ASTRONOMY BEAT

The ASP—125 Years Ago Today

James Manning (*Astronomical Society of the Pacific*)

"The cordial cooperation of many amateur and professional astronomers in the very successful observations of the Solar Eclipse of January 1, 1889 has again brought forward the desirability of organizing an Astronomical Society of the Pacific, in order that this pleasant and close association may not be lost, either as a scientific or as a social force."
— Circular, February 7, 1889

1889 … Benjamin Harrison became the 23rd U.S. President. The Dakotas, Montana and Washington were admitted to the Union.

The Eiffel Tower opened at the International Exposition of Paris, becoming the tallest structure in the world—and the *Moulin Rouge* cabaret opened a few months later, becoming famous for its can-cans and Toulouse-Latrec's artwork. Gustav Mahler's First Symphony premiered, and Vincent Van Gogh painted *Starry Night* at St. Remy-de-Provence.

The Johnstown flood killed 2,200 in Pennsylvania, and yellow fever interrupted the construction of the Panama Canal. Johns Hopkins Hospital in Baltimore opened, the *Wall Street Journal* began publishing, the Pemberton Medicine Company incorporated in Atlanta (eventually to become the Coca-Cola Company), and Herman Hollerith received a patent for his electric tabulating machine in the U.S. (his company eventually to become IBM). And the Oklahoma Land Run added thousands to that territory's population in a single day.


The Eiffel Tower at the International Exposition.

Belle Starr and Jefferson Davis died; Charlie Chaplin and Adolph Hitler were born. The astronomical community lost Maria Mitchell, the first professional woman astronomer in the U.S., in Massachusetts. And Edwin Hubble, the man who would expand the universe, was born in Missouri.

There was a total eclipse of the sun visible on New Year's Day just north of San Francisco. And just over a month later, the Astronomical Society of the Pacific itself was born. A group of 40, including many members of the Pacific Coast Amateur Photographic Association (PCAPA) fresh from the eclipse as well as six astronomers from the year-old Lick Observatory, convened in downtown San Francisco in the PCAPA meeting rooms. The result was a new Society, with

Observers gather for the January 1, 1889 total solar eclipse.

Edward Holden, the Lick Director who had encouraged the eclipse observations, as its first president, and a set of bylaws declaring the organization's charge: "Its object shall be to advance the Science of Astronomy and to diffuse information concerning it."

The universe was a very different place back then, so far as we knew it, and thus, so was the astronomy to be advanced and diffused. During the 125 years since, the ASP has grown up and grown along with our increasing understanding of the cosmos in arguably the most exciting era of astronomical discovery in human history.

In Astronomy Beat #15 in 2009, Andy Fraknoi, on the occasion of the ASP's 120th anniversary year, provided a glimpse of the long and venerable history of the Society and I encourage you to go back and read it. Rather than repeat that history on the occasion of its 125th, I thought I might place the Society in the context of the astronomical times that gave it birth—what the universe was like "125 years ago today." It was certainly simpler and less well understood; whether it was more mysterious than the universe we perceive today, I leave to the reader …

The Sun

To begin with, back when the Society was formed, nobody understood how the sun shined. It was understood that mere combustion was not the answer, for if the sun burned like a lump of coal, it would have exhausted its fires in about 6,000 years. For a time, a bombardment theory was bandied about: perhaps a steady influx of impacting meteors could generate the heat that kept the sun shining so steadily and for what the geological record of Earth was suggesting was a very long time.

By the time of the Society's founding, the most popular notion was that the sun shined through a process of steady, slow contraction that produced heat escaping into space. Calculations suggested that such a contracting sun could last as long as 25 million years, but geologists were still skeptical, given that their studies of the Earth argued that that the planet had been warmed by the sun for considerably longer than that.

In 1889, the discovery of the electron in the experiments of J. J. Thompson was still eight years in the future, and it wasn't until scientists began to understand atomic structure and mass-energy equivalency that a new theory arose. Albert Einstein's famous equation $E=mc^2$ trotted out in 1905 demonstrated the power of mass converted into energy; if the mass of a star like the sun could be so converted, it would explain how the sun could shine so hot for so long. By 1925, Cecelia Payne in her doctoral thesis scandalized the astronomical community by suggesting that the sun was made mostly of hydrogen and helium (helium having been first detected on the sun in 1868). In 1926, Arthur Eddington (1924 winner of the ASP's Catherine Wolfe Bruce Medal) proposed the fusion of hydrogen into helium as the energy-producing mechanism rather than mere mass annihilation, and by 1938, Hans Bethe (the 2001 Bruce Medal recipient), Charles Critchfield and Carl von Weizsacker had worked out the details of the proton-proton fusion process that primarily fuels the sun and lower-mass stars and the carbon cycle fusion process that fuels higher-mass stars.

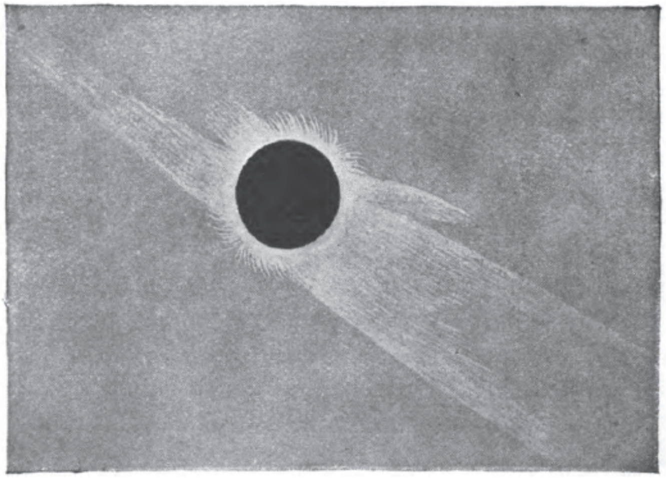
At last, the sun had a way to shine that explained its long life and the Earth's obvious great age.

In the intervening decades, we've learned a great deal more about the sun's magnetic nature, its internal mechanisms and external structures, and its effect on the Earth. Today, a fleet of spacecraft watch its every move, every burp and shudder, flare and coronal mass ejection—and yet we do not know so much that we can explain why the current sunspot cycle unfolded so slowly and with such an apparently anemic peak.

The Moon

In 1889, the second great light of the sky—the moon—was seen for what it was by most astronomers: a lifeless world due to its apparent lack of water (despite the ongoing Latin moniker of *mare*—"sea"—for its dark plains) and a similar lack of atmosphere (or one so thin that it didn't matter). But what people didn't know for sure was whether what they saw on the moon—craters—were volcanic in origin or caused by impacts. It wasn't until well into the 20th century and the advent of the Space Age that unmanned spacecraft and pre-Apollo studies proved conclusively that nearly all of the craters had to be of impact origin. It took until then to finally resolve the likelihood of life on the moon; some had held out for the possibility of simple forms in residence, but when the Apollo astronauts returned uncontaminated by so much as a lunar cold germ, the probability of even fossil remains was considered remote.

Another lively debate in 1889 was how the moon formed in the first place. The popular theory of the day belonged to George Darwin, second son of Charles, who theorized that as the molten Earth cooled and contracted, its increasing spin rate caused it to split into two unequal parts, with the smaller piece spun off to form the moon. The theory had its technical problems, and was generally discounted by the early part of the 20th century. By 1955, the German astronomer H. Gerstenkorn suggested instead that the moon was a body captured by the Earth. Others elaborated on the capture theory, everyone more or less ignoring the 1945 theory of geologist Reginald Daly that it wasn't a capture but an impact that produced the moon.



THE CORONA OF 1ST JANUARY 1889
(M^{rs} TODD, *Composite from* 100 *sketches*)

Total eclipse of January 1, 1889, from *Total Eclipses of the Sun* by Mabel Loomis Todd.

In 1975, William Hartmann and Donald Davis revived the impact notion, postulating that a Mars-sized body hit the Earth early in the history of the solar system; the cores merged, but mantle material was blown off and aggregated into a moon with the small core and depleted volatile elements that we see today. It remains the most popular current theory of how the moon formed.

