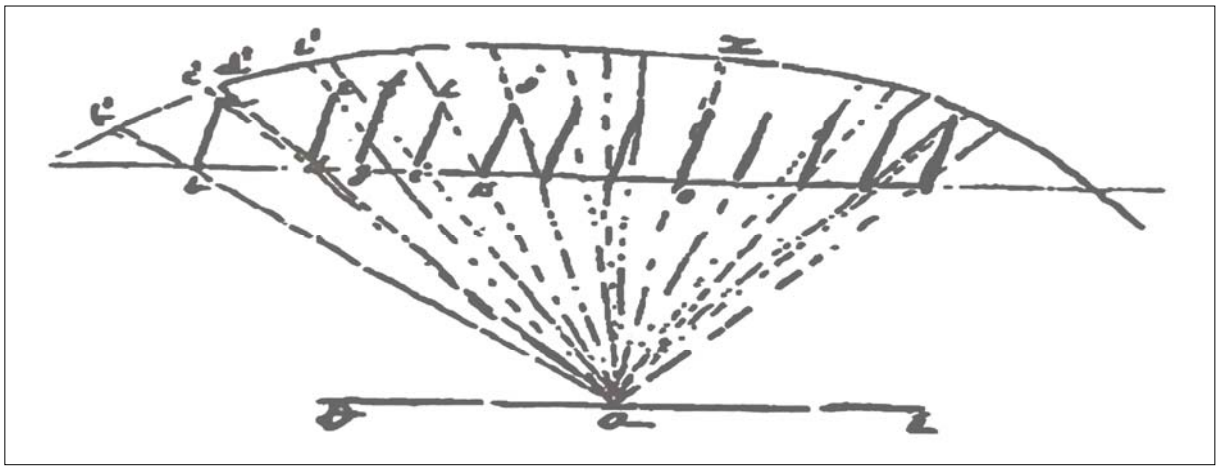


Figure 3: Henry's interpretation of the meteor shower, Henry Notebook Entry, 13 or 14 November 1833), Joseph Henry Collection, Record Unit 7001, Smithsonian Institution Archives (after Reingold *et al*., 1975: 117).

in addition to purchasing scientific equipment for the College and learning about the latest research in physics, Henry visited several observatories in Europe and took extensive notes on equipment and structure. The text accounts and sketches that survive demonstrate the sort of information he was interested in.

For example, on 24 March 1837 Henry visited the observatory (Figure 4) of Peter Barlow (1776–1862). In his account of the visit Henry noted that the observatory was made of wood, was about 12 feet in diameter, resembled a tent, and

> In the cover or top of the tent a slit is cut from the apex to the circumference of about a foot in width to admit the light to the end of the telescope.

Over the slit was a hinged door; the roof moved on rollers (Reingold et al., 1979: 198).

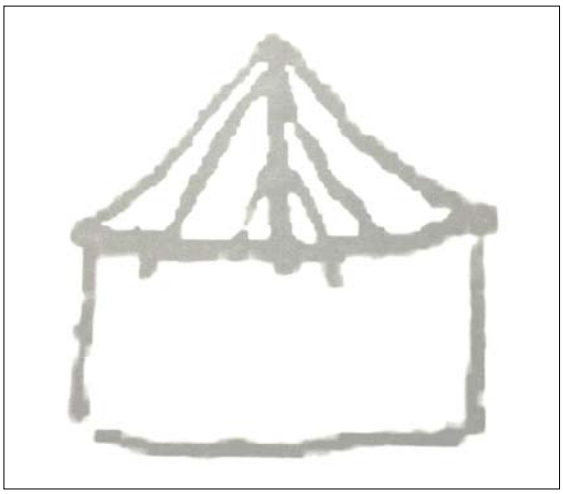


Figure 4: Peter Barlow's observatory, Henry's European Diary Entry, [March] 23, [1837], Joseph Henry Collection, Record Unit 7001, Smithsonian Institution Archives (after Reingold *et al*., 1979:198).

