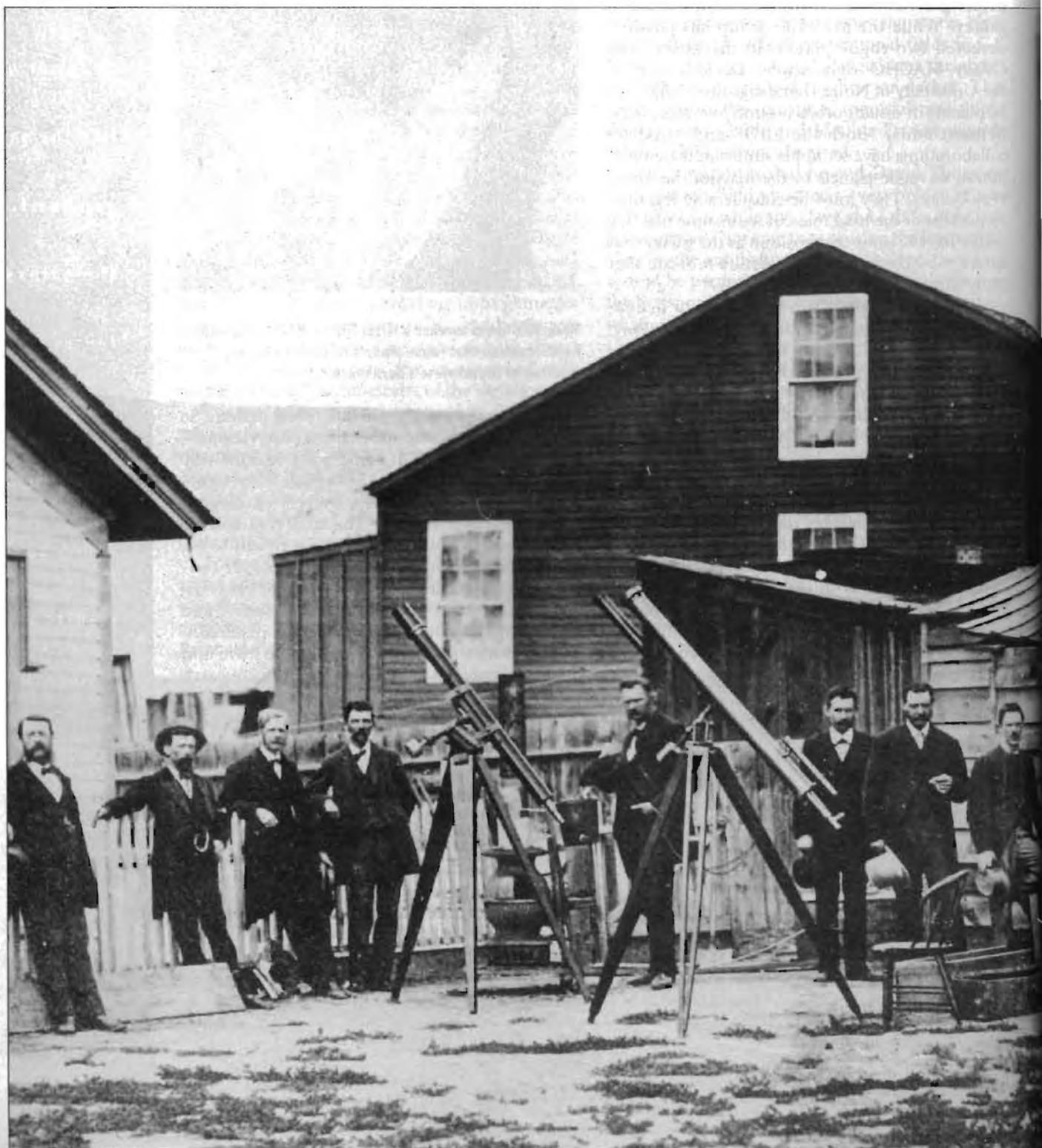


# V U L C A N





## *The Search for an Inside Planet*

by **William Sheehan**  
and **Richard Baum**

**I**N SEPTEMBER 1846, AT THE AGE OF 35, URBAIN JEAN Joseph Le Verrier of France stood at the pinnacle of the astronomical world. His calculations had led to one of the supreme discoveries of astronomy — Neptune, a giant world circling the sun in the frigid realm beyond Uranus, the hitherto most remote known planet. Neptune had been sighted by Johann Galle of the Berlin Observatory less than one degree from the position predicted by Le Verrier based on its gravitational disturbances of the motion of Uranus. The discovery was hailed as a remarkable vindication of Newtonian theory.

Now Le Verrier returned with confidence to another problem that had hung like a dark cloud over him. Having reordered the outer solar system he turned his attention to Mercury, on its inner edge. Mercury is a difficult object to observe because of its proximity to the sun. Some 13 times a century it passes in front of the solar disk