2025

SPRING ISSUE

CLEAR SKIES

BROWN
Department of Physics

images taken with:
Celestron Origin

A LADD OBSERVATORY QUARTERLY PUBLICATION

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Welcome to Clear Skies!

With the weather finally getting comfortable, we hope you will spend a few minutes with Clear Skies before you go outside to enjoy the real sky overhead.

To help you, Jim has, as ever, given you star charts for the upcoming months. We hope you find them useful.

In addition, Bob has given us highlights of upcoming events for you to watch for. And, look for his beautiful image taken while in a very dark sky.

Curator Mike has given us a lot of Time to think about, as well as the incredible work involved in lighting up our buildings, including Ladd.

All of us are fairly familiar with scientist Louis Pasteur, and his remarkable work in developing the process of vaccination, but he was also responsible for dispelling the concept of spontaneous generation.

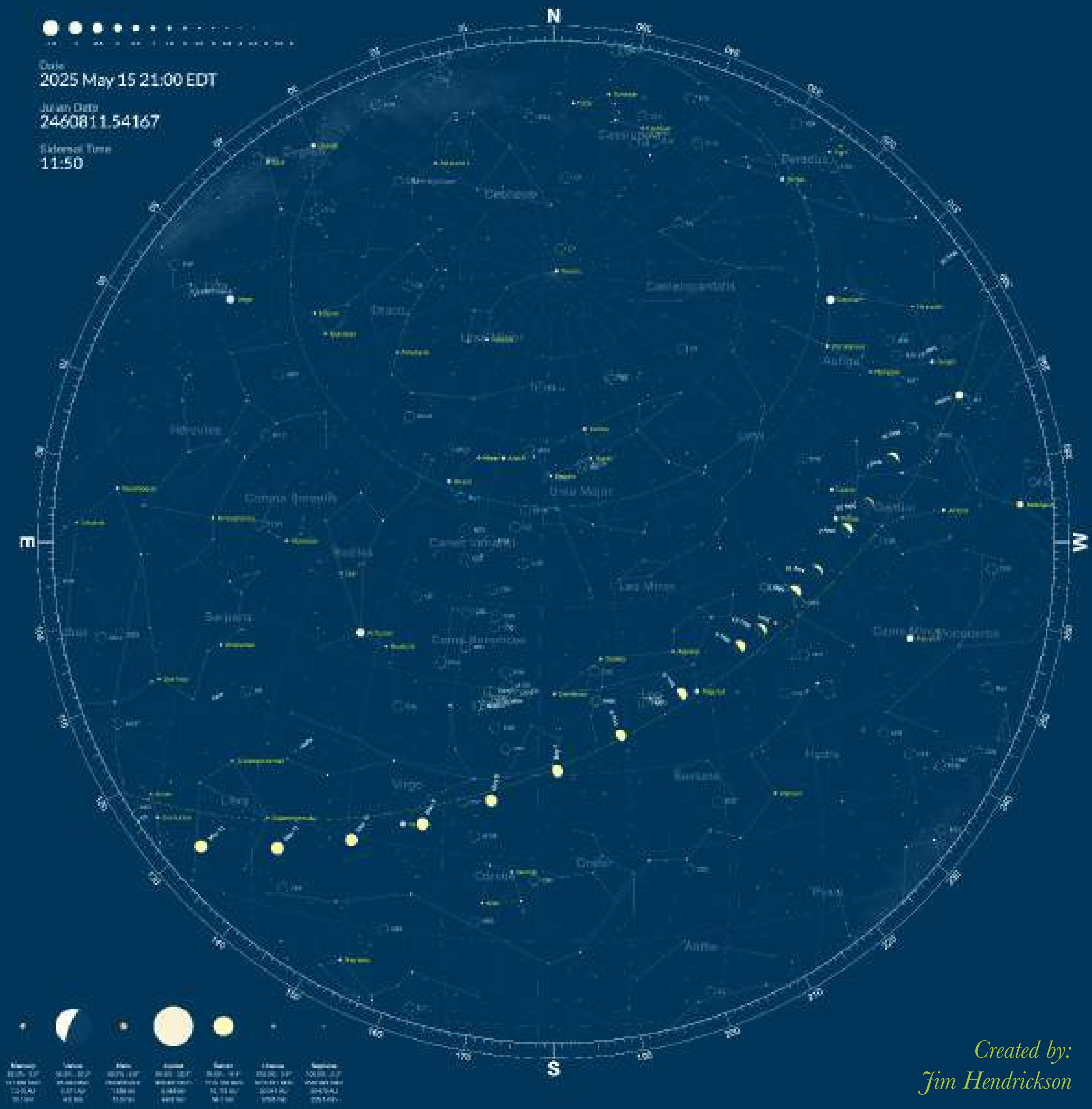
One of Brown's Planetary Geology department's professors for many years has been Jim Head. He recently sat down with Ryan for an exclusive interview, and he also introduced Ryan to Astronaut David Scott.

The Brown Astronomy Club has been very busy lately. Ryan will give us a rundown of its recent activities. If you'd like to be a part of it, he's also given you the information to do so.

In this edition, we're bidding good-bye to Kate, Indigo and Mahmoud, who have spent the past couple years giving us the best-looking magazines ever. Kate and Mahmoud are both graduating from Brown, and Indigo's upcoming schedule will only allow her to assist our new layout team, Ina and Shaliz, when needed. Thanks to all for everything you've done!

