

The curious aftermath of *Neptune's discovery*

Deborah Kent

Controversy following the announcement of the new planet propelled US astronomers to the international limelight.

The sensational news of Neptune's observation reached the US about a month after the initial sighting at the Berlin Observatory just after midnight on 23 September 1846. The discovery was seen as a remarkable accomplishment of celestial mechanics. Not only was Neptune just the second major planet detected in recorded history, but the planet had been mathematically predicted before it was observed. The ensuing dispute over the priority of that monumental discovery captured both scientific attention and popular interest in Europe and the US. A handful of ambitious US scientists, by dint of personality and nationality, viewed the Neptune affair as a welcome opportunity to advance the visibility of US science and assert national scientific competence on an international stage. Prominent among them was Harvard mathematician Benjamin Peirce (pronounced "purse"), who questioned the mathematical particulars of Neptune's discovery and thus ignited controversy on both sides of the Atlantic.

Ambitions in the US

In the late 1830s and early 1840s, a core of elite scientists in the US worked to develop specialized publication outlets, improve advanced scientific training, and find funding to support research. They aspired to establish and define US science in response to perceived European scientific superiority. It seemed unlikely that the newly emerging scientific community in the US could eclipse European research in any well-established area. Continental researchers enjoyed the advantages of well-developed scientific infrastructure and quick access to new results, but US scientists would seek creative solutions.

In their short-lived research journal *The Cambridge Miscellany of Mathematics, Physics, and Astronomy*, Peirce and Harvard physicist Joseph Lovering planned to communicate European mathematics to their readers in hopes of engaging them in research. Peirce and Lovering aimed to focus US mathematical attention on light, astronomy, mechanics, and probability. They especially highlighted the field of

astronomy as an area in which mathematical sciences might excel—if support could be found. In advocating for science, the journal circulated impassioned appeals to national honor. The few astronomical observers that the US now has, Peirce wrote,

must leave the field or become martyrs to their perseverance, if their midnight toil is not to supply them their daily bread. The observer, who withdraws from all society, in order to devote his nights to watching the stars, is enervated by his loss of sleep, and unfitted for the labors of the day. He cannot live two lives; and if he works while others sleep, he must sleep while others work. While he sustains science, we must sustain him.¹

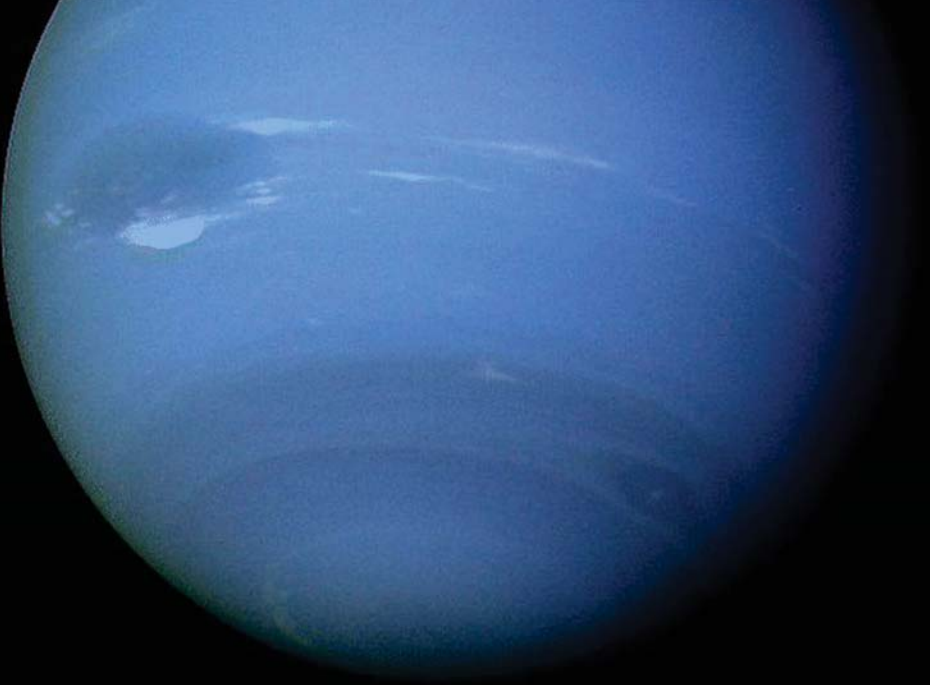
Peirce specifically requested that Harvard president Josiah Quincy fund William Cranch Bond, the first director of the Harvard Observatory, at "the same salary with one of the professors, so that he may devote the remainder of his life to the cause of American astronomy with undivided zeal."² Peirce emphasized the importance of Bond's work and stressed how "his observatory must compete with those of [George Biddell] Airy and [Friedrich] Bessel and [Otto] Struve. We are proud of his skill and genius," Peirce concluded, "let us give them fair play."