People haven't set foot on the moon in more than 40 years, but we continue to hurl spacecraft in its direction, several of which have returned evidence for water in the form of ice mixed into the soil in the perpetually shaded floors of polar craters. Return visitors may be able to take advantage of it to supply drinking water, air, and fuel rather than cart them out of the gravity well of Earth.

The Solar System

The origin of the solar system as a whole was also a matter of debate in the ASP's founding year. Immanuel Kant had suggested in 1755 that the solar system formed from a cloud of gas that became a flat, rotating disk as it contracted, throwing off blobs of gas that condensed and cooled into the planets, the core forming the sun. In 1889, Pierre LaPlace's similar Nebular Hypothesis was by then nearly a century old and stated that the sun and planets formed from a spinning, contracting cloud of gas that spun off rings of material that formed the planets, the remaining central blob forming the sun. But scientists had shown that original nebula wouldn't have had enough angular momentum to spin off the rings. In 1870, Richard Proctor suggested that another star had delivered a glancing blow that splattered material that formed the planets, but it didn't explain how the planets obtained moons—a whole series of coincidental glancing blows being very unlikely.

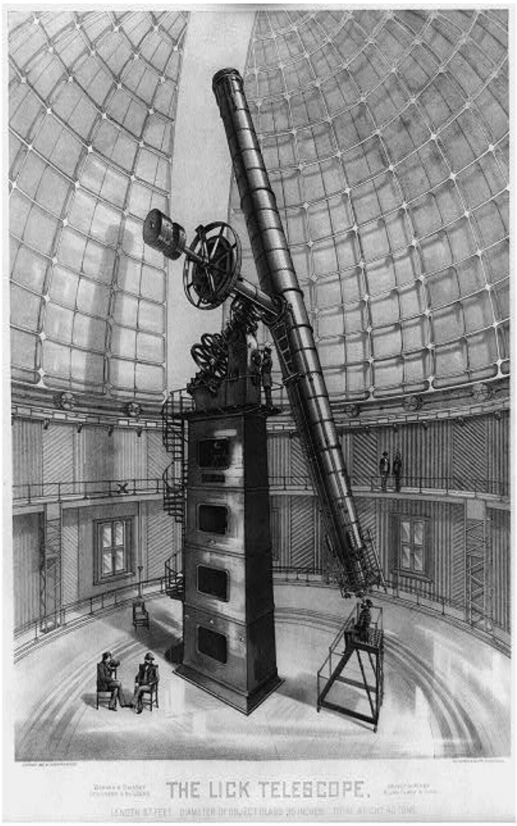
Around the turn of the century, several variations—the one by James Jeans having been worked out mathematically—tweaked the theory to state that a close encounter by another star drew out of the sun a long tail of gas that broke into individual blobs that formed the planets—the sun then pulling tails of gas out of the forming planets to create their systems of moons.

But none of the theories quite held up to scrutiny, and in 1943, Weizsacker suggested that "vortices" in the presumed solar nebula condensed material into small, chunky "planetesimals" that accreted to form the planets. Work by Harold Urey and Victor Safronov in the 1950s refined the model in terms of how colliding planetesimals could actually do the job and explain certain features of the solar system. And this "accretion" theory in one form or another is the theory usually cited today.

We still find plenty of leftover bits whizzing about to support the notion of accretion—the Chelyabinsk meteor detonating on atmospheric entry over Russia in February, 2013, a recent good example.

Lick and the Planets

An early feature of the *Publications of the Astronomical Society of the Pacific* (PASP) in the years after the founding were regular notes from Lick Observatory and articles by many of its astronomers. This is not surprising, given the influence of Director Holden in the formation of the Society, and the fact that he and his associates possessed the largest refracting telescope on the planet (until the Yerkes 40-inch supplanted the Lick 36-inch in 1897). Lick also acquired one of the best reflectors of the day in 1895: the 36-inch Crossley reflector with its novel aluminized mirror (as opposed to being silvered). The observatory, located on Mount Hamilton overlooking San Jose, was the first permanent mountaintop observatory—the premier facility on the U.S. West Coast at the time. And it was nearby.



The Lick Observatory 36-inch refracting telescope, 1889.

Among the *PASP's* ubiquitous accounts of variable star, binary star and nebula observations, treatises on equipment, and the goings-on at sister observatories, were many pieces on observations of the moon, Jupiter and its satellites, Saturn, Mars, comets, asteroids, eclipses and other solar system matters—including a notice in 1892 relating the telegram sent by Lick astronomer Edward E. Barnard (the 1917 Bruce Medalist) on his discovery of the fifth moon of Jupiter, later to be named Amalthea. It was the first Jovian satellite to be added since Galileo had aimed his considerably smaller refractor at the sky in 1610—and the last moon to be discovered visually in an era of increasing use of photography to study the heavens.

Barnard offered an account of the discovery in a later issue of the *PASP*: "Nothing of special importance was encountered until the night of September 9, when, in carefully examining the immediate region of the planet Jupiter, I detected an exceedingly small star close to the planet, and near the third satellite. I at once measured the distance and position angle with reference to Satellite III. I then tried to get measures referred to Jupiter, but found that one of the wires had got broken out and the other loosened. Before anything further could be done the object disappeared into the glare about Jupiter. Though I was positive the object was a new satellite, I had only the one set of measures, which was hardly proof enough for an announcement.

"I replaced the wires the next morning. The next night with the great telescope being Professor Shaeberle's, he very kindly gave the instrument up to me, and I had the pleasure of verifying the discovery, and secured a good set of measures at elongation."

The "great telescope" was proving its mettle in digging deeper into space. In its very first test run of optical quality on the night of January 7, 1888, astronomer James Keeler discovered the Encke Gap in Saturn's A ring. (A tinier gap near the very edge of Saturn's A ring, discovered by a Voyager flyby in the 1980s, was in turn named for Keeler.)

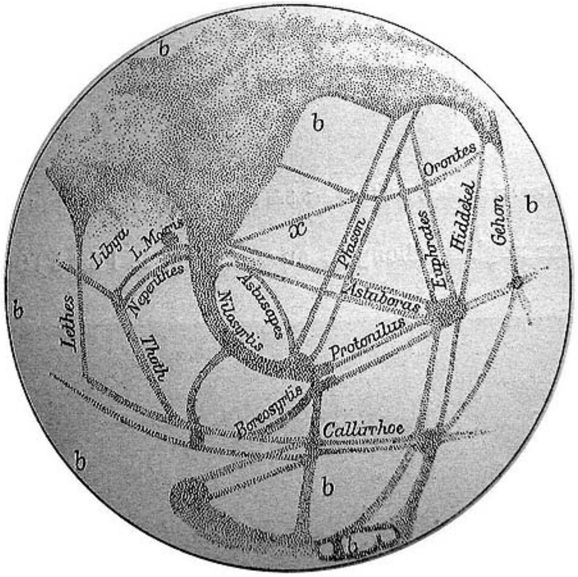
Both John Schaeberle and James Keeler, incidentally, served as presidents of the ASP Board of Directors, in 1893 and 1900 respectively.

The Inner Planets

Across the astronomical community, there was much to do in the realm of the planets, for the approaching end of the 19th century found astronomers still scrambling to work out many of their characteristics—rotation rates, surface temperatures, physical features, and the like—with time to speculate on whether any could or might be habitable like Earth.

Mercury's unsettling precession of its perihelion point—changing faster than Newtonian celestial mechanics should allow—was still confounding observers, and astronomers were still unable to find a theorized inner planet (named Vulcan) that might be perturbing Mercury. It wasn't until 1915 that Einstein explained the effect with his new general theory of relativity, which predicted the observed result. Mercury's surface was not unmasked until the flyby of Mariner 10 in the 1970s, revealing a landscape not unlike the moon's. And despite its perilous location so near the sun, it appears Mercury may harbor ice in the shadowed floors of crates near its poles, just as the moon does.