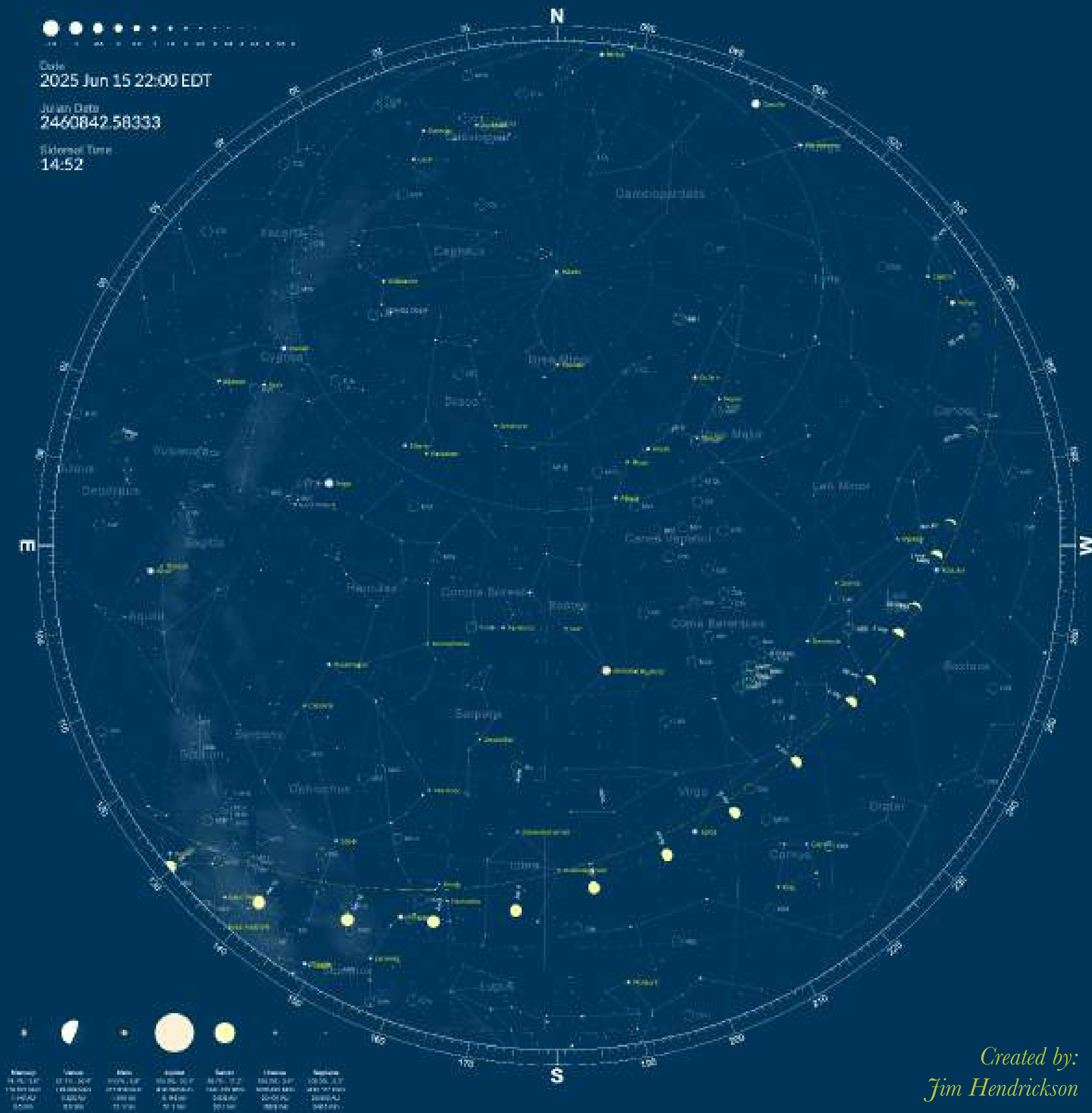
Happy reading!

May Sky Chart



Created by:
Jim Hendrickson

June Sky Chart



Created by:
Jim Hendrickson

JUNE ASTRONOMICAL HIGHLIGHTS

LUPINES, FIREFLIES, AND THE MILKY WAY

With summer's arrival on June 20th, the nights are shorter, with evening twilight not ending until about 10pm, and then the sky brightening again, at the start of morning twilight, around 3:30am. This limits our stargazing to just a few, late hours. However, June can be a very special month that combines the beauty of nature with the heavens above.

A special stargazing pleasure I have enjoyed for many years with my family is taking nighttime strolls in June, in New Hampshire, in the open fields of lupines in full bloom, near our summer cottage. At this time of the year, the Milky Way is seen as a hazy arch of light, rising from the eastern horizon, then cascading downward to the south. But the real magic at this particular place during June is the multitudes of fireflies, flying all about in every direction, creating a beautiful, sparkling, natural fireworks display over the fields, sometimes blending in with shooting stars overhead. For our family, this has always been an enjoyable time to take a short vacation to the mountains, away from light pollution, to enjoy this wonderful show that nature provides.

On June 1st, the Moon is a waxing crescent, and located in the spring constellation, Leo, the Lion, close to the Lion's brightest star, Regulus, which will be just to the lower left of the Moon. Just above the Moon are the rest of the stars that form the head of the Lion, looking like a backwards question mark.

Mars is nearby, just 7 degrees to the right of the Moon this evening. However, if you're observing Mars with a telescope now, don't expect to see all that much detail. Our last good views of Mars happened back in January, when the orbits of Earth and Mars brought the two worlds within about 60 million miles of each other. Then it was possible to make out surface detail and the polar ice cap in a small telescope. We are now an additional 100 million miles further from the Red Planet, so the fun of observing Mars now is seeing it move through the sky, from night to night, relative to the background stars. Throughout June, watch Mars get closer to Regulus, passing just above the star mid-month. By month's end, Mars will be 7 degrees to the left of Regulus. It's going to take a while for Earth and Mars to catch up with each other again. The next good opportunity to see detail on the Martian surface with a telescope will happen when Earth and Mars come within 63 million miles of each other in February, 2027.

The Full Moon in June is known as the Full Strawberry Moon, and will be seen rising around 9:20pm on June 11th. Enjoy some strawberry shortcake after dinner, and then go find a nice spot to watch the Moonrise!

Each night after Full Moon, moonrise comes later, and by the time of the arrival of the summer solstice, at 10:42pm EDT on the 20th, the Moon does not rise until the early morning hours, providing for dark skies once again. The later half of June is the ideal time to begin exploring the summer constellations. Using binoculars, and scanning through the Milky Way, will reveal many star clusters and nebulae. A book I like to recommend to beginning and seasoned stargazers alike is "Binocular Highlights" by Gary Seronik, a wonderful little guide, filled with star maps, and good advice on choosing and using binoculars for stargazing. The book lists many different objects that can be observed throughout the year.

