

Air and Space this Week

Item of the Week

Triton

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William Lassell Cantaloupe Geysers

*Astronomer William Lassell discovered Triton, the largest (and then only known) moon of Neptune **175 years ago this October 10**. Both Neptune and especially Triton had a number of surprises for us the first time we saw them “up close.” Triton is not a mere icy ball, it has tectonic features on its surface and what appear to be active nitrogen geysers! But we’ve only seen it once, with the phenomenally-successful Voyager 2, in 1989.*

Voyager 2

This week’s Item is not a two-parter, but it does dovetail with a recent Item, “Two Accomplishments at Saturn,” here. Rather than repeat the info about the *Voyager 2* mission and spacecraft here, I’ll include the references in the web version of this Item, and refer you to [here](#) for the details.

The Discovery of Neptune

Uranus was discovered by William Herschel in 1781. He was systematically counting stars in sections of the night sky, in part to help determine the structure of the Milky Way, so his finding Uranus was not exactly accidental, but it’s not like he was specifically searching for a planet (as would be the case for Neptune and (dwarf) planet Pluto)).

Acceptance of Herschel’s finding a planet of our Solar System did not come right away. The same was true of Herschel’s choice for the name of the new object. The latter, “Georgium Sidus” or “George’s Star,” was Herschel’s gesture of appreciation to King George III, his patron. It was simply ignored in favor of “Uranus” (Saturn’s father), in keeping with the mythological gods and begets nomenclature. Careful additional observations and mathematical analysis, especially that of astronomer Johann Bode, would conclusively prove that Uranus was, in fact a planet, orbiting the Sun farther away than Saturn.

But that is not all careful observations and analysis showed. Working the math backwards showed and detailed analysis of astronomical records showed that Uranus had been spotted previously several times, but its non-star nature had not been recognized.

Continued careful tracking of Uranus showed that it deviated a slight amount from its predicted position, in a way that could not be mathematically duplicated, if Uranus was out there by

itself. But what if there were another planet out there, beyond Uranus? Could it be responsible for the exact location of Uranus?

There was another planet farther out there, and, like Uranus, it had already been observed a number of times before but not recognized as a moving object, including once by John Herschel, William's son.

Alexis Bouvard had made and published position predictions for Uranus, and his observations of the deviations made him hypothesize, in print, that another planet, farther out, might be responsible. He also listed a few other possible causes.

Bouvard's observations and hypothesis sparked the imagination of two men, John Couch Adams in England, and Urbain Le Verrier in France. Both made predictions about where a perturbing planet might be. Neither knew of the other or their interest in the same problem. Adams sent his to James Challis, the director of the Cambridge Observatory; Le Verrier sent his to the French Academy of Science. Either Challis sat on Adams' predictions, or the Astronomer Royal George Airy did, until word got to England of Le Verrier's prediction. The English began a systematic search in July, 1846, but Challis' star maps were not strictly up-to-date; he actually saw Neptune twice without knowing it.

Le Verrier has having more trouble inspiring his countrymen to action than Adams. Finally, he sent his predictions to Johann Galle at the Berlin Observatory. Galle immediately jumped into action, along with his student Heinrich d'Arrest, who knew of a recently-prepared chart of the part of the sky in which Le Verrier's prediction lay.

Neptune was discovered after only *one hour* of searching. It was only 1° off from Le Verrier's predicted position. Adams had presented at least some predictive material up his chain first, but it was Le Verrier's more-complete predictions that actually led to the discovery. Credit of discovery was extremely important from a national pride perspective, and there has been much controversy ever since, in which both Adams and Le Verrier shared little. Subsequent analysis and other factors suggest priority should go solely to Le Verrier, but for now, the credit is shared.

William Lassell and the Discovery of Triton

William Lassell was born in Lancashire, England, on June 18, 1799. His father's death ended young William's formal education, and he was apprenticed to a Liverpool merchant for seven years. He had ambition, and used his experience in business to start a brewery. It made him a wealthy man, free to indulge his primary interest, observational astronomy. He named his home, "Starfield," built an observatory structure on it, and made his own reflecting telescope, of 24" aperture and a then-novel equatorial mount, which made tracking objects much easier.