Mariner 10 also took a passing peek at Venus in 1974, but in 1889, it was an enigma. Observations had revealed evidence of an atmosphere



Dessin de Mars fait le 4 juin 1888, par M. Schiaparelli, à Milan.

Giovanni Schiaparelli's Map of Mars, June 4, 1888.

as early as the 1760s, but its featureless surface (the planet being completely masked by clouds) made it hard to determine even its rate of rotation. It wasn't until the 1960s when Earthlings bounced radio signals off the planet that an accurate determination of its retrograde 243-day rotation was obtained.

The masking atmosphere allowed for a lot of speculation. In his 1897 book *The Story of the Heavens*, Robert S. Ball wrote that "If water be present on the surface of Venus and if oxygen be a constituent of its atmosphere, we might expect to find in that planet a luxuriant tropical life, of a kind analogous in some respects to life on Earth."

Edgar Rice Burroughs took the idea and ran with it in his 1930s Venus series of science fiction books, but by the 1930s, scientists were finding carbon dioxide—lots of it—in the atmosphere instead. By the 1950s, radio emissions also showed that it was awfully hot, Mariner 2 in the 1960s measuring just how hot (some 700 degrees Kelvin). And the Soviet Venera 7 lander measured a surface-level atmospheric pressure 90 times that of Earth.

Mars—it's not our great-great grandfather's planet anymore. Modern image from the Curiosity rover in residence. *[NASA/JPL-Caltech/MSSS]*

A century after the ASP was formed, the Magellan radar mapper orbited the planet and provided the first good look at its infernal, volcanic surface under the sulfuric acid haze. Today, Venus is the planetary poster child for what happens when a greenhouse effect runs completely amuck.

But it was Mars where much of the fun was happening in the inner solar system in those early days (not so different than today), for its thin atmosphere was transparent and its tantalizing features led to all manner of fanciful notions. It was Giovanni Schiaparelli, an inveterate planetary observer and the 1902 ASP Bruce Medalist, who recorded, during the 1877 and 1879 oppositions of Mars, a network of lines he called *canali*—"channels" in Italian—that some people liberally translated as "canals," giving Mars a system of irrigation ditches that suggested intelligent design. Others also observed linear features, and canals and the possibilities of life there were hot topics in 1889 about a world with polar caps, dark areas presumed by many to be seas, and seasonal changes sweeping its small globe during the course of its year.

Lick observers got into the act as well. Astronomer J. M. Schaeberle, based on his preliminary observations during the 1892 Mars opposition, argued in that year's September issue of the *PASP* that the dark areas on Mars might be the land areas and the bright areas the watery parts. Among his arguments were that the dark areas showed "irregular gradations of shading" one would expect to see on land, and he could see darker streaks extending for some distance in nearly straight lines across those dark areas—while "there is a gradual increase in the steady lustre of the brighter areas towards the center of the planet" as one might expect of a body of water reflecting the sun. He further suggested that the observed "canals" in the brighter regions might be single and parallel "ridges of mountain chains" sticking up above the surface of the water.

Percival Lowell entered the Martian arena at the next opposition in 1894. He noticed that the dark areas changed their appearance with the seasons, and so also concluded that they were not bodies of water. But he found canals—lots of canals, and theorized that they had been built by intelligent beings to shuttle water from the polar caps to the dark areas he assumed were areas of vegetation. His subsequent books popularized the notion even as other astronomers failed to find the irrigation network that Lowell and some others had observed.

Also in 1894, Barnard of Lick, considered by many to be one of the best observers of the day and possessing a superior telescope, wrote to astronomer Simon Newcomb (in an account given by Gerard Kuiper in the October 1955 issue of the *PASP*) that "I have been watching and drawing the surface of Mars. It is wonderfully full of detail. There is certainly no question about there being mountains and large greatly elevated plateaus. To save my soul I can't believe in the canals as Schiaparelli draws them. I see details where he has drawn none. I see details where some of his canals are, but they are not straight lines *at all*. When best seen they are very irregular and broken up … "

But the allure of canals and the work of Lowell over 15 years of observations was just good press. As Samuel Bayne wrote matter-of-factly in his 1896 book *The Pith of Astronomy – The Latest Facts and Figures as Developed by the Giant Telescopes*, "Percival Lowell, of Boston, has lately devoted his life and fortune to the observation of Mars. He has erected an extensive observatory at Flagstaff, Arizona … now providing a special telescope with magnifying power of 2400 diameters, for the purpose of examining this planet.

"Mr. Lowell's extended observations lead him to believe that Mars is inhabited by a highly civilized race of beings, who are now carrying on great engineering works, including the famous canals, which have been the subject of so much speculation."

Eugene Antoniadi and others with larger telescopes in the early 1900s showed that high magnifications broke those Martian linear features into series of spots and irregular bits, just as Barnard had observed some years earlier—the *canali* were an optical illusion. But astronomers still speculated that the dark bluish-green areas on Mars might be vegetation; no signature of chlorophyll was ever detected, but some still held out hope for Martian lichens. The Space Age dealt a severe blow to hopes for Martian life when Mariner 4 buzzed the Red Planet in 1965 and found instead a desolate world of dust and craters; the dark areas were simply dark areas, with changes in appearance wrought by seasonal changes in wind direction blowing lighter reddish dust to and fro over the areas.

The fortunes of Mars ping-ponged. The orbiting Mariner 9 in 1971 rehabilitated the Red Planet as an interesting world when it found shield volcanoes, the gigantic rift canyon Vallis Marineris, and evidence of *canali* after all: channels apparently eroded by the flow of water. But the Viking landers of 1976 found no direct evidence of living organisms in the soil—another blow. Yet later orbiters, landers and rovers—some currently operating in orbit and on the surface—are finding ice under that surface, and mineral deposits and surface features suggesting a welcoming watery environment for some period in the distant past. They're finding an environment that could have been conducive to the rise of at least simple life forms if the conditions lasted long enough. Whether fossil proof will ever be found—or better—is the Holy Grail that keeps Mars a popular place as the ASP heads into its next 125 years.

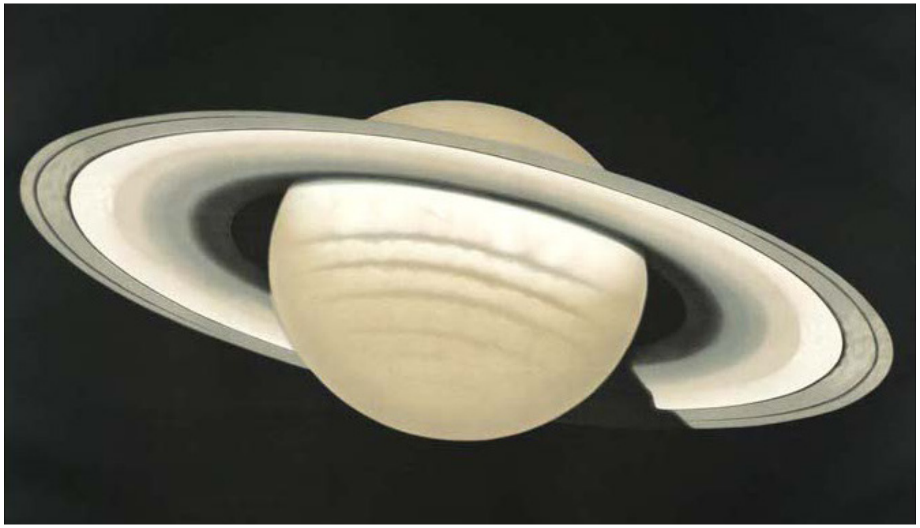
The Asteroids

On February 8, 1889, the day after the ASP's founding, Auguste Charlois observing from Nice, France, discovered the 283rd asteroid then known. He christened it Emma, the convention of the time being to give these "minor planets" feminine names.