and during these transits, its position relative to the sun can be measured with great accuracy — to within an error of only one arcsecond. Thus its motion is perfectly known. In the absence of the disturbing action of the other planets, the perihelion of its elliptical orbit — the point where it approaches nearest to the sun — would remain fixed unalterably in space. But the other planets pull on Mercury and cause the line between its perihelion and the sun to advance slowly forward. From an exhaustive analysis of the timings of Mercury's transits, Le Verrier found that the rate of precession was slightly faster than predicted by Newtonian law. The discrepancy was minute — according to Le Verrier's calculations, the planet completed one extra unexplained revolution every 3,000,000 years. Still, it was enough to suggest a crack in the foundations of celestial science.

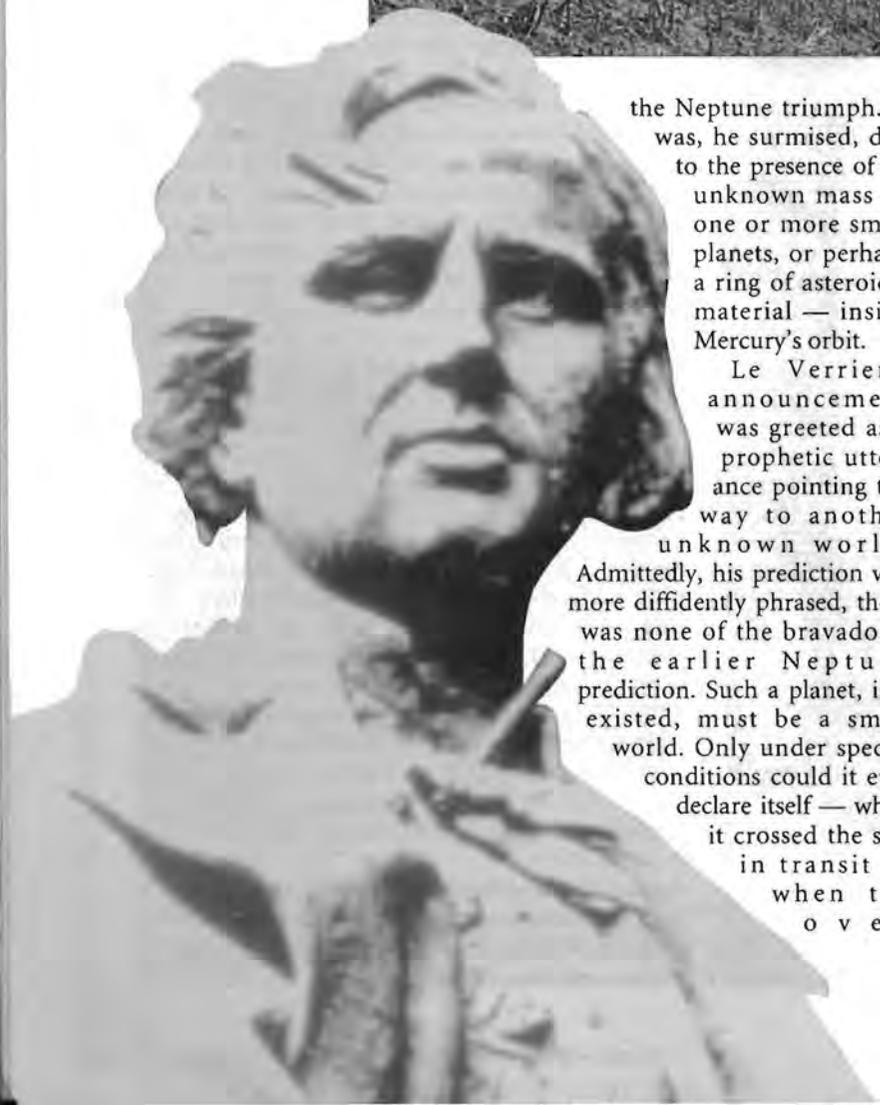
By September 1859, Le Verrier had resolved to account for the unexplained advance of Mercury's perihelion using the same strategy that had led to