A new planet

Neptune had been sighted before its 1846 discovery, but it had never been recognized as a major planet. In 1843 University of Cambridge graduate John Couch Adams began to pursue the idea that the well-documented orbital deviations of Uranus resulted from an unknown body, probably a planet. Astronomer Royal Airy ignored Adams's computations. Telescope time from Cambridge Observatory director James Challis also eluded Adams, who needed observational data to confirm his prediction.

In the summer of 1845, French scientist Urbain Jean Joseph LeVerrier also started to study the irregularities of the orbit of Uranus. LeVerrier's predicted location for the perturbing body, "a planet as yet unknown," appeared in the *Times* of London in

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The planet Neptune was discovered in 1846 by German astronomer Johann Galle and his assistant Heinrich Louis d'Arrest. This image was captured by the *Voyager 2* spacecraft in the summer of 1982. (Courtesy of NASA.)

July 1846. Earlier that month LeVerrier had written about his predictions to Airy, who recalled Adams's previous work and pressed Challis to conduct a search at the Cambridge Observatory. Airy asked Adams to prepare a star catalog to facilitate British observations, which began in late July. Although Challis did sight Neptune, his search technique did not allow him to realize he had in fact located the new planet.

Meanwhile, after a lukewarm reception from French observational astronomers, LeVerrier sent his request to Johann Galle at the Berlin Observatory. Galle agreed to look for the unknown planet, guided by LeVerrier's prediction. Galle's student assistant Heinrich Louis d'Arrest chose their complete copy of the detailed Berlin Academy star map for the project. According to d'Arrest, after less than an hour of observing, Galle reported "there is a star of the 8th magnitude in such and such a position, whereupon I immediately exclaimed: that star is not on the map!"³ The observation occurred 15 minutes after midnight on 23 September 1846. Although 19th-century contemporaries awarded the optical discovery to Galle, scholars now generally agree that Galle and d'Arrest jointly discovered the planet at the telescope in Berlin.

Galle verified the initial observation the following night. The next morning he sent word to LeVerrier saying, "The planet whose position you have indicated really exists."⁴ By 1 October, the news reached London, where it appeared in the *Times*. Controversy ensued. Some at the University of Cambridge lamented their near victory, swapped accusations of blame, and fought to salvage a share of the fame. Others in the UK argued that Adams did not deserve any credit. In France, too, some scientists quibbled about particulars of the discovery and regretted that the first sighting had not happened in France. As claims of priority and charges of plagiarism ricocheted across the channel, both the Paris Academy of Sciences and the Royal Society of London waved flags of national pride.

Eventually, tempers cooled and enough facts came to light for the fellows of the Royal Society of

