Air and Space this Week

Item of the Week

THE LEVIATHAN OF PARSONSTOWN

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The process of scientific inquiry, and the technology that enables it, go hand-in-hand. The needs of inquiry generate new technology, which raises new questions, which require new technology – and Science marches on. Astronomy provides a series of excellent examples. Observers of the skies could but moving points of light, but still learned much about the skies above. The advent of the telescope answered some fundamental questions, but that only inspired more questions. Big advances in understanding follow big advances in supporting technology; examples include the 100" Hooker telescope; the 200" Hale telescope; the Hubble Space Telescope*, and now the* James Webb Space Telescope*, just to name a few. The above examples are all from the last 100 years or so, but there was another, in the first half of the 1800s, that is the topic of this installment of the Item of the Week.*

THE STATE OF ASTRONOMICAL TECHNOLOGY IN 1840

The telescope had been around for over 200 years, and astronomers made continuous progress in telescope and observation-related technology. Positional astronomy remained important; accurate measurements of planetary movements and some good mathematics led to Kepler's Laws of Planetary Motion and Newton's Laws of Motion, and Newton's Law of Gravitation. The spectroscope had been invented, and with it, astronomers were learning the composition of the Sun. Photography was in its infancy, but showed promise.

Grinding of high-grade glass to produce ever-larger lenses was an important developing technology during this period. However, one does not need to be a Pink Floyd fan to know what happens when light is passed through a prism. Telescope development was hampered by the color distortion inherent in lenses. One solution still in use is to make the lenses with different types of glass, where the dispersion of light though one partially cancels the adverse effect of the other. Another solution was to minimize the color distortion by using lenses with very long focal lengths, the less dispersion, the less distortion. The down side of using such a lens is that the resulting telescope was tens of feet long, making using it and finding things with it, quite difficult. Both approaches worked, but lenses weren't the best way forward.

Chromatic aberration was only one problem with lenses, however. They of necessity have to be supported from their rims only – the shape of really large lenses could/would sag a bit under

the weight load, degrading the images. The largest lens ever used in a telescope was only 40" across.

Isaac Newton had a better idea (surprise, surprise). Instead of using a lens to focus light passing through it, Newton built a telescope with a precisely-curved mirror to collect the light. Mirrors don't disperse light the way lenses do, and mirrors could be supported from their back, not their edges. Newton's design, or a variation on it, has been used ever since for large (optical light) telescopes.

THE STATE OF ASTRONOMICAL KNOWLEDGE IN 1840

Telescopes were good enough by 1840 to allow astronomers to make decent maps of the Moon and compile many positional measurements of fainter stars. Some star clusters, such as the Pleiades, were known from Antiquity. But now, many more star grouping were seen. In some, the individual stars comprising the grouping could be clearly seen, but in others, it looked more like glowing gas than a cluster of discrete stars.

The star maps of the time were good enough to help astronomers find new objects. The maps had helped with the discovery of first few asteroids by 1840, and the maps were a boon in the discovery/recovery of comets, too. In 1781, astronomer William Herschel found the planet Uranus, the first new planet to be discovered in historical times. Telescopes were good enough to show some surface features (but not too well). Venus didn't show surface markings, but Mars and Jupiter did. We knew that Mars had polar caps that changed with the seasons, and variations in color on its mottled surface. Jupiter had a Great Red Spot and banded clouds.

Perhaps the biggest astronomical question of the day in 1840 dealt with the fuzzy objects Herschel and others were seeing. They had been given the general name of "nebulae," from the Latin word for "cloud." Some were seen to be not clouds at all, but close groupings of stars. But some nebulae did not resolve into discrete stars. Were they clusters of stars that would be resolved with a better telescope, or were they something entirely different?

The technologies that enable "Big Science" were getting increasingly sophisticated, and increasingly expensive. The telescopes in Space are the latest example, almost all built by government funding. The big telescopes of the previous century were largely philanthropic efforts. But in 1840, there was still an opportunity for a wealthy astronomer to self-fund a telescope that could allow big advances in understanding …

WILLIAM PARSONS, THE THIRD EARL OF ROSSE

Try as I might, I cannot fathom the intricacies of the Irish Peerage of the 18th Century. If the family tree of our story's hero is of interest to you, check it out at:
https://en.wikipedia.org/wiki/Earl_of_Rosse and
https://en.wikipedia.org/wiki/Lawrence_Parsons,_2nd_Earl_of_Rosse.