A month later he visited the observatory of Francis Baily (1774–1844) (Reingold et al., 1979: 334–336). He made several sketches of the transit observatory (Figure 5), including one of the cross section (a) and plan of the observatory (b). Henry was particularly interested in Baily's thoughts on the set-up of an inexpensive transit telescope observatory and concluded (Reingold et al., 1979: 335) that

> … this [Baily's observatory] is a cheap and sufficiently exact observatory for ordinary purposes … [and Henry hoped that] … one of a similar kind ... may be fitted up at small expense at Princeton. (Reingold et al., 1979: 339).

Yet another example of Henry's interest in observatories comes from Henry's visit on 7 August 1837 to the Royal Observatory, Edinburgh, under the direction of Thomas Henderson (1798–1844) (Reingold et al., 1979: 447–454). Henry included seven sketches in his account. He supplied detailed descriptions of the friction wheels, counter-weights, and setting circles of the transit instrument. He then

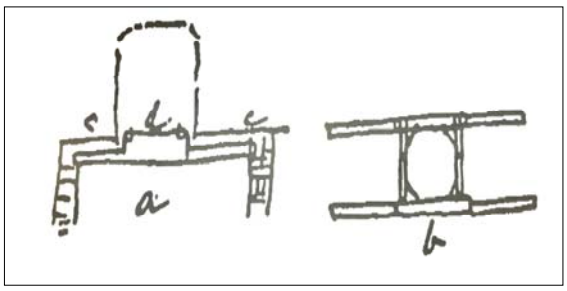


Figure 5: Joseph Henry's drawing of Francis Baily's observatory, where c was the ceiling and d the shelf upon which the dome of the observatory was placed. In Henry's European Diary Entry, 28 April [1837], Joseph Henry Collection, Record Unit 7001, Smithsonian Institution Archives (after Reingold *et al*., 1979: 335).