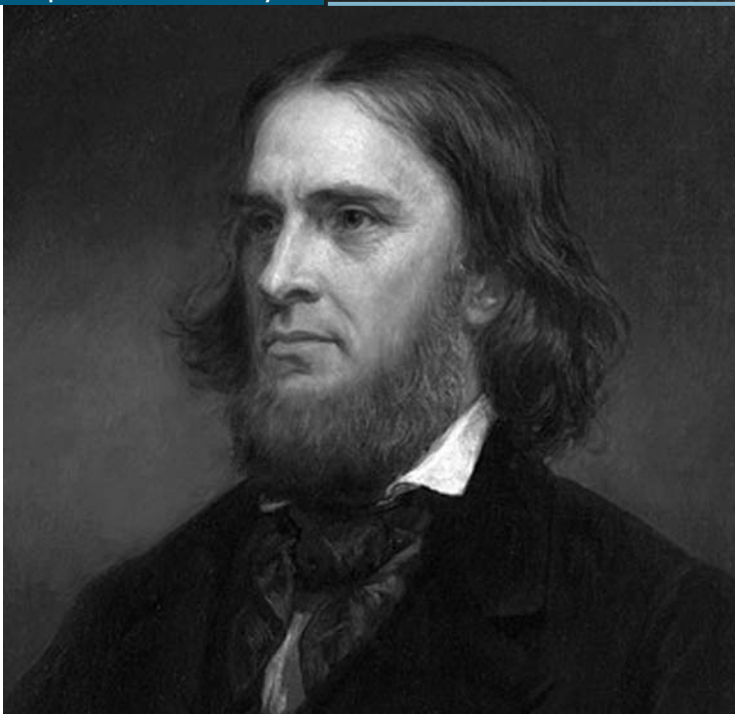
London to award the Copley Medal to LeVerrier in 1846. At the time they deemed Adams's involvement too tentative, although he did receive the Copley Medal in 1848. The Royal Astronomical Society, on the other hand, eventually gave up after extensive deliberation and decided not to award its Gold Medal to anyone in 1847. The following year the Royal Astronomical Society voted to suspend the bylaws relative to medals and instead awarded 13 testimonials to individuals—including Adams and LeVerrier—whose astronomical services would have been "under ordinary discussion for the medal of 1848."⁵

Traditionally, historians have credited both LeVerrier and Adams with independent mathematical predictions for the location of the planet Neptune. In 1999, however, the "Neptune File" of correspondence related to the planet's discovery appeared in Chile after having been missing from the Royal Observatory, Greenwich, for decades. That same year St. John's College library in Cambridge completed a computer index of the John Couch Adams archives. Together, those two events fueled scholarship that reevaluated the traditional story; the revised narrative attempted to claim sole priority for LeVerrier, asserting that the recovered documents demonstrated how Adams's credit resulted from intentional post-discovery spin formulated by some British administrators of science.

Enter US scientists

Once word of Neptune's discovery reached America via steamship, the sensational news became a hot topic for newspaper articles and letters to the editor. Not only were matters of planetary theory, predictive accuracy, and, ultimately, national pride paramount in those accounts, but newspapers also included mathematical details on which US astronomers staked a claim. Daily papers in Boston and Washington, DC, would, in fact, serve as primary outlets for American results.

How had LeVerrier and Adams arrived at their predictions? Locating an unknown perturbing body was a difficult business at best and involved a



Harvard University mathematician Benjamin Peirce championed US science and challenged the validity of the European claim of Neptune's discovery. This portrait was painted by Daniel Huntington in 1857.

determination of its orbital elements from the discrepancies in the orbit of Uranus. In their approach to the problem, Adams and LeVerrier used the Titius–Bode law—an empirical rule that adequately approximates the semimajor axes for planets Mercury through Uranus—to determine the orbital radius of the perturbing body. Both Adams and LeVerrier relied on Laplace's theory of perturbations as it appeared in Philippe le Doulcet de Pontécoulant's text *Théorie analytique du système du monde* (*The System of the World*). Adams used perturbation theory and tinkered with various values for orbital elements of a possible eighth planet to decrease the differences between the calculated and observed orbits of Uranus. The assumption of the Titius–Bode law distance for the hypothesized eighth planet produced a highly ec-

centric orbit. The computation of Adams and LeVerrier involved a Fourier expansion with 79 separate cosine arguments and 144 terms. Suffice it to say, the two scientists had chosen a challenging problem.

When LeVerrier's first published predictions for the location of the as yet undiscovered planet reached Washington, DC, in August 1846, US Naval Observatory scientist Sears Cook Walker suggested to his superintendent Matthew Fontaine Maury an immediate investigation. Although Maury listened to Walker's idea, more pressing duties took priority. But when word of Galle and d'Arrest's discovery reached Washington two months later, Maury remembered the suggestion and appointed Walker to investigate the new planet. They hoped to earn credit for some related discovery.