William Parsons was born in York, England, on June 17, 1800. His father was highly-placed in Irish society, and young William had privileges accordingly. He graduated from Trinity College

Dublin and Magdalen College, Oxford with highest honors in mathematics. He had a great interest in the natural sciences, particularly astronomy, and was quite adept at engineering. He married in 1836, and began a large family (13 children, but only 4 survived to adulthood).

William had been using his engineering skills to build telescopes. He started small but learned how to build reflecting telescopes of considerable size, up to one with a mirror three feet across. He was intrigued by the observations made a few decades before by William Herschel, and resolved (sorry) to do the same, only better. William's next telescope would be twice the size of his last.

William's father, who had become the 2nd Earl of Rosse, passed away in 1841, and William inherited his father's earldom and a large estate in Parsonstown, in what was then King's County, now County Offaly, Ireland. The estate contained a large fortified building, Birr Castle. The money involved allowed William to pursue his dream of owning and operating the largest telescope in the world.

Construction began at Birr Castle in 1842 on a Newtonian-type telescope with a mirror that was six feet across and weighed 6000 pounds. Its tube and mounting apparatus would quintuple the total weight. There was no way a fully-steerable mounting could be built to accommodate that size, so William opted for a modified version of a "transit telescope," one which could only point in one direction (due south) but could elevate from horizon to zenith (almost). His would have a few degrees leeway to track as an object crossed the meridian (north-south line in the sky). His mounting design reflected his engineering skills; in spite of the telescope's great weight, William could aim it single-handedly, and his two assistants could track an object briefly as William observed.

Building the telescope took three years, and its initial use was hampered by the Great Irish Famine, but a meaningful observing program was established by 1847.

The giant telescope became known as …

THE LEVIATHAN OF PARSONSTOWN

The weather at Birr Castle made it a rather poor location to site a major telescope. However, the new 3rd Earl of Rosse was a dedicated observer. Rosse engaged in mapping areas of the sky, discovering many new nebulae along the way. He also was able to see with greater clarity a number of the nebulae discovered earlier by others. One such was noted comet finder, Charles Messier of France, who prepared a list of objects that had attracted his attention but then proved to be not a comet.

Rosse observed the very first entry in Messier's catalog, a fuzzy object in Taurus that Rosse saw resembled a crab. We still know it today as the "Crab Nebula," an expanding cloud of gas and debris emitted by a super-nova explosion back in 1054 CE, observed by both Chinese astronomers and the Anasazi at Chaco Canyon.

Rosse was particularly interested in the nature of the nebulae he and other astronomers were seeing. The matter was not only astronomically important, it had implications for theology as

well. Was the Solar System made at one stroke, or did the Solar System come about in a more evolutionary way, condensing from a cloud of gas and dust (a nebula)? If (some of) the nebulae being discovered were not collections of stars, but were rather clouds of gas and dust, then the evolutionary model was supported. Darwin's *On the Origin of Species* was on the horizon (published in 1859), but the thinking about processes as being evolutionary in nature was already underway.

William Herschel's son, John, was firmly in the evolutionary camp. Rosse was firmly in the star cluster camp, and he used his Leviathan to examine nebulae as much as possible to resolve the issue (again, sorry). Both looked at the #42 entry in Messier's catalog, the Orion Nebula known to all backyard observers. Herschel saw it as a true nebula, Parson claimed to have resolved it into its stellar components (wrong).

Then Rosse turned the Leviathan toward nebula #51 on Messier's catalog.

MESSIER 51

Canes Venatici is a nondescript constellation lying beneath the handle of the Big Dipper. The grouping was created by Hevelius to represent two hunting dogs being used by Boötes in his chase of the Great Bear. Its brightest star, Cor Caroli, is a beautiful double in the backyard telescope, but the constellation is pretty much devoid of items of interest. Save one.