There are many star clusters, nebulae and galaxies that belong to a catalog of objects, well known to amateur astronomers as The Messier Catalog.

June 26th happens to be the 295th birthday of the man who created the Messier Catalog, French astronomer, Charles Messier, born on this date in 1730. Although born into a moderately affluent family, the 10th of 12 children, his early life was not easy. Six of his siblings died during childhood, and when Charles was eleven, his father passed away. Charles was educated by his older brother. It is said that his interest in astronomy was inspired by seeing the Great Comet of 1744, a wonderous, six-tailed comet that was as bright as Venus, rising just before sunrise. Who wouldn't be awestruck by such a sight!

Messier went on to become a prolific comet hunter, while working as an astronomer for the French Navy and the French Academy of Sciences. Charles Messier discovered 13 comets, but today he is remembered for the catalog he created, from 1774 to 1784, of 110 objects that appeared comet-like in his small telescopes, but turned out not to be. This was done mostly as a guide to help fellow astronomers in their quest to hunt comets, and not be confused by these objects.

The Messier Objects are wonderful celestial treats for stargazers, which include open star clusters, globular star clusters, nebulae, and many galaxies. All can be seen in a small telescope, and quite a few can be seen in binoculars. Most star maps and guides will list these objects, usually simply designated as M1 through M110. Some of the brightest Messier objects are found within the Sagittarius/ Scorpius region of the Milky Way, looking near the southern horizon late at night. To me, the brighter stars of Sagittarius form an image that looks like a teapot, and the Milky Way here looks like steam pouring from the spout. This is a great place to start hunting for Messier objects, such as M8, the Lagoon Nebula, M17, the Swan Nebula, and M24, the Sagittarius Star Cloud. Your local library, besides having guide books, might even have a telescope that you can borrow.

I hope you enjoy your early summer stargazing, along with fireflies creating a mystical show for you!

- Robert Horton

ASTRONOMY CLUB UPDATES

This semester, the Brown Astronomy Club has been extremely active within the Brown community. We hosted many successful events at Ladd, as well as throughout Brown's campus and Providence. In March, we teamed up with the CCRI Astronomy Club, the Frosty Drew Observatory, and the Skyscrapers to participate in a viewing session on the Michael Van Leesten Bridge in downtown Providence. Furthermore, we hosted two solar observations at Brown on the Main Green. Brown students had the unique opportunity to create cyanotypes, or solar prints, utilizing ultraviolet light from the Sun.

In addition, we recently returned from a joint trip with the Brown Outing Club to Little Compton Beach. There, we had a great time observing Jupiter and the Galilean moons before our view was inevitably clouded out. We are grateful to the Nature Conservatory for their hospitality.

As this school year comes to an end, we are already looking forward to next year's events. If you would like to stay updated on our activities (or if you enjoy looking at and taking pretty pictures of space), you can find us on Instagram @brown.astro!

IN BRIEF

SPRING 2025

Pasteur Vs. Spontaneous Generation

by Francine Jackson

All of us at some time in science classes have heard of the concept of "spontaneous generation," usually with respect to mice being "born" in bundles of rags tucked into barn corners; yet, in the 19th century, people would become ill from germs believed to be spontaneously generated. According to scientist Felix-Archimede Pouchet, "spontaneous generation is the production of a new organized being that lacks parents and all of whose primordial elements have been drawn from ambient matter."

Scientist Louis Pasteur was asked to attempt to understand fermentation in beet juice, although Pouchet stated that the beet juice must have spontaneously generated the germs in it.

Pasteur replied that that concept was totally flawed, and the French Academy of Sciences, to determine which of the two scientists was correct, created a 2500 franc contest. Pasteur, attempting to prove that germs actually existed in air, climbed the largest glacier in France, Mer de Glace, carrying glass flasks, which he kept open overnight. In the morning, most were filled with microorganisms.

In late 1860, Pasteur brought his flasks to the Academy of Sciences, placed them on a table, and had the judges peer into them, believing this would quell the discussion. However, Pouchet still refused to accept the evidence, although he did withdraw from the competition. Pasteur, to confirm his theory, in 1864, filled a theater with Parisian elites. He told his audience he would not allow the audience to leave until he proved the air contained "invisible germs." His statement: "We can't see them now for the same reason that in broad daylight we can't see the stars."

Pasteur then had all the lights turned off, except for one small light that showed floating dust motes. He then used a pump to drive air through a sterile cotton. He soaked the cotton in water, then put one drop under a microscope, projecting the image on a screen. The audience could then make out movement. "These, gentlemen, are the germs of microscopic beings." The astonished audience gave Pasteur a standing ovation.

What Pasteur began in the 1880s is the study of what we now know as aerobiome, the collection of microorganisms and their metabolic byproducts in a given airspace. Although his decades of work often treats this work as just a small part of his many discoveries, there are some who now think that aerobiomes could possibly float within the clouds of other planets. A fantastic concept? Much less fantastic than spontaneous generation.

The Leo Triplet - M65 (Bottom), M66 (Middle), and NGC 3628 (Top) by Ryan Seeb - as seen through the Astronomy Club's 8-inch Dobsonian telescope. NGC 3628 is sometimes referred to as the Hamburger Galaxy due to its edge-on appearance. This image contains around 200 light frames, and it was stacked and processed in Siril and Photoshop.

Bob Horton - Winter Constellations departing the sky, seen over Mooselookmeguntic Lake, Rangeley, Maine on April 22nd.

TO THE MOON AND BACK

AN INTERVIEW WITH APOLLO SCIENTIST JIM HEAD AND APOLLO 15 COMMANDER DAVID SCOTT

The rising crescent Earth viewed from the Apollo 15 orbiter. Image courtesy of Jim Head.