**James C. Watson (sixth from right) and famed inventor Thomas A. Edison (second from right) sought Vulcan during an 1878 eclipse expedition to Rawlins, Wyoming.**

The Mary Lea Shane Archives of the Lick Observatory

The small brick building in front of the Washburn Observatory housed Watson's 24-foot-long hole in the ground, from which he searched for Vulcan.

The Shane Archives



the Neptune triumph. It was, he surmised, due to the presence of an unknown mass — one or more small planets, or perhaps a ring of asteroidal material — inside Mercury's orbit.

Le Verrier's announcement was greeted as a prophetic utterance pointing the way to another unknown world. Admittedly, his prediction was more diffidently phrased, there was none of the bravado of the earlier Neptune prediction. Such a planet, if it existed, must be a small world. Only under special conditions could it ever declare itself — when it crossed the sun in transit or when the  
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powerfully brilliant disk of the sun was darkened in eclipse. Even then, it was hard to imagine how it could have been missed by earlier scourers of the sky, because the mass required to throw Mercury off its predicted course was apparently equal to that of Mercury itself. "How could a planet," Le Verrier wondered, "extremely bright and always near the sun, fail to have been recognized during a total eclipse? And would not such a planet pass between the sun and Earth, thereby making its presence known?"

There were good reasons for Le Verrier's diffidence. Astronomers had carefully watched the face of the sun ever since the invention of the telescope. A particularly thorough survey had been carried out by German pharmacist Heinrich Schwabe. Hoping to find an intra-mercurial planet, Schwabe, beginning in 1826, examined the sun's face every clear day he could — an average of about 300 days a year. He kept up his vigil for 12 years, recording every small spot that could be regarded as a suspect. During all this time he noted no new planets, though he did record something of even greater consequence: the 11-year sunspot cycle. He wrote

**French mathematician Urbain Jean Joseph Le Verrier started the Vulcan goose chase. His calculations revealed a nagging, unexplained discrepancy in Mercury's orbital motion.** Astronomical Society of the Pacific

afterwards: "I may compare myself to Saul, who went out to seek his father's asses and found a kingdom."

Le Verrier had no sooner dropped his bombshell on the astronomical world when he received a curious response. A country doctor and amateur astronomer in the small village of Orgères-en-Beauce, Edmond Modeste Lescarbault, who for many years had been secretly pursuing his own quest for an intra-mercurial planet, claimed to have recorded it as a small black spot in transit across the sun. He made the observation on March 26, 1859, but communicated it to Le Verrier only in December. The master mathematician reacted with indignation — who was this amateur Lescarbault, and why had he remained silent for so long? Still, despite his skepticism, he could not put the matter out of his mind. On New Year's Eve, 1859, he decided to pay an unannounced visit to Orgères and walked 15 miles from the nearest train station to the doctor's house, easily distinguished by the cupola-observatory atop Lescarbault's office. He rapped imperiously at the door, and was greeted by a shy little man — a case of the lion and the lamb. The Parisian put a series of probing questions to Lescarbault. After about an hour he left satisfied Lescarbault could be trusted; he returned to Paris convinced — as he would remain for the rest of his life — of the reality of the new planet. He and Lescarbault apparently never met again.