Nebula #51 in Messier's catalog was well-known to the astronomical community. Most of the telescopes of the day showed it as a fuzzy ball; the better telescopes, like the one of John Herschel, showed it as a small fuzzy ball surrounded by a discontinuous/complex ring of nebulosity.

Rosse first tried to observe M51 in March, 1845, when the Leviathan was just coming into trial use. The night of March 5/6 had unusually good seeing, and Rosse saw the "ring" part resolved into separate stars, and saw stars between the ring and the central nebulosity. A month later, Rosse looked at M51 again, and this time ascertained that it actually had a spiral structure. Alas, Rosse was not as good at record-keeping as he was at engineering, so we aren't sure of the exact time and nature if this particular observation. Why the spiral shape was seen in April but not in March?

In any case, Rosse likened the appearance of the M51 nebula to a whirlpool, and it is known as the Whirlpool galaxy to this day, the first of many such known, seen face-on, or more obliquely. The most important discovery made using the Leviathan was that a number of nebulae have spiral structure.

THE SMITHSONIAN CONNECTION

The Smithsonian Institution was established in the United States in the late 1840s. It has a unique relationship with the Federal government, and was dedicated to the "increase and diffusion of knowledge."

The formation of the National Academy and scientific societies in the U.S. was yet to come. In the meantime, the new Smithsonian functioned as a non-university diffuser of knowledge, including to the general public. Toward that end, the new institution hosted a lecture series, with the first installment on February 25, 1847, held at the local Odd Fellows Hall (as the Smithsonian had yet to build out a suitable venue for such presentations). The very first lecturer in the series was William Scoresby, an Anglican minister and Arctic explorer. But he didn't speak that evening about religion or his own exploration; his topic was the Leviathan of Parsonstown and the 3rd Earl of Rosse's work!

And that led to the next big question, one that would take seventy years and much better telescopes to answer: Were the spiral nebulae part of our own neighborhood, or were they "island universes" much further away than the stars we see in the night sky?

Joseph Henry, the first Secretary of the Smithsonian, helped build out professional science in the United States, including the National Academy. Fittingly, the Smithsonian again played host in 1920 to an important scientific presentation, in this case, the "Great Debate," about whether the spiral nebulae first seen by Rosse were part of the one-and-only congregation of stars, the Milky Way, or if they were actually "island universes" far distant from our own. For more on that event, see here. [BTW: We know the spiral nebulae today to be other "galaxies" more-or-less like our own Milky Way.]

The Leviathan was the largest telescope in the world from 1845 to 1917, when the 100" Hooker telescope began operations. There Edwin Hubble used it to determine the answer to the "galaxy" question Rosse had started seven decades before. For more on Hubble and galactic distances (and Henrietta Leavitt), see here.

THIRD EARL OF ROSSE: SUMMARY

William Parsons, in addition to his astronomical research, also served as a Member of Parliament from 1821-1854, served a two-year stint as president of the British Science Association (1843-4), received his Irish peerage and became the 3rd Earl of Rosse in 1845, served as the president of the Royal Society of London from 1848-1854, and was the Chancellor of Trinity College Dublin from 1862 to his death on October 31, 1867.

BIRR CASTLE TODAY

Birr Castle has remained in the hands of the Parsons family for over 400 years. It's presently inhabited by the 7th Earl of Rosse, the (much of its) castle and its elaborate grounds are open to the public. There's a gift shop and café, and more importantly, a science center.

The Leviathan had fallen into disrepair by 1900. The supporting walls and tube remained, but the main mirror had been transferred to the Science Museum in London. Patrick Moore, the popularizer of backyard astronomy in Britain for many years (and later befriended by one Dr. Brian May – an astronomy Ph.D. well-acquainted with Mercury – Freddie Mercury) did a program about the Leviathan back in the mid-1970s. The renewed interest the program generated led to a successful effort to reconstruct the Leviathan.

Astronomical research is no longer conducted by the Leviathan at Birr Castle. However, the tradition of astronomical research at this place continues to this day. Birr Castle is the site of one of the 50 or so LOw-Frequency ARray (LOFAR) low-frequency radio telescope stations installed across Europe in the past decade. The LOFAR antennae are linked electronically to provide higher resolution data. For more on the LOFAR system, see here and here.

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