While Dr. Jim Head was working on obtaining his PhD from Brown University in the 1960s, he saw an ad in a book of job listings saying "Our job is to think our way to the Moon and back." From this listing, Dr. Head would go on to work as a lead scientist for NASA during the Apollo missions. Now, he works here at Brown researching the geological structure of the Hadley Apennine region and the history of the Ina Irregular Mare Patch, both on the Moon. I had the chance to sit down with Dr. Head and reflect on his career at NASA and beyond.

Q: "Can you talk a little bit about your background and how you got your first job at NASA?"

A: "My background was in traditional Earth geology. I was studying layered deposits in the Appalachian Mountains that were formed in the Devonian, which is about 420 million years ago. … There was a group of us here at Brown, where I was a graduate student, [that] worked in different parts of the geological column, and it was really, really an incredible time. I had a professor, one of my two advisors, Tim Mutch. … He was a classic Earth stratigrapher, which is what you do when you look at layered rocks, but he also was a visionary. … He was 6'3", maybe, I don't know, 6'2", and he was always parallel processing, so to speak. So he'd stop in the middle of a sentence in a lecture and just be totally quiet. And then he'd kind of look out and come up with something like, whoa, where did that come from? [One] day he walked over to the window in the middle of his lecture, stopped talking, … looked out the window, and we're sitting there waiting for the next communication from six feet up. And he turns around and he says, 'You know, there's just no fundamental problems left in Earth stratigraphy.' … We were a year before trying to get a job, but our advisor tells us there's no fundamental problems left in the field. … [We were] still reeling from that one when he said, what we ought to do is take our stratigraphic principles and apply them to the Moon. … And we're just like, really? And so he said, yeah, so the next semester he said, let's organize a course to look into this. And we did. … So this is Tim's vision.

"You know, we always said at six foot two or whatever he was, he could see over the horizon, which we couldn't. … He went up to work in [the] USGS Astrobiology Branch by this time, so I was kind of on my own and looking for a job. I found this college placement manual, which is a book of jobs [that] comes out every year. And I turned to the index, and I looked up geologists. [It had pages] 16 to 20 and then 42, and I said, what's that outlier? Tim had taught us, obviously, to look for the outlier. [On 42] there's a picture of the Moon, and it just said 'Our job is to think our way to the Moon and back' [with] a [phone] number [at] the bottom. It wasn't clear who it was. … It turned out to be … the systems engineering branch for NASA, which was run by Bell Labs.

"And so I applied, got the job, and all of a sudden I was a planetary scientist, training astronauts, developing priorities. You know, what do you do? Where do you go? Where do you land? We had to figure that out. What do you do when you get there? You know, what kind of samples do we want? How do we get them? … How do we train astronauts in geology? And then how do you do the mission? So we would do all of that, come back, do the mission. And then we'd debrief with the astronauts when they got back. And then factor that into the next mission's goals and objectives and experiences, etc. So, yeah, that was an incredible first job. And I ended up at that point when I think early '73 probably or so. Somewhere in there, Tim asked me if I would like to come back to Brown to help him start a planetary program. And I said, wow, you know, how could I pass that up? So I did that. And I've been here ever since, more or less. … But, yeah, … it was a great time. Lucky to be where I was at the time. Lucky to have somebody like Tim Mutch make me even think about looking at the outlier, you know. And, yeah, here we are."

Q: "What did a typical day look like working on Apollo?"

A: "I worried at the beginning of my job that people would find out I didn't know anything about the Moon, that I was just some guy who worked on Earth rocks. And in the course of my first couple of months there, I realized that, oh, wait, nobody knows anything about the Moon, and I felt much more comfortable that way.

"It was like pedal to the metal. I mean, like, unbelievable. I hadn't finished my thesis at this point. So a typical day would be, you know, you clearly had a mission coming up. The upcoming mission was the most immediate concern. You know, what's going on? What are the requirements? What do we have to do? How do we get everything ready for launch, et cetera? Any last-minute training of the astronauts? So those are the immediate things. But the next thing was, okay, the mission following that, we had to pick the landing site for that one typically before, well, from maybe [Apollo] 12 on… before that previous mission had flown because the science was kind of independent of how they did … on the surface. I mean, they might say, well, you know, we need something like a wheelbarrow or something like that. Okay, that's independent of science. It just makes it more efficient. So that's kind of the day. … There wasn't a lot of work, you know, after hours. … That's when I worked on my thesis. So that's how I got probably into my series of bad habits in terms of working long hours in a day, but I love it, so it's not really work. So yeah, those kinds of things. A lot of what we do at work and a lot of meetings, working with operations people. You couldn't just say, I want to do this. You got to say, OK, we got to think about … consumables and how far can [the astronauts] go? What are the [metabolic] rates? … So I knew all the metabolic rates of the astronauts. It's pretty interesting how they vary and kind of a little bit with personality, it turns out. But that's another story."