The planet was duly given a name, Vulcan, after the Roman god of fire. It soon became "the only topic of converse at the seances of philosophy and the salons of fashion. Garibaldi and the weather were no longer of interest; and the village doctor, in his extempore observatory . . . were the only subjects of discussion." The shy little doctor, at Le Verrier's insistence, was awarded the Legion of Honor by Napoleon III, while Le Verrier was acknowledged as one of the great heroes of science and received the adulation of an awestruck world.

But then, unexpectedly, Vulcan began to fizzle. Le Verrier suggested that it ought to transit the sun once or possibly twice in late March or early April, also in late September or early October, each year. Beginning with its next predicted transit, in March 1860, it failed to keep its scheduled appointments. Nor did it register an appearance at the July 1860 total eclipse in Spain. Disappointment grew into disillusionment, and Vulcan became suspect. "I refuse to go on a wild goose chase after Le Verrier's mythical birds!" declared astronomer C. H. F. Peters of Hamilton College, New York, at the eclipse of 1869.

Whether irritation at Vulcan's failure to show itself had anything to do with Le Verrier's increasing reputation for ill-temper is unknown. Certainly he was much feared by his subordinates at the Paris Observatory. In appearance, he was "a decided blond, with light chestnut hair turning gray, slender form, shaven face, rather pale and thin, but very attractive, and extremely intellectual

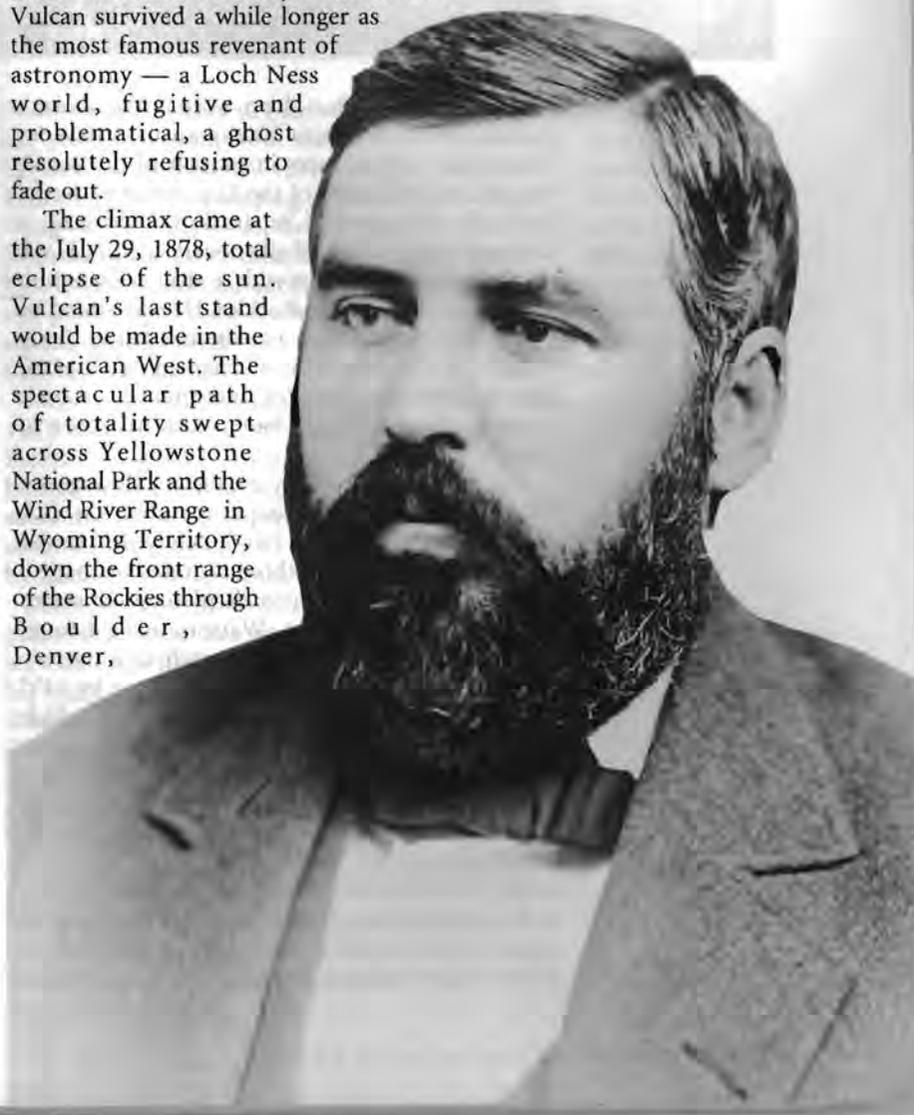
features." But his personal manner was less attractive than his features. One colleague described him as a *mauvais coucheur* (a bad bedfellow), while an English scientist who wanted to meet him during a visit to Paris was warned: "I do not know whether M. Le Verrier is actually the most detestable man in France — but I am quite certain that he is the most detested." After his staff threatened to resign in 1870, he stepped down as director of the Paris Observatory, but returned to power after his successor, Delaunay, died in a boating accident. (Delaunay had an extreme phobia of water, as both his father and brother had drowned. He crossed the English Channel only once, in order to accept the gold medal of the Royal Astronomical Society. In autumn 1872, he departed from his usual caution and accepted an impromptu invitation to go sailing; immediately a sudden squall came up, and the boat, with the unfortunate Delaunay on board, was lost.)