Asteroid hunting was then nearly 90 years in progress since the discovery of the first (and still the largest of the "classical" asteroids), Ceres. That first discovery had been hailed as filling a "gap" in the order of the planets between Mars and Jupiter called for in the famous Titus-Bode law (since discredited), but it was soon found to be rather small by itself, and even sooner was found to have sisters orbiting in the same Mars/Jupiter gap. Wilhelm Olbers suggested in 1802 after the second, Pallas, was found that perhaps the missing planet had exploded. But as more were found of varying orbits and inclinations, a more popular theory emerged that these were leftovers from the solar system's formation that were prevented from coalescing into a planet by the perturbations of their mighty neighbor, Jupiter.

There was a time gap of about 38 years between the discovery of the fourth asteroid and the fifth, but by 1889 asteroid detection was becoming a booming business—especially when photography was brought to bear just a few years later, in 1891, by German astronomer Max Wolf, who became the 1930 ASP Bruce Medalist.

Wolf has a rather special connection to the Bruce Medal, for he gave his very first asteroid discovery in 1892 (the 323rd to be found) the name Brucia, after none other than Catherine Wolfe Bruce, the New York philanthropist and astronomy supporter who established the Bruce Medal with the ASP in 1898 to be awarded "for distinguished services to astronomy." During the decade of the 1890s she had also generously provided funds for the acquisition of new telescopes at the Harvard College Observatory, the Yerkes Observatory, and the *Landessternwarte Heidelberg-Konigstuhl* that was being built and of which Wolf was the director. Wolf obtained a grant from Bruce to purchase the new observatory's primary research instrument, and Wolf ultimately named his first asteroid in honor of his patroness. Two years before his death, the ASP recognized his lifetime achievements in astronomy with the Catherine Wolfe Bruce Medal, thus completing the circle.



Saturn drawing by Etienne Trouvelot, November, 1874.

Asteroids, of course, have since been found in profusion, casting little doubt on the accretion theory for solar system formation, especially considering that many have strayed from the Mars-Jupiter gap and threaten modern-day accretions that would be most unwelcome. Today, the Minor Planet Bureau has data on more than 600,000 asteroids of detectable size, more than half of them with numbers, some 16,000 with names. Some 10,000 have been found that periodically pass near the Earth or cross its orbit and so bear close watching. Nearly 200 have been dubbed "centaurs," after those Grecian creatures part horse and part man, ranging beyond Jupiter among the gas giant planets while we make up our minds as to whether they're asteroids or comets or, like the centaurs, both.

And Charlois' 283 Emma made the news again just a decade ago when astronomers found the 90 mile-wide minor planet to be sporting a seven mile-wide moonlet—one of more than 150 asteroids currently found to have companions, most of them literally "chips off the old block" resulting almost certainly from past impacts or collisions.

Once thought a nuisance for the tracks they left on photographic plates, some asteroids truly would be a nuisance if they should aim for Earth. And increasingly, they are seen as a resource, filled with useful metals and minerals and even water if ever Earthlings can make a going business of mining in the sky.

The ASP's first rented rooms in the summer of 1889 were at 408 California Street in San Francisco. *[Bank of California Museum]*

The Outer Planets

Beyond the swarming Asteroid Belt lay the realm of the giant planets. Jupiter and Saturn had been know from antiquity, but Neptune's discovery had occurred just 43 years previous to the ASP's founding year, and Uranus was only 65 years older than that in the public mind. They were all large and all mysterious as the telescopes of the day strained to discern their details and people entertained speculative notions in the absence of solid information about these gas giants.

Jupiter, the largest and closest, was thought at the time to be quite hot, its large size causing it to lose the heat of its formation much more slowly than, say, the Earth did. And with cooling might come habitability. As Ball of the 1897 *The Story of the Heavens* wrote, "The time will assuredly come when the internal heat must decline, when the clouds will gradually condense into oceans. On the surface dry land may then appear, and Jupiter will be rendered habitable."

In the meantime, a hot Jupiter was thought by others to create a very nice living situation for the four Galilean satellites. As the Reverend George Searle stated, in an account of a lecture given before the Catholic University of America called "Are the Planets Habitable?" published in the July 1890 issue of the *PASP*, "There is plenty of room on them for a very large population; the surface of the largest does not fall far short of that of the land part of our own globe. There is no reason why they should not be in the same general physical state as the earth is; we have already seen that, as far as light and heat are concerned, they may be considered as amply provided; perhaps, indeed, even better than we; for the great planet itself, round which they circulate, would probably serve as a much better luminary by night than our own moon, and may very probably contribute not a little to keeping them comfortably warm, if it is indeed still in a melted and glowing condition."

Jupiter's most prominent feature, the Great Red Spot, became so about a decade before the Society was created. As Barnard wrote in the November 1889 issue of the *PASP*, where he described and presented a series of drawings he made of Jupiter from 1879–1885, "What principally attracted my attention to the planet was the appearance of the Great Red Spot. The early history of this object seems to be rather obscure, but it was certainly seen as early as July 1878, by Professor (Carr Walter) Pritchett, at Glasgow, Missouri, and was probably seen at intervals as early as 1870." It may have been seen intermittently from as early as the 1660s, but the modern version of this gigantic anticyclone has been continuously observed since the time of Pritchett's view.

Saturn, in contrast, showed much less contrast than Jupiter's constantly changing cloud bands and stormy spots. As Holden wrote in the January 1891 issue of the *PASP*, in which he presented observations and drawings he made of Saturn from 1879-1889, "The planet has been observed on very many occasions of which there is no note here, without seeing any feature calling for special remark." In late 1876, Asaph Hall (the discoverer of Mars' two moons in the following year), noticed a bright white spot that billowed, stretched, a faded in a few weeks. (Such transient storms appear from time to time, most recently in late 2010, well documented by the Cassini orbiter). But other than such occasional outbursts, Saturn's planetary features were vanishing subtle beyond faint longitudinal bands.

The Ringed Planet's best feature was of course, its rings. First glimpsed as "ears" by Galileo in 1610, Christian Huygens suggested in 1655 that the planet had a ring, Giovanni Cassini in 1675 said it was several rings with little gaps between, James Clerk Maxwell said in 1859 that they couldn't be solid because they would become unstable and break, and in 1895 Lick's Keeler used spectroscopy to show that the inner and outer edges moved at different speeds, confirming their particulate nature.

Moons it had aplenty, and in 1899, William Pickering found Saturn's ninth, Phoebe—the first to be discovered photographically, as would be very other solar system moon thereafter.

Uranus, the next planet out, was discovered in 1871 by William Herschel in the midst of his sky survey, and the orbits of its four known moons at the end of the 19th century indicated that the planet was tipped over on its side. It was farther, smaller, and even more featureless than Saturn, but careful astronomers noted that it was deviating from its predicted path, as if something were perturbing it. In 1844, the hunt was on for a trans-Uranian planet, and two years later, Johann Galle found it in a triumph of mathematics, the Englishman Adams and Frenchman Leverrier both having calculated where the perturber ought to be. Neptune seemed a twin of Uranus in size and color, with one known moon that indicated this planet wasn't orbiting on its side. They were expected to have cooled more rapidly then their larger sisters due to their lesser bulk.

Not a lot more was known or suspected about the gas giants in 1889, though much was speculated, and they were certainly different from the solid little planets neighboring Earth. As Simon Newcomb (the very first Bruce Medalist in 1898) wrote in his book *Popular Astronomy* in 1899, "It is … probable that Jupiter is not yet covered by a solid crust, as our earth is, but that his white-hot interior, whether liquid or gaseous, has nothing to cover it but the dense vapors to which that heat gives rise."

It would take improvements in technology and visiting spacecraft to reveal more. In the early 1920s measuring astronomers were surprised to find the cloud tops of the giants to be actually very cold (though Jupiter and Saturn still radiate twice as much energy as they receive from the sun). They were found to be composed of hydrogen and helium, with methane and ammonia and other atmospheric constituents. With the advent of radio astronomy, Jupiter's monstrous magnetic field was first detected in 1955. More moons were found among the four.