Walker initially examined old catalogs of star sightings, searching for something seen and recorded in approximately Neptune's location. He discovered that about 50 years earlier, on 10 May 1795, French astronomer Joseph Jérôme Lalande had observed something of the eighth magnitude within the limits of the Neptunian region Walker had calculated. Walker then refined his orbital calculations under the assumption that Lalande had seen Neptune. His new computation suggested a nearly circular orbit for the planet. Walker published that result in the Washington *Daily Union* newspaper on 9 February 1847, along with an announcement identifying Lalande's earlier sighting as Neptune.

The following week Maury reprinted Walker's findings in the Boston *Courier*. A copy of that newspaper arrived in London, where a state agent sent it on to LeVerrier in Paris. LeVerrier received Walker's conclusions the same day he got word from German astronomers who had also discovered the Lalande sighting. LeVerrier then asked Victor Mauvais at the Paris Observatory to consult Lalande's original manuscripts for more unpublished observations. LeVerrier reported those new developments to the Paris Academy, which published Walker's results in its March 1847 proceedings.

"A happy accident"

In the same month that the Paris Academy published Walker's results, Peirce communicated them

Harvard University. May 9. 1845

Dear Sir,

The tender, which has just been made to Mr Bond of the superintendence of the National Observatory at Washington, and the opportunity of securing to his son George, an excellent situation in the same observatory, have most forcibly pressed upon me the somewhat mortifying fact that Mr Bond and his son are laboring at our observatory without any other compensation than the mere rent of his house. The

In this letter to Harvard University president

Josiah Quincy, Benjamin Peirce argues for the importance of adequately funding Harvard Observatory director William Cranch Bond and his son, George. The letter begins, "The tender, which has just been made to Mr Bond of the superintendence of the National Observatory at Washington, and the opportunity of securing to his son, George, an excellent situation in the same observatory, have most forcibly pressed upon me the somewhat mortifying fact that Mr Bond and his son are laboring at our observatory without any other compensation than the mere rent of his house."² (Courtesy of the Harvard University Archives.)



The Berlin Observatory was the site of Neptune's discovery. This etching of the observatory was created by Ernest Grünewald in 1835. (Used with permission of the Bildarchiv Preussischer Kulturbesitz, Berlin/Art Resource, New York.)

to Boston's American Academy of Arts and Sciences. He explained that he had undertaken a careful re-examination of the data, inasmuch as the details of Walker's orbits deviated so widely from the predictions of Adams and LeVerrier. Peirce verified Walker's results and also asked Harvard Observatory director William Bond and his son George to investigate Neptune's distance and motion from observations conducted only at the Harvard Observatory. Walker's twice-confirmed results convinced Peirce that the actual orbit of Neptune differed from that predicted by LeVerrier and Adams. Before Boston's academy, Peirce asserted that "Neptune is not the planet to which geometrical analysis had directed the telescope; that its orbit is not contained within the limits of space which have been explored by geometers searching for the source of the disturbances of Uranus; and that its discovery by Galle must be regarded as a happy accident."⁶

To substantiate his incendiary statement, Peirce incorporated data from Lalande's observations to compute a less eccentric orbit of Neptune. He took issue with the distance limits LeVerrier used, claiming that LeVerrier's planetary equations could not explain the perturbations of Uranus. In sum, Peirce concluded, "Neptune cannot . . . be the planet of M. LeVerrier's theory."⁷

Peirce nevertheless held that the "real" planet Neptune could account for the disturbances in Uranus's orbit if the problem were reconsidered with a more probable mean distance. Peirce said LeVerrier had arrived at a practical solution to "where among the stars astronomers must look in order to see the disturbing body,"⁸ but had not pro-

vided orbital elements for that body. Peirce demanded a complete orbit for Neptune. While awaiting additional observations to fortify their theory, Walker and Peirce continued to tweak their calculations and agreed that "nothing but a rigorous calculation of the perturbations of Neptune can throw any further light on the subject at present."⁹

For 18 months Walker and Peirce corresponded about the brightness, mass, distance, and motion of Neptune. They tinkered with their calculations as Walker compiled more than 500 observations. Peirce admitted the possibility of error but insisted that the



Sears Cook Walker, working at the US Naval Observatory, calculated Neptunian orbits that were at odds with those assumed by discoverers Johann Galle and Heinrich Louis d'Arrest. This portrait first appeared in an 1894 issue of *Popular Science Monthly*.