When Le Verrier died on September 23, 1877 — the anniversary of the discovery of Neptune — Vulcan was qualified with a question mark and skepticism was widespread. Still, many astronomers held out hope since there was no obvious alternative for unraveling the troublesome matter of Mercury's motion. So Vulcan survived a while longer as the most famous revenant of astronomy — a Loch Ness world, fugitive and problematical, a ghost resolutely refusing to fade out.

The climax came at the July 29, 1878, total eclipse of the sun. Vulcan's last stand would be made in the American West. The spectacular path of totality swept across Yellowstone National Park and the Wind River Range in Wyoming Territory, down the front range of the Rockies through Boulder, Denver,

**James Craig Watson searched for Vulcan at the bottom of a 24-foot-deep underground shaft.**

The Shane Archives



**Albert Einstein's general theory of relativity brilliantly solved the Mercury mystery. Vulcan was no longer necessary.**

Yerkes Observatory



and Pikes Peak, then across Oklahoma Indian Territory into Texas and Louisiana. Among the astronomers in pursuit of the planet was Simon Newcomb of the U.S. Naval Observatory, who observed at Separation, Wyoming, a railroad station in a dull, nearly uninhabited sagebrush-covered plain with a view bounded by the distant peaks of the Rockies. He was joined by University of Michigan astronomer James Craig Watson, a heavy-set man nicknamed "Tubby" by Ann Arbor undergraduates, and renowned for his mastery of celestial mechanics and his score of asteroid discoveries.

On the morning of July 29, the sky throughout Wyoming was, as a local paper reported, "as slick and clean as a Cheyenne free-lunch table." In the early afternoon, as the three minutes of totality began, Newcomb used a small telescope to sweep the space east of the sun. Watson, using a four-inch refractor, confined his search to a narrow zone on either side of the sun  $15^\circ$  long by  $1\frac{1}{2}^\circ$  wide. Possessed of a phenomenal memory which had won him a reputation as a lightning calculator, Watson had previously memorized the positions of all stars on a map of this zone down to seventh magnitude. Thus he got over the ground quickly. He covered the sky east of the sun where Newcomb was roving, then began sweeping to the west; between the sun and Theta Cancri. He came across "a ruddy star," not on the map, of about magnitude 4.5. Resuming his sweep even

farther west, he came across another, even brighter red star, hurriedly marked its position, and ran over to Newcomb to try to get him to verify it. Newcomb, alas, was absorbed in tracking down his own planet suspect — a mere star, it later proved. Then suddenly the eclipse was over.