But it was the Pioneer and Voyager flybys of the 1970s and '80s that finally unmasked them, with additional ground-based firepower thereafter, giving us the view we have today: four giants, Jupiter and Saturn more gassy, Uranus and Neptune more "icy," fast rotators with solid, compressed cores, liquid envelopes around them, and enormously active atmospheres around those, every one with a system of rings (Saturn's composed of more than 1,000 ringlets), all with large magnetic fields, and all surrounded by scads of moons, many of Jupiter and Saturn's probably captured asteroids or comets. And some of those moons were interesting worlds on their own, from Jupiter's sulfurously volcanic Io to Neptune's nitrogen geyser-spouting Triton.

While the Reverend Searle would not today find these moons "amply provided" for in terms of life on their surfaces, in Saturn's orange-shrouded moon Titan we find a world that may be similar to the early Earth. Saturn's diminutive, icy Enceladus is gravitationally squeezed and thus warm enough inside for liquid water to exist and spew out through cracks in its south polar crust. And Jupiter's Europa seems to have a subsurface ocean of liquid or slush as a result of similar gravitational squeezing, with recent evidence of vapor plumes wafting up from surface ruptures. In Enceladus and Europa we may find some of the best chances for simple life to have arisen in the solar system beyond Earth.

The Outermost Solar System.

The solar system enlarged with the discovery of Neptune in 1846, and yet there still seemed to be unaccounted-for irregularities in the orbit of Uranus. So it was natural for many to assume that there must be still another planet lying beyond. Searches were made in the 1870s and '80s without success. In the early 1900s, Percival Lowell of Martian canals fame spent considerable time and resources looking for his "Planet X," rather in competition with William Pickering who was doing the same for *his* "Planet O." Neither succeeded, but Clyde Tombaugh fulfilled Lowell's legacy in 1930 with the blink comparator discovery of Pluto, ranging in an eccentric orbit mostly beyond Neptune.

The discovery has seemed fortunate with the passage of time and the continual shrinkage of Pluto's size under better scrutiny (from Earth-sized to today's 1,400 miles, just two-thirds the diameter of the moon) to the point where it couldn't perturb Uranus—the latter-day analyses suggesting that any residual irregularities involving Uranus were probably observing errors anyway. But for decades Pluto reigned on the frigid margin of the solar system as the ninth planet—until many more Plutos (forming a company of leftover icy building-block planetesimals that formed the larger planets back when the solar system began) started being found in the 1990s.


Starry Night by Vincent Van Gogh, 1889.

One could as readily call Pluto a giant comet as a dwarfish planet, for its make-up seems pretty much the same. Comets were known from antiquity—and not thought well of, being considered heralds of doom. By the late 1600s, they were also viewed as hazards as they whizzed through the solar system, and Isaac Newton tracked the orbit of the visitor of 1680 using his understanding of gravitational force to show its orbit was a parabola. Edmond Halley built on Newton's work to successfully prove that comets were returnable, as the one named for him did in 1758.

By the late 1800s, spectroscopy was beginning to reveal the composition of these small and flimsy visitors that partially vaporized on every visit to the sun and spewed out gas and dust that formed their characteristic fuzzy heads and sweeping tails. About six years before the founding of the Society, the sky at the end of 1882 was graced by the Great Comet of that year, a sun-grazer that became exceptionally bright (doing what the very small and fragile Comet ISON did not do at the end of 2013) before its nucleus broke into five pieces on its way back out.

But out where? Newton and Halley and later calculators of orbits showed that comets were not mere solar fly-bys, but mostly solar captives. By 1950, the astronomer Jan Oort (the 1942 Bruce Medalist) hypothesized the existence of a vast reservoir of comets far beyond the recently discovered Pluto, as much as one-half to two light years from the sun. Gerard Kuiper a year later suggested they were leftover condensations of the original solar nebula that got kicked out into the so-called "Oort Cloud" by the outer planets. When a passing star or a rare collision sends them sunward, they become the comets we see; if the planets corral them into shorter orbits, they come back more frequently, like Halley's comet.

At Halley's 1986 visit, a fleet of spacecraft provided unprecedented examination, including the first view ever of a comet nucleus, showing vaporized jets spewing out of cracks in the crusty surface. Since then, a handful of other comet nuclei have been observed, and that of Comet Tempel 1's was assaulted by the Deep Impact mission's impactor in 2005 to learn more about comet composition. The efforts are giving us ever better understanding of not only comets, but of the conditions in the early solar system that gave them birth.

By the 1990s, astronomers and their big telescopes started finding the comets' larger cousins, giving rise to the Pluto troubles. Even at the time of Pluto's discovery in 1930, astronomers Frederick Leonard and Armin Lueschner (ASP Board president for three separate terms and the 1936 Bruce Medalist) suggested it was likely there were more where that one came from. Kenneth Edgeworth in 1943 and Kuiper in 1951 further suggested that a many leftover planetesimals might exist, orbiting in a disk stretching from the orbit of Neptune out to 50 astronomical units from the sun. In 1992, the first of these "Kuiper Belt" objects (the region is also sometimes known as the Edgeworth-Kuiper Belt) was found—technically the second, allowing for Pluto. Soon they were turning up in large numbers—more than a thousand to date—including a couple approaching Pluto in size (Haumea and Makemake, both about 900 miles wide). In 2005, Mike Brown and his team discovered the more distant Eris, orbiting in a region called the "scattered disk," an outer extension of the Kuiper Belt populated by objects in very eccentric orbits. It proved to be the same size as Pluto—and more massive.

And so, with Pluto-class objects suddenly multiplying, the International Astronomical Union made the fateful decision in 2006 to create a new classification of solar system objects—"dwarf planets"—and made Pluto its prototype. Pluto remains, for now, king of the Kuiper Belt (the more massive Eris orbiting in the scattered disk, and Sedna, a 600-mile wide object discovered by Brown and Company in 2003 orbiting even more remotely at the hypothesized inner edge of the Oort cloud).

Pluto has perhaps exacted some small measure of revenge for its demotion by coming up with four additional tiny moons besides Charon (discovered in 1978 by James Christy), all found via the Hubble Space Telescope in the 2000s—making Pluto, for all its dwarfishness, the fifth-ranked solar system object in number of natural satellites. They were probably produced, as are asteroidal moons, most likely, by a good whack from something in the past.

In Neptune's Triton, we may have seen preview of what Pluto looks like. But next year, if all goes well, we will find out for ourselves, as the New Horizons spacecraft zips past Pluto for a reconnaissance before it heads into the Great Beyond of the Kuiper Belt and ultimately, the Oort Cloud that likely awaits.

The Stars

Beyond the Oort Cloud lie the stars. And in 1889, scientists didn't know how they shined any more than they did the sun. Energy produced from contraction was the most popular theory, as inadequate as it seemed to be in providing a long enough lifetime to account for, for example, Earth whose geology seemed older.

At the founding of the Society, the study of stars was decidedly observational, focusing on characteristics such as position, brightness and color. Distances had been estimated for perhaps two dozen stars based on their parallax—tiny shifts in their position compared to more distant stars as the Earth moved from one side of its orbit to the other.

The pages of the *PASP* included regular notes on new binary stars being discovered by the Lick 36-inch refractor, which was particularly good—in the hands of expert star-splitter S. W. Burnham—at discovering them. Burnham identified more that 200 close binaries in his four years at the observatory. Meanwhile, Keeler was eyeballing stellar spectra and using dark line displacements to estimate the line-of-sight motion of Arcturus in relation to Earth. Holden was writing about the use of star trails in the measurement of the position and brightness of stars.

Women "computers" catalogued the spectra of the Draper Catalogs. *[Harvard College Observatory]*

In the November 1890 issue of the *PASP*, in an article entitled "The Future of Stellar Photography," a letter by George Bond written in 1857 was excerpted in which he expounded on the virtues of that technology, opining that "On a fine night the amount of work which can be accomplished, with entire exemption from the trouble, vexation and fatigue that seldom fail to attend upon ordinary observations, is astonishing." (Bond had in that year taken photographs of the double star Mizar, the middle star in the handle of the Big Dipper, using the new wet collodion process introduced six years before, and found that the process could measure stellar brightnesses by the size of the images.)