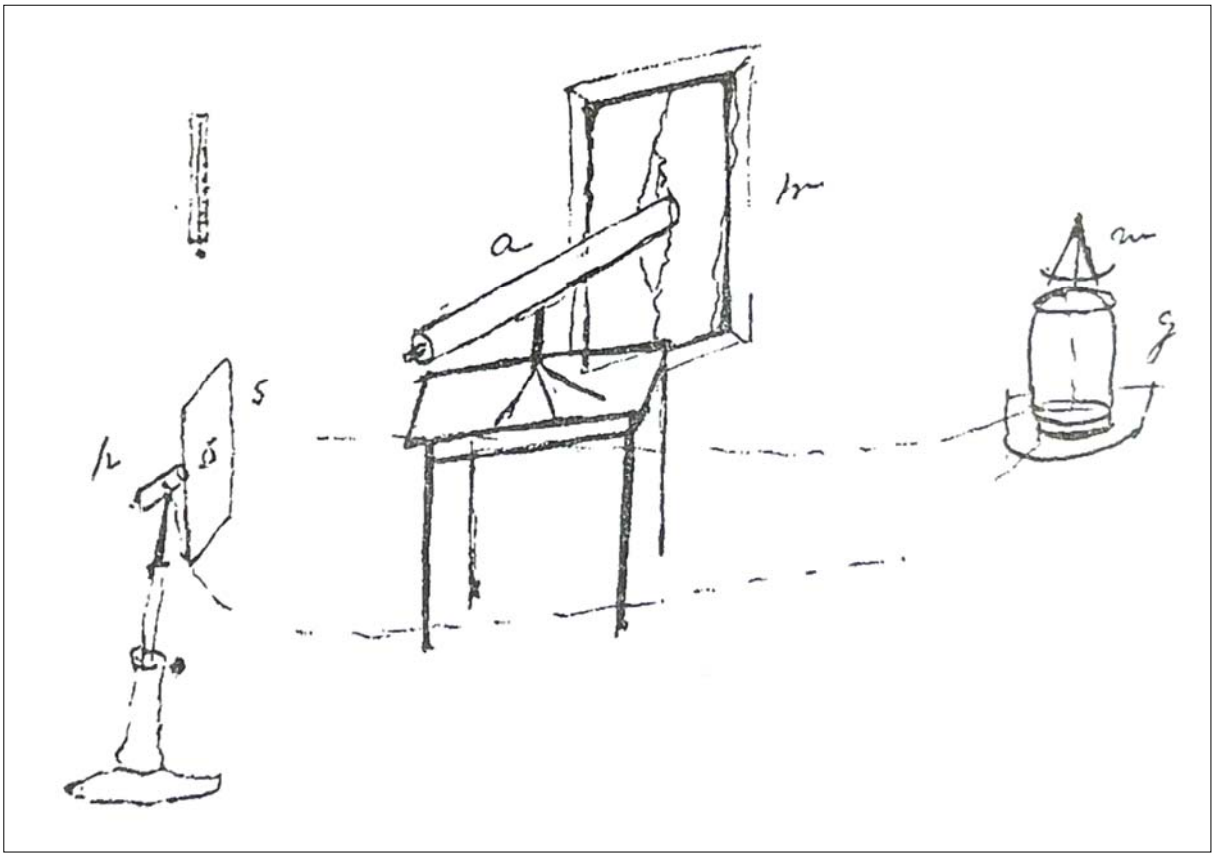


Figure 6: Joseph Henry's experimental setup to observe solar temperatures, where a is the Princeton telescope (a 3.5-inch Fraunhofer refractor), S is a paper screen to receive the solar image (subsequently a hole was punched to allow the image to strike the thermoelectric pile), and g is the galvanometer. In "Record of Experiments," 4 January 1845, Joseph Henry Collection, Record Unit 7001, Smithsonian Institution Archives (after Rothenberg *et al*., 1992, 146).

provided a detailed discussion of the reversing stand for the transit instrument. He praises the stand, originally developed in Germany, as a superior method to the practice at Greenwich. Finally, provided a detailed description of the "… chair used for observation." (Reingold et al., 1979: 454). No detail was too small for Henry.

So, what happened when Henry returned to Princeton in November 1837 with all this information about observatories? Nothing. While he was in Europe the Panic of 1837 had struck, and Princeton was in rather desperate financial shape (Reingold et al., 1981: 28). In addition, in Henry's absence the teaching of Astronomy at Princeton was given to Stephen Alexander (1806–1883), a mathematics tutor at Princeton, who was both Henry's first cousin and brother-in-law (Rothenberg, 2014). Upon his return Henry petitioned for Alexander to continue to have responsibility for Astronomy, providing a professional niche for his relative (who became Professor of Astronomy at Princeton in 1840 and in the 1860s finally persuaded the College to build an observatory). This freed Henry to focus on physics.

2.2 Observing the Sun

Although no longer teaching astronomy, Henry remained interested in astronomical topics, and in late 1844 he read an article in French by Alfred Gautier (1793–1881), Professor of Astronomy at the Geneva Academy. Gautier (1844) was attempting to answer whether an active Sun, that is, one with many sunspots, generate more or less radiant energy. This in turn would provide the answer, indirectly, to the question whether sunspots were hotter or colder than the brighter solar surface. Gautier compared the temperature at various places on the Earth during periods of high sunspot activity to that of the temperature at low activity. He found a lower temperature during periods of solar activity, although the differences were not great. This contradicted the most well know indirect attempt to measure solar radiation, that of William Herschel (1738–1822), using grain prices (Herschel, 1801).

In response to Gautier's article Henry

> … was struck with the ease with which the question of the heat of these spots

> could be determined by the use of the thermo-electrical apparatus. (Rothenberg et al., 1992: 145).

And on 4 January 1845, he proceeded to do so, when Stephen Alexander informed him that he had observed a very large sunspot (Rothenberg et al., 1992: 145–148).