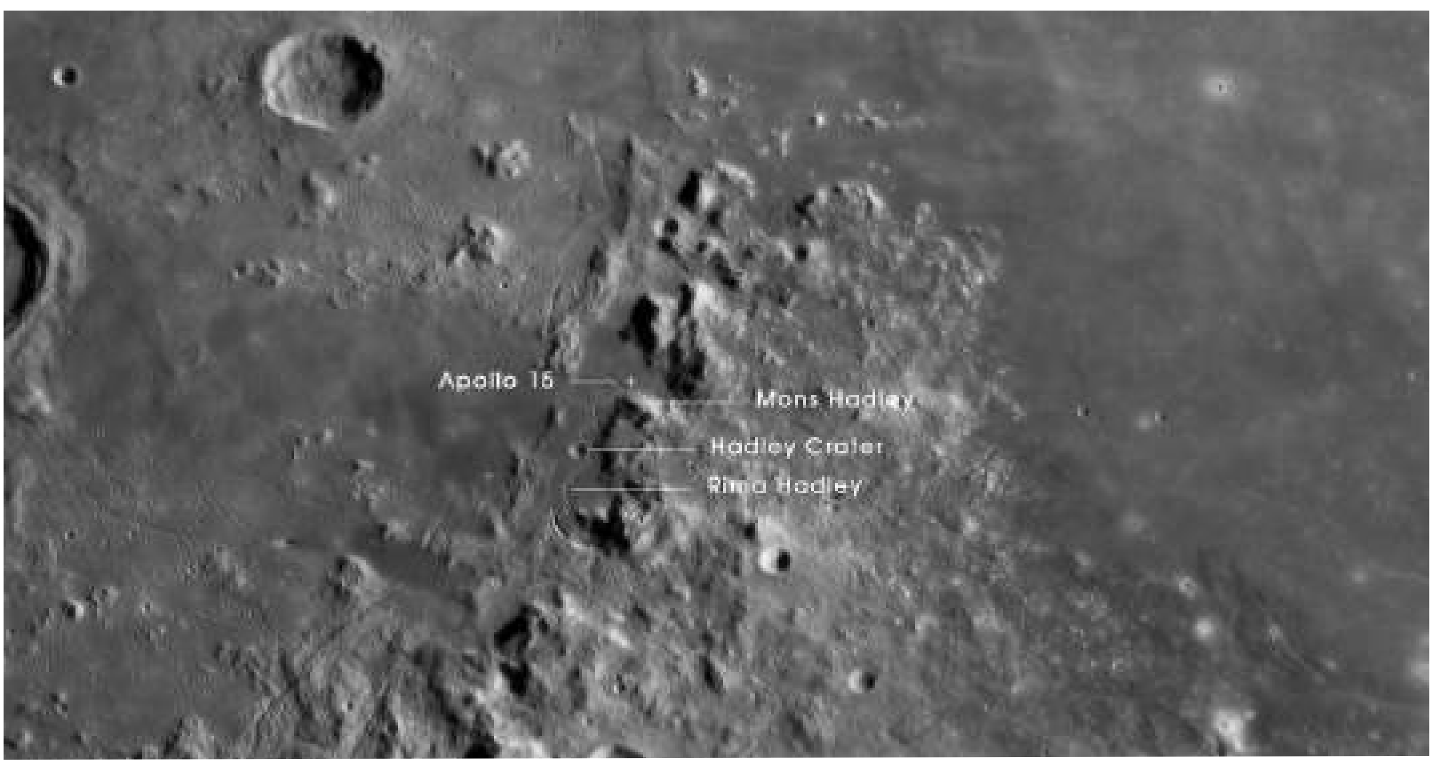


Image of the Apollo 15 region captured by Ladd astronomer Scott MacNeill.

Q: "Looking back at your career, what project that you worked on are you the most proud of?"

A: "I've been really lucky in my career to be involved in a bunch of different things, each of them with a lot of science, a lot of good science and real thrills about … doing it. I mean, I think diving to the bottom of the seafloor in the Alvin and another submersible is a pretty amazing experience. And going to the inside of active volcanoes at Mount St. Helens and [in] Hawaii is a real adrenaline rush but so incredibly informative. You really see geology in action. It's not just like a rock after it's solidified, it's like, oh, this is how it's made. I think five seasons in Antarctica was a real eye-opener in terms of your personal development. … Can you live psychologically and physically in a very, very harsh environment for three or four months? And the science in that was incredible.

"But if I look back, I would say that being involved in Apollo was incredible, particularly for my first job, because it wasn't just the excitement of accomplishing a national objective. It was in the progressive increase in our exploration capabilities and turning that into real scientific return, and the astronauts became more and more focused on the geology with time as they knew better how to fly the missions and land successfully, etc. … I think a really important thing is that … it wasn't just one individual. It was a team. You hear that all the time, but it was absolutely true. And the beauty of that is that I had to learn so much. I had to learn. I work with cosmic ray physicists. I work with transient atmosphere people. I work with geologists, petrologists, geophysicists, people who studied gravity waves. … Stuff like that. … A part of my job was to figure out the best place to put [their instruments]. So I had to learn about what they were trying to do, which was really intimidating in the beginning. … Working on a team has really been, I think, one of the best lessons I've learned, and I learned it in my first job. So, it really affects the way I do science because it isn't just, oh, let's look at this. It's like, well, what are we trying to solve here? What kind of data do we need? … So, yeah, that was a big, big, important lesson for me, I think."

Q: "The final question I have is, what advice do you have for someone who wants to work for NASA or get into space sciences but does not know where to start?"

A: "I would say that the best way to get into planetary sciences is, first of all, to be the very best at what you like to do. So, you know, the reason I work so hard is because it's not work for me. It's just a passion for understanding the unknown. … I think you need to find what your passion is and be good at it. I don't know whether that applies to me or not, but at least I know what I'm excited about and I work very hard at it because I'm totally engaged in it, you know what I mean?

"…Space science is so broad that let's say you're at a university and you are in the past and present engaged with your excitement as a physicist, just for example, then that's great, okay, because … we need not only physicists for space exploration, but we also need people who are in different disciplines because space science is so broad. So, I'm in planetary geosciences, which is a very broad field. I work with geophysicists, I work with atmospheric modelers, I work in all kinds of things, and I think that's the key. Follow your passion.

"There's many, many internships and many, many universities that have space activities. And yeah, I mean, if you feel that passion coming along, I would advise anybody to definitely follow it up and communicate with people who can help you with that. This is not very explicit, but I think finding a space science track in a university – typically those don't exist at [the] undergraduate level explicitly, but that's less important than building a strong basis in some aspects of science."

Following our conversation, he reached out to the Apollo 15 Commander David Scott and asked three questions on my behalf. Thank you to Dr. Head for facilitating this connection. Here is what the seventh person on the Moon had to say:

Q: “How has seeing the Earth from the Moon’s point of view given you a new perspective on humanity?”

A: “It is indeed awesome and unforgettable. But my favorite perspective is the view we had from lunar orbit as we saw crescent Earth rising. It looks like the Moon, but then you look down and there is the lunar surface!”

Commander David Scott on the Moon. Image advertising a talk Commander Scott gave at Brown in 2012, courtesy of Jim Head.

Q: “Can you describe your experience when you were in the orbiter on the far side of the Moon?”