Principal US cast members in the Neptune drama

► **George Phillips Bond** (1826–65). Observational astronomer. In 1850 he and his father William were the first in the US to use daguerreotypes for astrophotography.

► **William Cranch Bond** (1789–1859). First director of the Harvard Observatory (1839–59). He and his son George discovered Saturn's moon Hyperion in 1848.

► **Asa Gray** (1810–88). Professor of botany, University of Michigan (1838–42) and Harvard University (1842–73). Instrumental in introducing Charles Darwin's theory of natural selection to the US, Gray also built a major herbarium at Harvard, wrote significant botanical textbooks, and linked US and European botanists through specimen exchanges and visits.

► **Matthew Fontaine Maury** (1806–73). US Navy lieutenant and first superintendent of the US Naval Observatory (1842–61). Maury championed international collaboration for charting seas, currents, and weather. Pope Pius IX established flags of distinction to be given to papal ships that kept log books for Maury.

► **Benjamin Peirce** (1809–80). Self-educated mathematician and professor at Harvard University (1833–80). In addition to serving as US Coast Survey superintendent from 1867 to 1874, Peirce authored *Linear Associative Algebra* and was instrumental in developing Harvard's mathematics curriculum. His son, Charles Sanders Peirce (1839–1914), was a philosopher, logician, and founder of semiotics. The surname is pronounced "purse," as the Peirces also explained to their contemporaries. Wordplay like "Peirceverance" and "Peircepicacious" appears in family correspondence.

► **Sears Cook Walker** (1805–53). Astronomer. Walker oversaw the Philadelphia High School Observatory before spending 1846 on staff at the US Naval Observatory. He and superintendent Maury did not get on well, and in 1847 Walker left the observatory to work at the longitude department of the US Coast Survey. There, he helped develop a method to determine longitude differences by means of a telegraph.

orbit deduced from observation had not yet been reconciled with theory. Likely few in Peirce's audience either comprehended the details involved or shared his concern with perfecting the theory of the new planet. Certainly, many did not share his comfortable self-assurance with the happy-accident hypothesis.

Reactions at home and abroad

Peirce's effort to make an international splash created nervous ripples in US scientific and political circles. Smithsonian Institution secretary Joseph Henry thought his friend had been premature in criticizing LeVerrier. Geologist James Dwight Dana pronounced Peirce's actions a "national calamity" and was appalled that Peirce had made himself a "critic upon European astronomy."¹⁰ Successor to Harvard president Quincy and former US minister to Great Britain, Edward Everett, worried about the public condemnation Peirce might bring on Harvard and the US. He entreated the American Academy not to endorse the improbable happy-accident idea. Everett actually requested that Peirce suppress the announcement of his results because they were so improbable. With characteristic bravado, Peirce replied, "It is still more improbable that there can be an error in my calculations."¹¹

Three days after the happy-accident pronouncement, Harvard fellow Jared Sparks (who

eventually succeeded Everett as the university's president) recommended a press release to modify Peirce's position since it was "extremely important that the first impression in Europe should be accurate . . . and [Peirce's] reputation is so much concerned that no pains should be spared to set the matter in a true light."¹² Peirce did release a statement that praised LeVerrier's genius, but he retracted neither the happy-accident hypothesis nor his specific criticisms of LeVerrier's calculations.

On the other hand, outspoken advocates for US science, such as astronomer Ormsby Mitchel and Benjamin Gould and botanist Asa Gray, applauded Peirce's efforts in defense of American astronomers who "have been passed over in silence, or met with sneers instead of arguments."¹³ Gray felt that Peirce's response to LeVerrier did Peirce "the highest credit" and was "just the style of reply calculated to place [him] at the greatest advantage."¹⁴ For those and other elite scientists, the pride of national science was at stake in the Neptune controversy. Amid hot debate over predicted and observed orbital elements, there was more concern about national scientific reputation than the correctness of painstaking orbit calculations.