Lassell was likely inspired by the great discoveries being made with astronomers using their own self-built telescopes. Lord Rosse's [Leviathan of Parsonstown](#) was a few decades before his time, but Johann Gottfried Galle discovered Neptune (based on a prediction made by Leverrier, as related above), using a telescope he had built with his own hands. Lassell just missed making

the discovery! Lassell turned his telescope to the Neptune and discovered its large moon on **October 10, 1846**, just over two weeks after the discovery of Neptune had been announced.

Lassell's find was no fluke. He would soon independently discover Saturn's odd moon, Hyperion (1848) and Uranus' moons, Ariel and Umbriel (1851). He was already a Fellow in the Royal Astronomical Society prior to finding Triton, and won the RAS' Royal Medal in 1858, based on his discoveries, and other honors. The University of Liverpool still awards the William Lassell Prize each year to the student with the highest grades graduating from the university's Program in Physics and Astronomy.

The planets known to the Ancients all received Romanized names of the Olympian gods, save Saturn, who was considered to be the Father of the others. When Uranus was discovered, the scientific community opted for the name of Saturn's father, Uranus, who was a terrible family man and had no father himself. This posed a problem when Neptune was discovered, but its blue color suggested the God of the Sea, Neptune.

Oddly, no formal name was given to Neptune's large moon for a century. When Belt hypothesizer Gerard Kuiper discovered a second moon at Neptune, just calling the bigger firstcomer "Neptune's moon" was no longer satisfactory, so Neptune's three-pronged spear, Triton, was a logical name to use. The new Neptune moon needed a Neptune-related name, and the "Nereids" were the 57 sea nymphs associated with Neptune, living in a silvery grotto at the bottom of the Aegean Sea, so.... Neptune has a few more known moons now, but we're not yet up to 57+2! The count to date is 14.

Triton

Triton has only been seen the one time, by *Voyager 2*. In some ways, Triton lived up to the pre-flyby expectations of the planetary scientists, but in some other ways, it was a big surprise.

We already knew it was pretty large (almost 1700 miles across), and a little denser than some of the large icier moons in the outer Solar System. The higher density implies about a 50/50 mix of rock and ices (not necessarily H₂O). We already knew that its orbit was most odd, indeed. Triton has a retrograde orbit around Neptune, unlike any other major moon in the Solar System (Triton orbits in a direction opposite of Neptune's rotation!). Like our own Moon, Triton's rotation is locked to its orbit; it always presents the same face to Neptune. Further, Triton's orbit is decaying slowly.

Triton's surface is much less-cratered than expected, implying some sort of process that obliterates craters fairly rapidly, the best images obtained suggest that flows of icy material, likely nitrogen, over a mantle of water ice a 100 kilometers-or-so thick. Another feature of note for the Triton surface, some of it is characterized by a surface so fractured by tectonic forces that it resembles the rind of a cantaloupe.

A retrograde orbit, evidence of internal heating, and a fractured surface mean only one thing: Triton was likely a captured body, not one that formed in place. Such a capture would likely have been a highly-elliptical orbit gradually circularized by large tidal forces, which likely would have melted the interior, allowed differentiation, and caused extensive tectonic and volcanic activity to be expressed on the surface. One more thing about the cantaloupe terrain – the

observed fracturing is consistent with the tidal forces Triton had to experience in the past, but *only if there was a sub-surface ocean*.

In any case, with Uranus' odd obliquity, Triton's capture origin, and Pluto's elliptical, inclined orbit, some strange things have been happening in the outer Solar System the last few billion years or so!

Triton has a tenuous atmosphere that varies with the season, almost certainly nitrogen freezing out and sublimating. But the oddest thing of all, is that *Voyager 2* actually observed geyser-like fountaining, much like that seen by *Cassini* at Enceladus. While the geysers could be like Enceladus', they could also be a purely surface nitrogen phenomenon, where nitrogen precipitates onto the surface and then, when insolation is higher, the sunlight passes through the nitrogen ice and warms the darker substrate beneath, which vaporizes the nitrogen ice immediately above. Pressure builds as more nitrogen turns to gas, until boom, an eruption of gas prevails, nourished by additional subliming gas as the confining pressure drops.

Triton, what a strange and interesting place!

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William Lassell

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Triton

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