A: “When you are in orbit on the sunlit side you see all of the amazing geology of the mare and cratered highlands in great detail, and as you approach the terminator, the shadows get longer and the detail is even more striking, as the low Sun highlights the topography. When you pass the terminator, the line separating the side illuminated from the Sun, it’s ‘light’s out!’ But slowly your eyes adapt to the darkness and you can actually see the surface features very faintly…. How? This is Earthlight, sunlight reflected off Earth! It’s the same as Moonlight on Earth, where you are seeing things due to sunlight reflected off the Moon. As you proceed further around the Moon, even Earthlight disappears, and there is no light at all! All you see is the stars. The only way that you know you are actually in orbit around the Moon is that there is a dark hole where there are no stars! You definitely know that you are alone… Then when you come to the sunrise terminator, the sunrise is like a lightning bolt! There is no ‘dawn’ like on Earth, because there is no atmosphere to diffuse the sunlight.”

Jim Head (right) reviewing Apollo 15 returned samples from the Moon with Apollo 15 Mission Commander Dave Scott (left) during one of many visits to Brown University by Commander Scott. They are discussing the most recent findings from the mission and the new questions that these samples raised, as a basis for future lunar exploration missions. Lincoln Field Building, 1990's. Photo by Peter Neivert. Caption and image courtesy of Jim Head.

Q: "What advice do you have for someone who is interested in pursuing a career as an astronaut?"

A: "Of course we were among the first astronauts, so we didn't think much about how to become an astronaut. NASA sent out a call, and as experienced military and test pilots who were familiar with new 'flying machines' and enjoyed testing them, we jumped at the chance to try all the challenges of going to the Moon. Today, NASA picks the best and the brightest in many different fields, so my advice would be to study hard, excel in your education, learn how to be part of a team, and take advantage of possible NASA internships."

My conversation with Dr. Head combined with the answers to the questions I asked Commander Scott helped me to gain insight on this rich time period of scientific discovery. With NASA's Artemis mission to the Moon in our near future, further breakthroughs are on the horizon.

Commander David Scott and Dr. Jim Head with Brown students in August, 2022. Photo by Anne Cote, courtesy of Jim Head.

Syncro-Clock Motor

The dial of the Synchro Motor.

When the Ladd Observatory opened in 1891 there was no electricity distributed in the neighborhood. The first electric company was Rhode Island Electric Lighting Company, formed in 1882. Two years later the Narragansett Electric Lighting Company started. The building that housed their steam engine powered dynamos were located on South Street. After many years of being vacant, the building was renovated starting in 2014. It was completed in 2017. The building now contains offices and teaching spaces for Brown University, Rhode Island College, and the University of Rhode Island.

When Ladd opened, the interior and streetlights provided illumination by using a flame fueled with natural gas. Our telegraph time system was powered by handmade batteries. Within about a decade there was electricity in the neighborhood that powered the then new form of electric lighting. The availability of electricity was transformative. At first, it was used to power machinery in factories, which had previously been powered by steam engines. It was also used for the first 75 electric arc streetlights in downtown Providence in 1884.

Prior to the availability of utility electricity, the Physical Laboratory at Brown would have used a small steam engine to generate electricity for physics experiments. Electricity also led to many inventions, such as the electric motor clock. The electricity is an alternating current. It oscillates at 60 cycles per second. Before the invention of the electric motor clock, the power companies did not synchronize to exactly 60. It could vary by 10 percent or more. The new electric clocks required the electric companies to standardize the frequency. A clock that is both powered by electricity and synchronized to the frequency of the electricity can keep accurate time. These synchronous motor clocks were available starting in the 1920s. In 1880, brothers Jacques and Pierre Curie discovered the principle of piezoelectricity. If an electric field is applied to a quartz crystal it will slightly change shape, and oscillate at a specific frequency. The resonant frequency depends on the exact size that the small crystal is cut to. It led to accurate time being available in battery powered clocks without needing the synchronizing frequency from the electric company. These quartz oscillators became available in 1927. For decades they were only used as precision laboratory instruments. They didn't become widely available to the public until the 1960s. The first quartz wristwatch was sold in 1969.

Mechanical pendulum clocks would have been used in homes and businesses before these inventions. The time would vary based on the temperature of the room. During the summer, a metal pendulum rod would thermally expand. This would cause the clock time to run slower. In winter, the rod would contract, causing the clock to run faster. The change in the length of the pendulum is very small. It is on the order of 1/1000 of an inch. This tiny change is enough to cause the clock to gain or lose 4 seconds per day, or 2 minutes per month. Our observatory was originally heated with a fireplace. In a building without air conditioning and the uneven heating by a fireplace fire, the drift could be much larger. Today, Ladd still calibrates our mechanical pendulum clocks twice per year: once for the summer temperature, and again at the start of winter when our heat stays on.

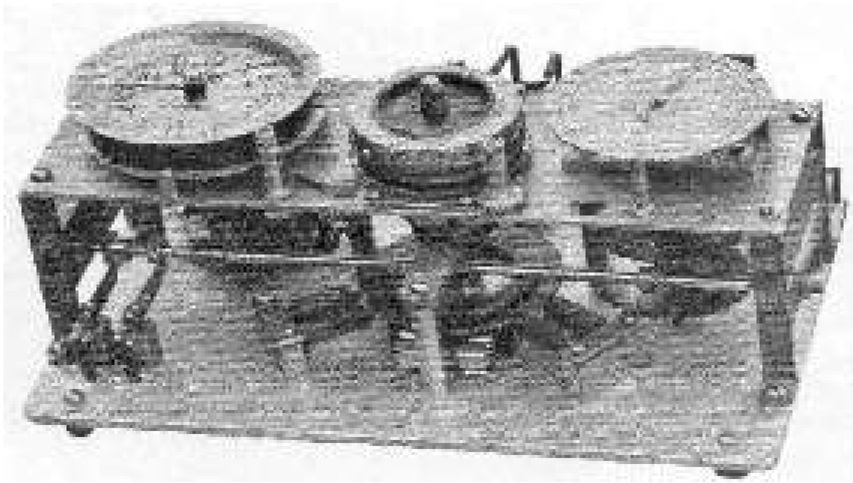
Quartz crystal timekeeping oscillators can be precise. Like a pendulum clock they are also susceptible to temperature changes. They are usually temperature stabilized. They are put inside a small metal box that is heated to a constant temperature that is somewhat higher than room temperature. This is called an "oven." Manufacturing quartz crystals in the 1920s was difficult. The crystals produced would have ever so slightly different sizes. This led them to resonate at slightly different frequencies, which is undesirable

The synchronous motor is beneath the disc.