The nascent US scientific community was caught in tension between desiring approval and asserting independence. Some, who wanted to avoid upset, attributed the onslaught of Peirce's publications and rescissions to overhasty calculation or personal overreaction. Others hoped to use the Neptune discussion to steal some limelight for the good of US science. Since Peirce raised the loudest American voice in the Neptune controversy, Sparks was right: The reputation of US science abroad was interlaced with Peirce's own European reputation.

So, what was the European response to the criticism from Peirce? The popular press maintained an air of self-assured scientific superiority. More serious scientific institutions radiated disapproval. The Royal Astronomical Society, for one, argued that accidental planetary discovery was unlikely and requested that Peirce suppress his paper. LeVerrier, meanwhile, "resented disparagement of his discovery" and wrote a scathing letter to the *National Intelligencer* in Washington, DC, in which he attacked Peirce and highlighted errors of detail. Peirce's response only escalated the situation. When George Bond visited France in 1850, he found LeVerrier still irritated about the exchange. Adams expressed the view that Peirce's objections were "founded on imperfect views of the nature of the planetary perturbations."¹⁵ Airy wrote to a colleague that the Americans stressed the phenomena of occultations too much in determining distant longitudes.

Shortly after Peirce announced his happy-accident hypothesis, the priority dispute in Europe died down as some astronomers redirected their antagonism toward US scientists. In November 1847 Glasgow astronomer John Pringle Nichol voiced a general feeling that the controversy had ended among European astronomers, but he continued to attack the happy-accident hypothesis. During an 1848 lecture in New York, he pointedly critiqued Peirce's view. English polymath John Herschel,

whose father had discovered Uranus, used an assault on Peirce's results to press the joint claims of Adams and LeVerrier. German mathematician Carl Jacobi viewed Peirce's "monstrous assertion" as harmful to the cause of astronomy in general. He declared it a great public disservice for a scientific authority to undermine a discovery that was "achieved through deep thought and years-long labor" by suggesting that "an accident had prevailed or played a part" in a work that would "be envied by our posterity and by our own time."¹⁶

Not everyone agreed. Airy—with perhaps his own political reasons—acknowledged that Peirce's work had proven LeVerrier's orbital elements to be incorrect. George Bond received praise in the UK as an excellent observational astronomer. Mathematician Carl Friedrich Gauss, too, viewed the US work favorably. He respected Peirce's position in the controversy and was also impressed by Peirce's subsequent work in analytic mechanics. The very selective journal *Astronomische Nachrichten* saw fit to republish Peirce and Walker's orbit calculations.

Peirce and like-minded countrymen hoped that the Neptune affair was only the beginning of a mathematical dialog with researchers abroad—particularly theoretical and observational astronomers. The 1846 report of the Harvard Observatory indicates a move toward increased cooperation. Specifically, the director of the observatory was expected to "establish and maintain a regular correspondence with the astronomer royal of England, and with the Directors of some of the principal observatories upon the continent of Europe." Peirce also gained approval to employ an agent in London to "send by every royal mail steamer to Boston, the latest astronomical intelligence received in London."

At a time when perceived arrogance from the European scientific establishment troubled some US scientists, the Neptune controversy enabled them to mount a defense of US science. While some French and British scientists and administrators quibbled over priority, Peirce and Walker—considered upstart US scientists—dared to question LeVerrier's mathematics. Though the mixed response from Europe distressed colleagues who desired only the approving nod of French and British academies, it also proved that US mathematics was entering the international scientific stage, with Peirce playing a leading role.

Although it is difficult—perhaps impossible—to sort out all the inflammatory letters and rapid-fire calculations and precisely to track Peirce and Walker's orbit calculations, it appears that the two US scientists were the first to determine an accurate, complete orbit for Neptune. Walker's early discovery that Lalande had spotted Neptune gave the Americans a significant advantage. Not only was Peirce galvanized by the opportunity provided by the planetary controversy, but he and Walker both worked quickly.

It is remarkable that US scientists challenged their European counterparts—and arguably triumphed—on a mid-19th-century question of cutting-edge research. As Airy wrote in 1847, "The

history, since the discovery of the planet, is, I think, more curious than that before the discovery."¹⁷

The online version of this article includes an extended list of additional resources.

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