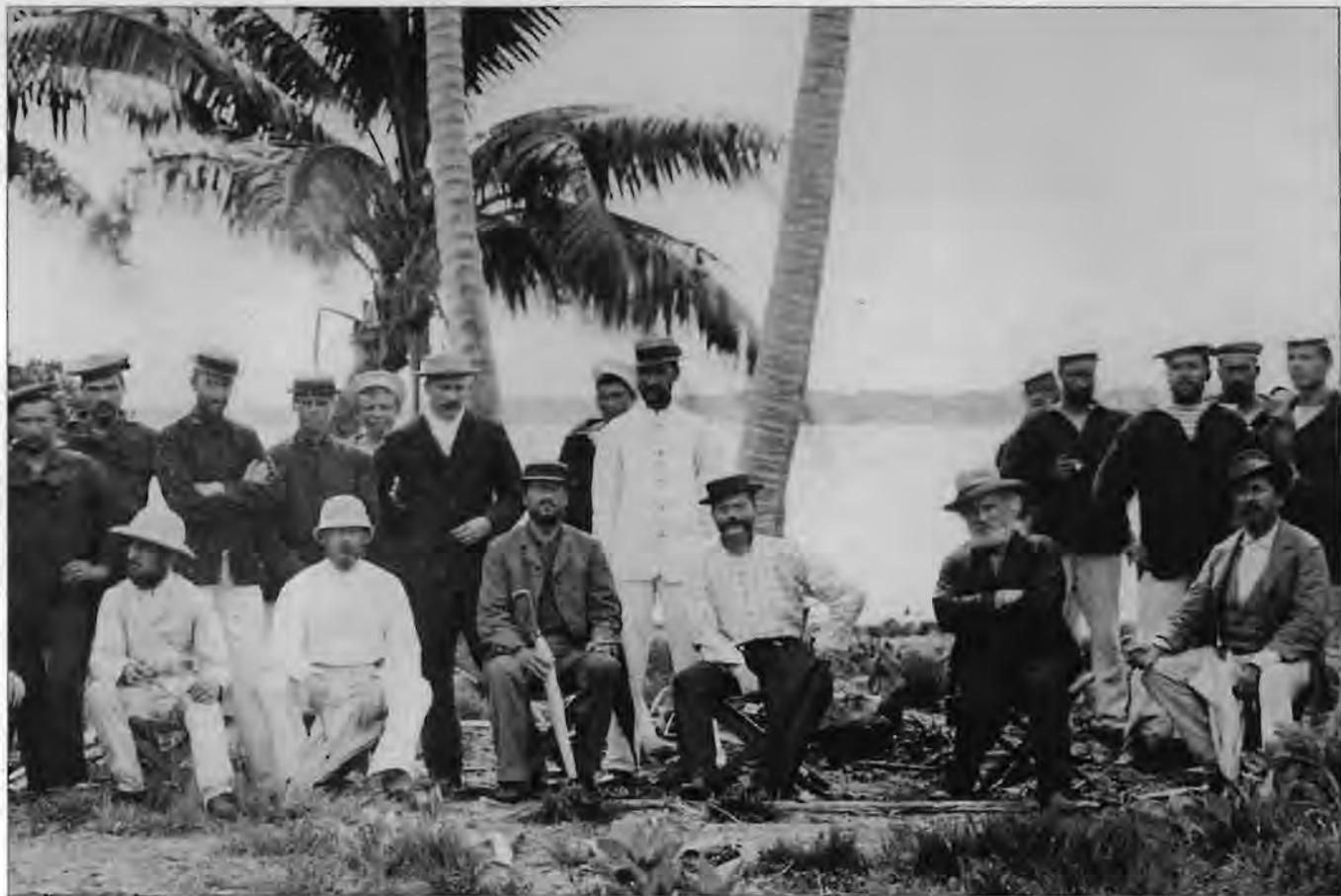
Watson, unquestionably a skilled observer, was convinced that he had seen one, possibly two, intra-mercurial planets. However, his observations were later criticized by Peters, who suggested he had made a simple mistake and incorrectly marked the two stars Theta and Zeta Cancri, "haste and excitement doing the rest."