Photographic techniques progressed from wet to dry and improved. By the 1780s, photography was seen generally as a useful tool in astronomy with its mostly faint objects. By the 1880s, nebulae were being photographed; A. A. Common's picture of the Orion Nebula in 1883 won him the Gold Medal of the Royal Astronomical Society. In 1886 the Henry Brothers photographed 1,400 stars in the Pleiades star cluster from Paris and confirmed the existence of nebulosity surrounding the brighter stars. And in 1887, astronomers from around the world met in Paris to plan the first photographic star catalogue of the entire sky. By 1889, photography was becoming a very important resource in the astronomer's tool chest; it proved to be immensely helpful in the study of stars—as in everything else.

No less important was spectroscopy. It was Isaac Newton in the 1660s who demonstrated scientifically that white light (sunlight in this case) is made up of a rainbow spread of colors—a "spectrum." In 1802, the English chemist William Wolloston first noted some dark lines in the solar spectrum, and in 1814, Joseph Fraunhofer discovered them in abundance with his experiments with slits and prisms. The patterns of dark lines corresponded with bright line "emission" spectra produced by glowing chemical elements in laboratories. In the case of the sun, they were missing—absorbed in its outer atmosphere of sorts as energy emerged from the sun. Since each chemical element produced its own set of lines, like unique fingerprints, astronomers were able to identify the presence of chemical elements in the solar atmosphere; they found it harbored the same substances as found on Earth.

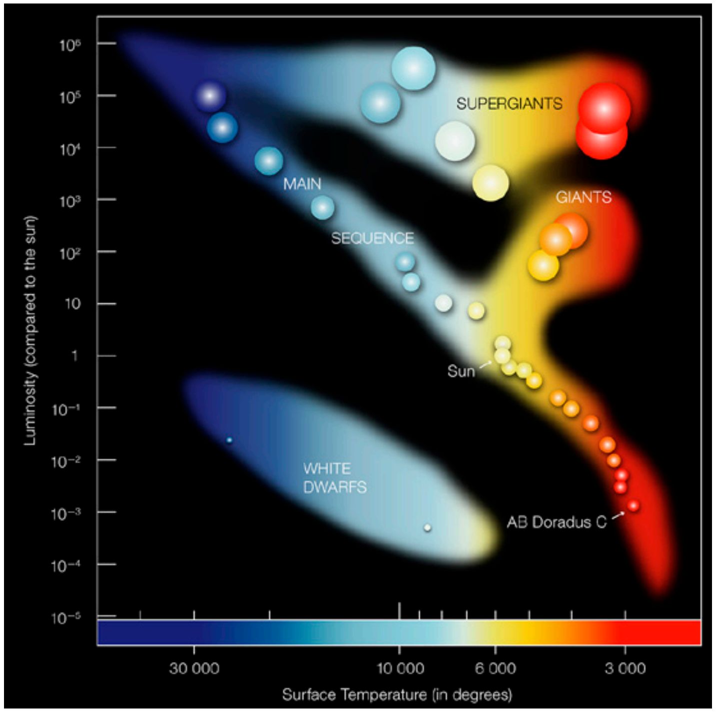
Fraunhofer didn't stop with the sun; he found that the brighter stars showed dark line or "absorption" spectra as well—except the patterns of lines were often different. When faced with such a conundrum, scientists did what scientists do: they began to catalog stars based on their "spectral types"—the patterns of lines they displayed.

In 1889, the most popular classification system in use was that produced by the Jesuit Angelo Secchi, who divided stars into four groups (which also proved to be color groupings—blue/white, yellow, orange, and red, more or less). But the year after, in 1890, Edward Pickering, brother of William, the director of the Harvard College Observatory and the future 1908 recipient of the Bruce Medal, introduced a new scheme with considerably more subdivisions, classifying stars from A through O based on characteristic lines in their spectra. The new scheme was used to classify the photographic spectra of more than 10,000 stars in the 1890 Draper Memorial Catalog, funded by the widow of Henry Draper, who had made the first photograph of a star's spectrum—that of Vega. Most of the classifying had been done by Williamina Fleming, one of the Harvard Observatory's female "computers" who did the data analysis at the observatory.

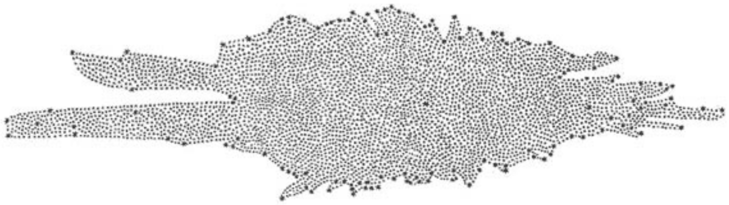
But Pickering didn't stop there; he engaged more women "computers" like Antonia Maury and Annie Jump Cannon to perform ever more detailed analyses of stellar spectra. The Harvard goal was not only to classify stars, but to determine their place in order of hottest to coolest, which was considered an evolutionary sequence. Both Maury and Cannon ended up shuffling the original alphabetical order and reducing the number of categories to today's well known OBAFGKM series, with other letters used for special cases. Cannon continued to classify stars until her death in 1941, categorizing nearly 400,000 stars, many of which appeared in later volumes of the Draper catalog.

Stellar Evolution

The Harvard system of spectral classification and its further subdivisions were instrumental in helping scientists to get a handle on how stars evolved. At the time of the Society's founding, many astronomers squirmed at the inadequacies of the contraction theory of energy production that didn't seem to allow stars to last long enough, given geologists' annoying penchant for finding an older and older Earth in their rock layers. And arguments about how stars evolved focused mainly on color. Some assumed stars went from blue to yellow to red as they presumably cooled off over time, blue being hottest and



Modern-day representation of the features of the Hertzsrpung-Russell diagram that revolutionized the study of stellar evolution. *[European Southern Observatory]*



William Herschel's "star-gauged" drawing of the shape of the Milky Way Galaxy, 1785.

red coolest. Others thought they started cooler as they formed, got hotter, and *then* cooled down—thus going from red to blue and white and back to red again.

But as scientists studied the stars, some began to suspect that stars of a certain color were not all the same given that they had similar surface temperatures but different luminosities—that reds and oranges and yellows, for example, came in brighter-and-thus-larger and dimmer-and-thus-smaller sizes. There was nothing left but to graph it all out to sort out the star types, and two astronomers did so in the early 1900s: the Dane Ejnar Hertzsprung and the American Henry Norris Russell (the 1937 and 1925 Bruce Medalists, respectively). The result was the famous Hertzsprung-Russell or H-R Diagram, which plots stars' absolute magnitudes (that is, luminosities) against their spectral classes (that is, surface temperatures).

It still took a while to sort out stellar evolution. For example, some thought—including Russell—that stars moved as they formed to the "Main Sequence," the curving band where most stars were located on the diagram, and then evolved down the main sequence as they aged, going from bluer to redder. Eventually, astronomers realized that stars' position on the main sequence depended on their masses, and they evolved on and off of it rather than up or down it. By the middle of the 20th century, astronomers were figuring it out, and modern theories of stellar evolution began to emerge. Stars form out of clouds of gas and dust, and how much mass they have at their birth determines their subsequent evolution and fate. Low mass stars become red dwarfs and live pedestrian lives for the most part, eventually cooling off and burning out. Medium mass stars like the sun spend a respectable 10 billion years fusing away in relative stability, then puff up to red giant size for a brief old age before losing their outer layers as planetary nebulas, leaving a small, hot white dwarf core behind. High mass stars live short and wild lives, bloating to red supergiant size before becoming unstable, collapsing, and exploding as supernovas, leaving compressed cores behind that become neutron stars, or, for the largest, black holes.