One early calibration device was the Type 411-A Synchro Motor made by the General Radio Company of Cambridge, Massachusetts, in the late 1920s. A quartz crystal circuit would be wired to it. The Synchro Motor would then be calibrated to a high precision pendulum clock. The time of the pendulum clock would be set based on observations of stars, an activity that Ladd Observatory engaged in shortly after it opened. The quartz crystal would then control the rate of the synchronous motor that drives the hands on the clock dial. The time shown on the dial would then drift, compared to the time on the precision clock. The amount of drift per day would then inform the person calibrating the quartz circuit how to adjust it accurately. The quartz circuit could then be used to control multiple, less expensive, electric clocks. In 1927, this Synchro Motor would have sold for $130. That would be equivalent to over $2,000 today, considering inflation. These precision clocks would only have been used in scientific laboratories, or to calibrate a commercial radio broadcast transmitter.

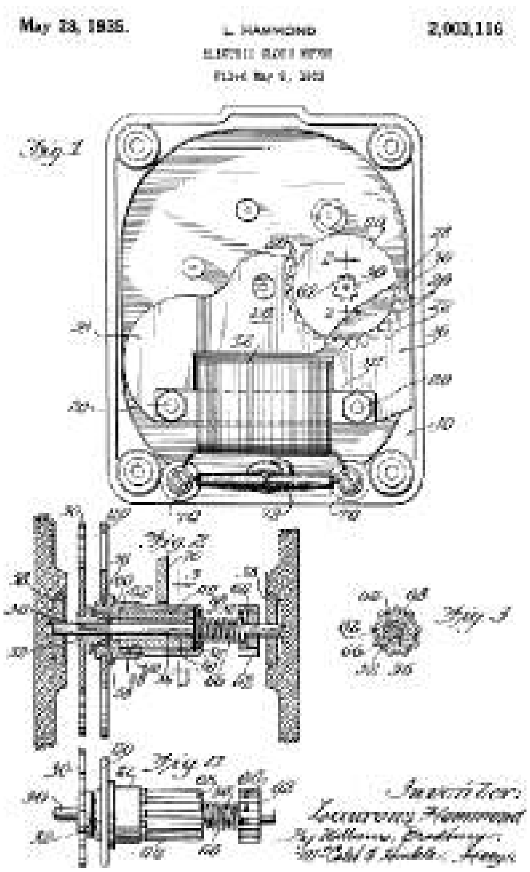
A closeup of the vacuum tube. (The tube is not original.)

In addition to the factory-made electric clock, there is also a handmade base attached. The base contains a socket for a vacuum tube and some wiring connectors. The tube oscillates at the same frequency as the quartz circuit, but amplifies the voltage. This extra voltage is needed to drive the synchronous motor in the clock. One curious characteristic of synchronous motors is that they don't start when you apply electricity. After turning the clock on, someone has to spin the main gear by hand to get it started. It will then be kept in motion by the electric power. This type of motor was invented in the 1880s.



The Type 511 Syncro-Clock Motor. Credit: The General Radio Experimenter, October 1930.

In about 1930 a newer model made by the same company, the Type 511, changed the product name to the Syncro-Clock Motor. The ordinary clock dial at left has the hours, minutes, and seconds hands. The dial



Patent for one of Hammond's electric clocks. Credit: Laurens Hammond, 1932.

Synchronous motors were also used in the Hammond organ. Before manufacturing musical instruments, Laurens Hammond's company mass-produced early electric clocks. The Hammond Clock Company was formed in 1928. During a power failure a clock would stop. After the power resumes you would then need to set the correct time and hand spin a "starter" on the back of the clock. Later, in 1935, he adapted his synchronous motor design to spin a "tonewheel" in an electromechanical organ. The rotating tonewheel would cause an electromagnetic pickup next to it to resonate, producing a musical tone that could be heard with a loudspeaker. The shape of the tonewheel determined the timbre, or characteristic organ sound, of the note. These tonewheel based organs were still produced until the 1970s. The tonewheels were then replaced by a newer technology, electronic integrated circuits, that produced similar sounds.

- Michael L. Umbricht

(Except where otherwise noted, photographs are by the author.)

From the Archives

These photos show both gas lamp and electric light chandeliers at Ladd Observatory. See the article Synchro-Clock Motor for more information about the early history and use of electric power distribution in Providence. - Michael L. Umbricht

Gas chandelier in the hallway at Ladd. Early 1890s. (The line is a crack in the glass photographic plate.) Credit: Brown University Library / Archives.

A closeup of the hallway chandelier. Credit: Brown University Library / Archives.

The chandelier in the library at Ladd was originally natural gas lamps when the observatory opened. Later, after electricity was distributed in the neighborhood, it was modified to also include electric lamps. Only the electric lamps were turned on when this photo was taken. This photograph likely dates to about 1898 – 1899. Credit: Brown University Library / Archives.

Closeup of the library chandelier. Note how crudely the wires were strung from the wall to the ceiling. The original gas lamps fixtures are partial globes. The electric lamps have fluted glass disks. Credit: Brown University Library / Archives.

“Fragments of Science”

A sign that cautions not to start a specific type of electric light with a match. Unknown author, circa 1900 – 1915.