Now Henry had an advantage over most astronomers. Not only was he aware of the Melloni thermomultiplier, which could detect small differences in heat, but he met Macedonio Melloni (1798–1854) in Paris in 1837, and Melloni had demonstrated the apparatus for him (Reingold et al., 1979: 394–397). Henry had quickly obtained one for Princeton. The apparatus consisted of a thermoelectric pile which would generate a current when a source of heat was present and a galvanometer which indicated the intensity of the heat (Figure 6).

There was a major limitation to the Melloni apparatus which in turn limited Henry's observations. The Melloni apparatus only had a relative scale. Although the bright solar surface repeatedly proved to be 1.5 degrees hotter on the Melloni scale than the sunspot, Henry had no idea what that meant in terms of a temperature scale or even if the differences were linear. All he knew was that the sunspot was cooler.

Henry repeated the observations later in January and in February (Rothenberg et al., 1992: 160–161; 221–222). In addition to observing the relative temperature of the sunspots, Henry compared the temperature between the solar center and the limb and found a distinct difference (Rothenberg et al., 1992: 163–164). He published a notice of his work in the *Proceedings of the American Philosophical Society* (Henry, 1845), and David Brewster announced his discovery to the 1845 meeting of the British Association (Rothenberg et al., 1992: 336) but Henry never completed the promised major paper. In 1848, he discussed his technique with Angelo Secchi (1818–1878), who was briefly in exile from Italy and residing at Georgetown College. Secchi took the technique and, upon returning to Rome, ran with it, without giving any credit to Henry. Soon, Henry's contemporaries credited Secchi with the insight (Rothenberg et al., 1992: 148).

Henry's observation only merited a single-sentence in his two-sentence entry in the *Biographical Encyclopedia of Astronomers* (Hockey, 2014). Why didn't Henry's broader insight that physical apparatus could be attached to the end of a telescope have a greater impact? Perhaps the answer lies in the lack of any follow-up by Henry to his announcement to the American Philosophical Society. And this failure is not an isolated event. Characteristically, Henry pursued a research problem for a limited amount of time, wrote a brief paper announcing his discoveries, and went on to a new problem. Around this time Denison Olmsted of Yale had written about "… men of one idea …", specialized researchers who pursued the study of nature deeply and narrowly. "Such a course will be the most likely of any to add to the sum of truth, and to gain [a researcher] a deathless name." (Olmsted, 1845: 7).

Henry did not quite fit Olmsted's definition of a man of one idea. During his career he pursued several research programs: acoustics, thermodynamics, terrestrial magnetism, meteorology, and of course, electromagnetic induction. In all these cases his research could be both broad and extensive (see Henry, 1886), but never quite brought to a conclusion. He also possessed a reluctance to put pen to paper. He returned to the United States in 1837 as knowledgeable as any American on the design and construction of astronomical observatories in England and France, but that knowledge remained buried in his letters and travel diaries, not to be shared with the American astronomical community. His insight in applying a thermoelectric pile to the problem of solar temperature was groundbreaking; his failure to continue his research on the topic and publish a comprehensive paper was characteristic. Henry summed up his publication career, and perhaps his failure to be transformative in astronomy, in an 1852 reflection on Secchi's publication on solar heat:

> It frequently happens that my results are so familiar to myself that I cease to put any value on them until some one else brings them forward or develops them in a more popular or a more definite manner. (Rothenberg et al., 1998: 350).

3 HENRY COMES TO THE SMITHSONIAN[3]

In December 1846 Henry is selected as the first Secretary of the Smithsonian. He was now a science administrator. Among his responsibilities was defending astronomy against attacks from politicians who thought the publication of ephemerides was a waste of money, and facilitating international communication among astronomers.