In the process, stars are the furnaces in which are forged all of the chemical elements beyond hydrogen and helium in a series of hotter and hotter fusion processes, all the way up to iron in the largest stars. Thereafter, it's the tremendous collapse and explosions of those largest stars that produce all of the elements heavier than iron.

Thus, one of the by-products of stellar evolution is us, and the planet on which we live. And if we exist, could other such planets exist, and others such as we?

In his long ago address to the Catholic University of America, the Reverend Searle, after speculating on the possibility of other places of habitation in the solar system, concluded thusly: "Neither can we tell whether the other innumerable brilliant suns scattered through space have attendant planets like our own. But it would be strange if they had not. If any considerable proportion of them have, evidently the chance that there are other habitable worlds in the universe becomes very great."

In modern times, one of the truly hot topics in astronomy is the search for other planets, "exoplanets," planets orbiting other stars, perhaps even planets like Earth. The evidence for other solar systems began to pile up with the discovery of an apparent debris disk around the star Vega by the IRAS infrared spacecraft in 1984 and subsequently around other stars. In 1992, the Hubble Space Telescope provided the first visual evidence by imaging "protoplanetary disks" around young stars in the Orion Nebula. Around the same time, scientists began detecting evidence for planets circling other stars by measuring tiny, periodic wiggles in the spectra of stars caused by planetary tugs on their parents. (Geoff Marcy—a past ASP Board member—and his team have been particularly successful is using this technique.) Others were found when they transited the faces of their parent stars, causing periodic dips in the light from those stars. The Kepler space mission, which for nearly four years stared at the same spot in the sky between Vega and Cygnus, has produced more than 3,000 planet candidates from observed transits, with much data still to be sifted through.

The conclusion is that planets are indeed common by-products of star formation. How common are planets with conditions suitable for life is still to be puzzled out, and is one of the prominent questions in astronomy as the ASP begins its second 125 years.

The Milky Way

In 1899, Simon Newcomb approached a discussion of the system of the visible stars in his book *Popular Astronomy* with an admonition: "Here we necessarily tread upon ground less sure than that which has hitherto supported us, because we are on the very boundaries of human knowledge."

The larger structure of the universe was still something largely to be guessed at in the era of the ASP's founding. The conventional wisdom of the day still dated from the English astronomer Thomas Wright's contention in 1750—promoted by the philosopher Immanuel Kant in 1755—that the system of stars surrounding the sun comprised a vast spinning disk with the sun at or near the center. The glowing, encircling band called the Milky Way, telescopically shown to consist of innumerable distant stars, was the interior representation of this disk.

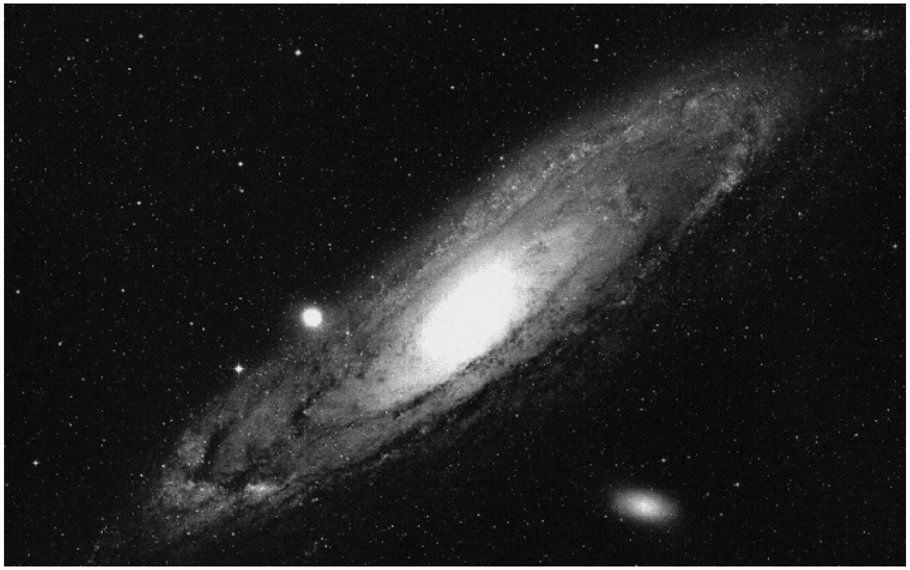
A modern-day image of the Cepheid variable star RS Puppis surrounded by reflective dust—a member of the class of stars that helped to make distances measurable and settled the island universe question. *[NASA, ESA, and the Hubble Heritage Team (STScI/AURA)-Hubble/Europe Collaboration]*

Around 1785, William Herschel quantified the theory through his method of "star-gauging," in which he counted the number of stars visible in the field of view of his telescope in a variety of directions. By assuming a roughly equal density of stars throughout the disk, he could assume that fewer stars meant shorter distances, more stars, greater distances. In this way, he confirmed the basic shape of the Milky Way system, also called the Galaxy (from the Greek word *galakt*, meaning "milk," in deference to the milky moniker of the sky's glowing band) to be a disk, about five or six times broader than it was thick. But the size of the disk was not so clear, since star distances could only be surmised beyond the very nearest. In the late 19th and early 20th century, astronomers used various analyses to improve their estimates.

Harlow Shapley (the 1939 Bruce Medalist) found a way to estimate the Milky Way's size using a class of pulsating variable stars called Cepheid variables. Henrietta Leavitt at Harvard College Observatory had discovered a period-luminosity relationship in 1908 for these variables, correlating their periods of variability with their luminosities. If you could measure the period, you could determine the absolute brightness of the star and calculate its distance by noting the difference between how bright it appeared and how bright it actually was.

Using Cepheid variables he found in globular star clusters, which surrounded the disk of the Galaxy in a halo, Shapley was able to estimate the distances to these clusters in 1920, thus calculating the disk of the Milky Way to be something over 200,000 light years. This was too large, but later refinements of the technique and additional methods reduced the disk's diameter to the modern value of about 100–120,000 light years.

By presuming the halo of clusters would be centered on the center of the Galaxy, Shapley also found the sun was considerably removed from the center—by about 30,000 light years in today's estimates.



The Andromeda "Nebula."

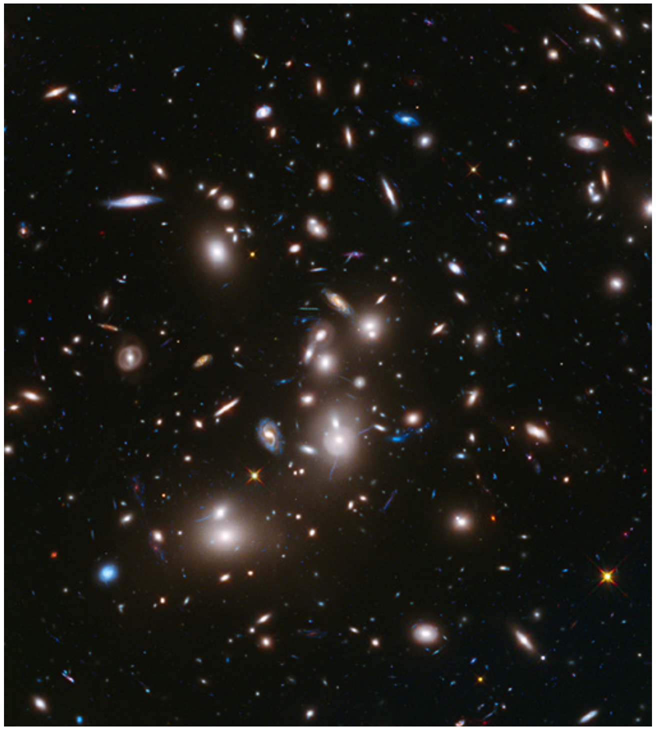
With the structure and extent of the Milky Way Galaxy coming into focus in the early 20th century, the nagging question was this: was that it? Was that all there was to the universe? One system of stars in the infinite dark? Or was there more?

The Structure of the Cosmos

From almost the beginning of the telescopic era, astronomers found more than stars in the sky; they also found little glowing blobs and whiffs and spiral shapes collectively called the *nebulae*—Latin for "clouds." And very early on, their nature stirred debate.