Watson refused to give up and spent the rest of his life pursuing his Vulcan obsession. After leaving Ann Arbor to supervise the building of the magnificent Washburn Observatory at the University of Wisconsin in Madison, he became, literally, a man with tunnel vision. He planned to track down Vulcan in broad daylight with a telescope located at the bottom of a 24-foot-deep shaft dug into a hill near Lake Mendota, hoping the shaft would act like an enormous dew cap and allow him to see stars near the sun against the bright sky. (The idea dates back to Aristotle, who once commented that stars could be seen during

**Christian Heinrich Friedrich Peters remained skeptical of Vulcan's existence, declaring "I refuse to go on a wild goose chase after Le Verrier's mythical birds!"**

The Shane Archives





the daytime from deep wells; however, it had been debunked many times before Watson tried it.)

**J**ames C. Watson died in November 1880 before the project was finished. He fell to complications of pneumonia contracted during the harsh Wisconsin winter — not, as rumored, while burrowing in the underground observatory but rather while supervising the installation of a furnace in the nearby director's house.

When his successor, Edward S. Holden, arrived in Madison the following spring to finish work on the underground observatory, Peters warned him: "One thing I would beg you most earnestly: Do not sit in that subterranean hole, to watch until Vulcan passes. Not that I apprehend you might discover him . . . but it might deadly ruin your health, and you better fill up the hole." Holden made a few observations in order to satisfy himself that it would be impossible to observe Vulcan by daylight — it was impossible — and the underground observatory was abandoned forever. In the 1930s, the tunnel was deemed a hazard by the university's building and grounds department and filled in; in the 1940s, the building was torn down completely. There is no longer any trace of it.

After Watson's death, Vulcan's fortunes fell, never to recover. The advance of Mercury's perihelion was brilliantly explained by Albert Einstein in November 1915 at his desk in Berlin

— his general theory of relativity finally exorcised the ghost of Vulcan from the inner solar system. Einstein presented a new theory of gravitation that conceived of it as a warping of the fabric of space-time. According to his theory, Mercury should precess slightly faster than the Newtonian rate — by 0.1 arcseconds for each orbital revolution of the planet, or 43 arc-seconds per century. This agreed exactly with the observed rate. Vulcan became redundant.

Nevertheless, Watson's observations at the 1878 eclipse have never been fully explained. Peters may well have been right in supposing that he had simply misidentified known stars, but a more intriguing possibility is that he saw a pair of small sun-grazing comets such as those recorded by satellites in recent years. The mystery remains.

Though now almost forgotten, Vulcan, the planet that never was, reminds us that those who seek do often find. Dead-end though it proved to be, Vulcan is more than a ghost; it is a reminder of discoveries — Schwabe's sunspot cycle and Einstein's theory of gravitation — far more important than the fugitive speck of matter that astronomers long dreamed of capturing on the inner edge of the solar system. ■

*William Sheehan and Richard Baum co-authored In Search of Planet Vulcan: The Ghost in Newton's Clockwork Universe (Plenum Press, 1997).*

**Astronomers traveled to Caroline Island in the central Pacific to search for Vulcan during an 1883 solar eclipse. Astronomer Edward S. Holden wears the checkered shirt.**

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