Henry's 1847 "Programme of Organization of the Smithsonian Institution" (*Smithsonian*, 1847: 173–177), which spelled out his plans for the Smithsonian, included the support of research through direct grants and the publication of original research in the *Smithsonian*

Contributions to Knowledge. Astronomy was one of the disciplines supported as witnessed by the publication of the paper by Sears Cook Walker (1805–1853) on the orbit of Neptune in the second volume of *Contributions* (Walker, 1851).

Such support was not without controversy. The publication of ephemerides and occultation lists was one of the targets of Senator Stephen A. Douglas (1813–1861), who wanted to divert the funds of the Smithsonian to agricultural research. The 1851 and 1852 clashes with Douglas were pivotal moments in Henry's secretaryship. He came out of the dispute with renewed confidence in the correctness of his program of supporting basic research and even managed to convert Douglas into a supporter (Rothenberg et al., 1998: xviii–xx). Perhaps his most memorable exchange with Douglas came at an 1851 agricultural society meeting. According to Henry, Douglas argued that the Smithsonian should confine itself "… to experiments and publications on agriculture than to waste the funds on matters pertaining to the moon." Henry responded,

> … that if the highest cravings of the human soul were confined to the desire for good potatoes this might be true. (Rothenberg, et al., 1998: 261).

One aspect of Henry's program was the diffusion of knowledge through the distribution of scientific literature. What began as the routine exchange of their own publications between the Smithsonian and learned societies in England grew into a much broader international exchange. The Smithsonian served as the middleman between the American scientific community and those in Europe. Publications flowed into Washington, D.C., from all over the United States, to be bundled and sent to agents in London, Paris, and Leipzig for further distribution. And those agents in turn forwarded material to the Smithsonian. Launched on a full scale in 1851, it grew quickly. The following year 1852 the Smithsonian sent almost eight thousand volumes overseas and received over five thousand foreign publications in return (Rothenberg et al., 1998: xxv–xxvi, 199). The exchange program continued in one form or another until 1992 (Smithsonian Institution Archives).

That solved one problem in the distribution of scientific information, but it did not solve a problem very pertinent to astronomy. How do you announce to the world the discovery of a new asteroid or comet? Until Henry intervened, such information would be distributed through the mail, requiring, for example, at least ten days to get from an observatory in the United States to one in Central Europe, and *vice versa*. But in January 1872, Christian Heinrich Friedrich Peters (1813–1890), the Professor of Astronomy at Hamilton College in upstate New York, and a German by birth with strong connections to the German astronomical community (Rothenberg, 2000), proposed that an international telegraph system be developed to distribute announcements, with the Smithsonian taking the lead. Henry persuaded both the Atlantic Telegraph Company, which ran the Atlantic cable, and Western Union to agree to free transmission of astronomical announcements. In May 1873, the system, which was a precursor of the Central Bureau for Astronomical Telegraphs, was in place, with the observatories in Greenwich, Paris, Berlin, and Vienna serving as the European nodes. In 1883, Spencer Baird (1823–1887), who had succeeded Henry as the Smithsonian Secretary, negotiated a transfer of control of the system in the United States to Harvard College Observatory (Rothenberg, et al., 2007: 447–448).

4 ATTEMPTS TO ESTABLISH ASTROPHYSICS IN THE UNITED STATES

In 1870 Henry took his second trip to Europe, where he visited Joseph Norman Lockyer (1836–1920) in England (Rothenberg et al., 2007: 302). He returned to the United States later that year full of enthusiasm for astrophysics. In response to a query from Leander James McCormick (1819–1900), who was planning to endow an observatory for the University of Virginia, he urged McCormick to fund an observatory to

> … investigate the nature and changes of the constitution of the heavenly bodies, to study the various emanations from these in comparison with the results of experiment. (Rothenberg et al., 2007: 340).

Henry provided other advice to McCormick based on his experiences and observations. One had to be careful about giving the observatory director too much teaching responsibility, but there should be some:

> … just enough by sympathetic communication with admiring pupils, to fan, as it were, his enthusiasm and to impart a portion of it to others. (Rothenberg et al., 2007: 342).