The aforementioned Thomas Wright, in his 1750 publication *An original theory or new hypothesis of the Universe* in which he characterized the shape of the Milky Way as a spinning disk, also contended that the little nebulae the astronomers were finding were actually similar systems of stars, very far away: "The many cloudy spots, just perceivable by us, as far without our Starry regions, in which tho' visibly luminous spaces, no one star or particular constituent body can possibly be distinguished; those in all likelihood may be external creation, bordering upon the known one, too remote for even our telescopes to reach." Kant promoted the idea in 1755 and wrote of "island universes" separate from our own.

While the idea was appealing, it was controversial given the lack of proof one way or the other, and many astronomers in the period of the ASP's beginnings pooh-poohed the notion. Newcomb, writing in his *Popular Astronomy*, described the visible universe as the flat, raggedy disk of the Milky Way with regions of nearby nebulae above and below the disk, associated with the Galaxy. Of Kant's model of the universe, he wrote that "although the possibility that this view is correct cannot be denied, yet the arrangement of the star clusters or resolvable nebulae militates against it." He found that the nebulae he thought most likely to be island universe candidates were clustered near the plane of the Galaxy, and thought it highly improbable



Hubble "Frontier Field" image of galaxy cluster Abell 2744, its massive dark-matter enhanced gravitational field warping and magnifying images of more distant galaxies, 3.5 billion light years distant in the accelerating universe. *[NASA, ESA, and J. Lotz, M. Mountain, A. Koekemoer, and the HFF Team (STScI)]*

that allegedly far-flung star systems would be so preferentially distributed.

The controversy raged on, and in 1920, Harlow Shapley and Heber Curtis (the 1912 ASP Board president) held a famous debate, Curtis arguing for other distant star systems, Shapely against. In the end, it would be Edwin Hubble (the 1933 ASP Board president and 1938 Bruce Medalist), using variable star distance estimates much as Shapley had for estimating the size of the Milky Way, who would settle the question.

In 1907, masterminded by George Ellery Hale (the 1916 Bruce Medalist), the Mount Wilson Observatory overlooking Los Angeles began operating, putting into service first its 60-inch reflector, and in 1917, the 100-inch Hooker reflector, the most powerful telescope in the world at the time. Hubble started using it in 1919, and in 1924 identified Cepheid variable stars in the spiral-shaped Andromeda and Triangulum Nebulae. They were so faint that they had to be very far away, and he calculated distances of 900,000 and 850,00 light years—less than modern-day determinations, but enough to show that they indeed lay well beyond the Milky Way.

The spiral nebulae were the island universes of Wright and Kant after all; the Milky Way Galaxy was not alone. But there was more.

Between 1912 and 1914, Vesto Slipher, the director of Lowell Observatory and the 1935 Bruce Medalist, had taken the spectra of 13 of the spiral nebulae and found that the shift of their spectral lines toward the red indicated that they were moving away from us. Milton Humason and Edwin Hubble expanded the effort in 1928 with the Wilson 100-inch, and in 1929 showed that this red shift or recession velocity increased linearly with increasing distance at a rate that become known as the Hubble Constant. Not only was the universe filled with galaxies; they were being carried away in a general expansion of the universe.

By extrapolating backwards, one could postulate a time when the expansion began—with all of the universe crammed into an infinitely hot and dense condition that changed drastically in an event that Fred Hoyle (the 1970 Bruce Medalist), derisively termed the "Big Bang." (Hoyle favored the now discarded Steady State Theory, in which matter is continually created as the universe expands.) In 1964, the discovery of the predicted cosmic microwave background, the afterglow of the Big Bang, was discovered, and in 1992, the Cosmic Background Explorer (COBE) confirmed its expected spectrum and tiny temperature variations, or anisotropies, that revealed the original clumping of matter in the early universe that eventually formed the galaxies. The Wilkinson Microwave Anisotropy Probe (WMAP) launched in 2001 and the Planck Mission launched in 2009 have since refined and extended the COBE findings that corroborate the Big Bang and expanding universe models as the leading cosmological theories that explain the universe as we see it today.

But it turns out that most of the universe *can't* be seen. In the

1930s, Fritz Zwicky calculated a gravitational mass for the Coma cluster of galaxies that far exceeded what the galaxies' luminosity suggested was there. In the 1970s, Vera Rubin (the 2003 Bruce Medalist) found that explaining galaxy rotation rates required much more mass than could be seen. Growing evidence suggested that the universe contained large quantities of matter, christened "dark matter," that could only be detected by its gravitational effect.

The universe got even darker when in 1998 and 1999, two research teams (both including Alex Filippenko, the 2001–03 ASP Board president) studying Type Ia supernovae made startling announcements. These supernovae all arise from similar circumstances, reach the same peak brightness, and can be used as distance indicators to their parent galaxies. They were being studied to characterize the expansion history of the universe, and the results showed that the expansion was accelerating. The culprit was called, for want of a better term, "dark energy," a mysterious form of energy that expands space at a currently increasing rate.

In 2013, the Planck Mission announced results that refined the proportions of the constituents of the universe, finding that the cosmos is made up of 68% dark energy, 27% dark matter, and 5% "normal" matter that comprises the galaxies, stars, planets, and the residents of Earth, in a universe that began 13.8 billion years ago in a Big Bang.

The Universe has come a long way from the single flattened disk of stars it seemed to be in 1889. Who knows what new understandings may emerge in the ASP's next 125 years?

Epilogue

1889—the year of the Eiffel Tower, Van Gogh's *Starry Night*, and a total solar eclipse that spawned a new Society.

Nearly two months after its founding on February 7, at a second gathering of the organization, its new president, Edward Holden, offered remarks about "The Work of an Astronomical Society." The tone was inclusive as Holden said, "we must remember how various are the opportunities and attainments of our different members, and try to lay the foundations of our efforts so broadly that every class will find a sphere of action in our programme, a stimulus in our proceedings, and a support in our friendly association."

He recognized that "the greater number of our members" would be amateurs, and laid out useful associations for those with telescopes and photographic skills and well as those "among us who have joined as learners; who are here to listen, to observe, to read and to study." He went on: "Let each member feel that he has a part to bear, both in the actual meetings, and outside of them, among his associates. In one word, let our society be a live one—active, intelligent, modest, competent."

Those early days were focused on meetings and publications. Over the years, the Society evolved just as our understanding of the universe has, and in recent decades has grown to include products, education programs, and new ways to touch and change lives, using the sky we love.

The Astronomical Society of the Pacific continues to fulfill its founding principles as well as the words of Edward Holden on that March evening: " … we may look forward to a career of real usefulness, not only to our members, but to the science of Astronomy." And to the cause of science education and communication and literacy, for all those we continue to serve.

In the September, 1889 issue of the *PASP*, Holden included a brief extract from a review of its first two issues in the publication of the German Astronomical Society by Professor E. Schoenfeld, director of the observatory in Bonn. It read: "The Reviewer has no right to speak in this place in the name of the *Astronomische Gesellschaft*; but, in his own name and in that of other members, he expresses a hearty greeting to the new Society which has been founded on the Coast of the Pacific Ocean and wishes for it all success and prosperity."

To which Holden commented, "It will be gratifying to our members to know of this early and courteous recognition of our modest beginnings."

From modest beginnings to a century and a quarter of achievement, may "all success and prosperity" continue to visit the Astronomical Society of the Pacific—125 years from today.

About the Author

Jim Manning is Executive Director of the Astronomical Society of the Pacific in San Francisco. He previously served as the head of the Office of Public Outreach at the Space Telescope Science Institute in Baltimore, which manages the Hubble Space Telescope, and spent 30 years as a planetarium director and educator in a variety of college, university and museum settings. Despite all of the recent advances in our understanding of the universe, he still enjoys most the parts of it that he can see. ✦

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1889 125TH ANNIVERSARY 2014

Happy 125th Anniversary ASP!