He warned of the danger of investing too much in the observatory building—to Henry a waste of money. Invest the funds in endowment for salaries and for instruments. As an example of an inexpensive building, Henry pointed to

Lockyer's observatory (Rothenberg et al., 2007: 342–343). As for the director of the observatory, he suggested making an offer to Lockyer (Rothenberg et al., 2007: 343). One of the points Henry made to McCormick was that an observatory

> … principally devoted to the observation and discussion of the motions of the planets and the determination of the relative positions of the fixed-stars …

such as Greenwich, was more expensive to operate than an astrophysical observatory because of the greater demand for staff. And a nation only needed one or two of these and the United States already had a fine one in the Naval Observatory (Rothenberg et al., 2007: 340).

Another opportunity arose for Henry to have an impact on American astronomy in 1873. That year Henry contacted James Lick (1796–1876), whom he had met during a trip to California in 1871, about Lick's proposed observatory. Henry made the same arguments to Lick as he made to McCormick regarding the cost of the building (he advised avoiding architects) and the need for an astrophysical observatory. Again, he argued that Lockyer would be the perfect director (Rothenberg et al., 2007: 482–484)

In both cases the complexity and expense of the construction delayed the observatory, as did other factors. The Leander McCormick Observatory was not completed until 1884 (Warner, 1968: 106), with Ormond Stone (1847–1933), who was not an astrophysicist, as Director (Teare, 2014), and McCormick Observatory was not launched as an astrophysical observatory. Lick did not begin operation until 1888 (Osterbrock, et al., 1988). Although it did open as an astrophysical observatory, there is no evidence that Henry's recommendation was a deciding factor (Wright, 1987). And Joseph Lockyer (Meadows, 2008) never took up a post in the United States.

5 CONCLUDING REMARKS

Upon reflection, Joseph Henry's direct contributions to the progress of astronomy are limited. He produced a few publications, but his knowledge of European observatories and his enthusiasm for astrophysics never translated into an observatory in the United States. His support was vital for the launching of the first system of the telegraphic distribution of astronomical discoveries, but the system was superseded after his death.

However, one might ask where astronomy in the United States would be in the twenty-first century if Henry had not successfully argued that understanding the orbit of the Moon was just as important as growing a great potato.

6 NOTES

1. Unless otherwise noted, information on Henry's life and work has been taken from the standard biography (Moyer, 1997).
2. Henry's copy of Volume 1 of Gregory (1808), with an inscription that summarized the impact of the book on his life, survives in the Alexander Graham Bell-Joseph Henry Library in the Dibner Library of the History of Science and Technology, Smithsonian Institution.
3. Jones (1965: 67–84) examined Henry's astronomical activities while at the Smithsonian, but only utilized printed and published sources.

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Dr. Marc Rothenberg studied astronomy at Villanova University and then received a PhD in history and philosophy of science from Bryn Mawr College. He is retired from the US Federal Government. After serving on the staff of the Joseph Henry Papers Project at the Smithsonian Institution from 1975 until 2006, he was agency Historian for the US National Science Foundation from 2006 until 2014.



Marc's primary interest is in nineteenth-century American science, especially science education in the United States from 1825 through 1875, the life and times of Joseph Henry, the founding and early years of the Smithsonian Institution, and the exploration of the United States by scientists. He has also ventured into the twentieth century, looking at the relationship between professional and amateur astronomers, the history of the National Science Foundation, and the history of the Cosmos Club in Washington, D.C.

He has served as Treasurer of the History of Science Society, 1997–2006; President of the Society for History in the Federal Government, 2012–2013; and Chair of the Historical Astronomy Division of the American Astronomical Society, 2014–2017.

Under his editorship the volumes of the *Papers of Joseph Henry* received the 2007 Eugene S. Ferguson Prize from the Society for the History of Technology and the 2009 Thomas Jefferson Prize from the Society for History in the Federal Government.