The Nernst Electric Lamp – Walter Nernst, of the University of Göttingen, has recently devised an electric lamp which promises to be an important addition to our present methods of lighting. The part of the lamp which emits the light consists of a small rod of highly refractory material, said to be chiefly thoria, which is supported between two platinum electrodes. The rod is practically a nonconductor when cold, but by heating it (in the smaller sizes a match is sufficient) its conductivity is so raised that a current will pass through it; after the current is once started, the heat produced by the resistance of the rod is sufficient to keep up the conductivity, and the latter is raised to a state of intense incandescence, and gives out a brilliant white light. As the preliminary heating by means of a match or other flame would in some cases be an inconvenience, Nernst has devised a lamp which, by means of platinum resistance attachment, can be started by simply turning a switch. The life of the rods is about five hundred hours. The lamps are said to work equally well with either alternating or direct and there is no vacuum necessary. If this lamp proves a success as a commercial apparatus, it will be another example of how slight a matter may make all the difference between success and failure. There have been numerous experimenters trying for the last ten years, and in fact ever since the appearance of the arc lamp, to utilize in an electric lamp the great light-giving power of the refractory earths in a state of incandescence; but owing to their high resistance at ordinary temperatures, no results were obtained until Nernst thought of heating this thoria rod, and this simple procedure seems to have solved the whole difficulty. It is claimed that the Nernst lamp is a much more economical transformer of electricity into light than the present incandescent electric lamps. An apparatus called a kaolin candle had been suggested by Paul Jablochkoff in 1877 or 1878. It consisted of a strip of kaolin, along which ran a "match" of some conducting material. The current was passed through this "match" until the kaolin strip became heated sufficiently to become a conductor itself. The lamp did not, however, prove a commercial success. *Fragments of Science*. Appletons' Popular Science Monthly, April 1899.

An automatically starting incandescent light fixture made by the Nernst Lamp Company, in 1902. There would have been a frosted glass globe diffuser covering the rods at the left. The glow rods in this example were made from thin rods of iron that had been coated with thoria. Credit: National Museum of American History / Smithsonian.

Today, we take it for granted that turning on an electric light is as simple as merely flipping a switch. Before the widespread adoption of electric lights there were gas lamps. A valve would first be turned to start the flow of natural gas, and then a match would be used to ignite it. Once lit, the lamp would continue to generate light by burning the gas.

A replica of Edison's 1879 carbon filament light bulb. Made in 1929 by General Electric Co. for the 50th anniversary.

The first Edison incandescent light bulb used a glowing filament of carbonized yarn thread. It lasted for less than 40 hours of continuous operation before burning out. He then tried many other cellulose sources of carbon. He settled on singed bamboo fibers as the ideal material. The bamboo was imported from Kyoto Prefecture in Japan. The bamboo fibers grown there are highly durable and flexible, with thick and sturdy fibers. These filaments lasted about 1,200 hours. These types of lamp would start to illuminate as soon as the switch was turned on. The earliest lamps were not very efficient. Twenty years later, the Nernst lamp invention was significantly brighter, and had a whiter color closer to daylight. The carbon filament lamps had a warmer yellow to amber color. The glowing rod was twice as efficient as the carbon type; it used half the electricity to produce the same amount of light. Two or more rods could be placed in the same light fixture to provide an even brighter illumination.

The materials mentioned are antiquated terms. Thoria was the name used for a chemical compound that is also known as thorium dioxide. Kaolin referred to an alumina silicate. These materials were formed into thin rods. It was often less than 1/10th of an inch in diameter, and an inch or two long. A refractory material is one that is strong and resistant to decomposition that can be caused by chemical reactions or very high temperatures. Unlike a carbon filament lamp, the rod does not need to be enclosed in a sealed glass envelope from which the air has been evacuated. The lack of a glass envelope allows access to the filament to heat it with a match and start it glowing. The rod must be heated to about 1,300 °F – the temperature of a match or oil lamp flame. The reason for preheating the filament is because the ceramic has a very high resistance at room temperature. When it is turned on it would get hot and possibly glow dull red. It wouldn't give a significant amount of illumination. When the filament is hot, the resistance is much lower. This allows the flow of a strong current of electricity. This current generates enough heat to maintain the low resistance and keep it incandescent for as long as the power remains on.

The Nernst invention was started using a "platinum resistance attachment" instead of a flame. This was a small electric heating coil with a thermostat to turn it off after the filament was heated enough. The Nernst lamp was more complicated and more expensive to manufacture. The initial cost to purchase it was higher. This was somewhat offset by the cost savings from using less electricity. The Nernst design was the first successful automatically starting ceramic filament lamp. Inventors had been trying to make a reliable coil started lamp that was inexpensive to manufacture for more than a decade. Before Nernst's invention, the flame started filaments were sometimes used. The ceramic filaments and heating coils in the Nernst lamp would periodically need to be replaced. The cost of replacing these parts in a Nernst lamp was reasonable. The platinum in a broken heating coil would be sent back to the manufacturer. The customer would get a discount on the cost of the replacement coil.

An early carbon filament light bulb. It was likely made before 1915. It uses about 30 watts.

An arc lamp is another early type of electric light that has two electrodes with a gap between them instead of a filament, with the electricity "jumping" across the gap to create a bright "arc" of light. These arc lights were very bright. They were usually only used outdoors, for example, in streetlights. They were also sometimes used to illuminate factory floors for the third shift workers.

Before the widespread availability of gas or electric lights, there were other methods of producing light. One involved a rod of quicklime, or calcium oxide, that was burned in a stream of hydrogen and pure oxygen gases. These were used in the mid-19th century for stage lighting in theaters. An actor was said to be standing on the stage in the intense "limelight" of the brightly burning quicklime.

The zigzag shaped metal filament in this lamp is about 3 feet long. This style is referred to as a "squirrel cage" arrangement. It is likely made of tantalum, instead of tungsten, was probably manufactured in the 1910s or early 1920s. It uses about 240 watts and is very bright. (A very short exposure was used to take this photo to make it easier to see the filament.)

Other materials were also tried for lamp filaments before the 1910s – transition metal elements such as osmium, tantalum, molybdenum, and tungsten. They are very conductive, and can withstand high temperatures. These metals were very difficult to work with a century ago. It took more than a decade for inventors to devise a method to economically produce filaments from one of these metals in quantity. By the early to mid-1910s manufacturers, like Thomas Edison's General Electric Company, solved these problems. The Brian Marsh Mill, a subsidiary of General Electric, manufactured tantalum filament light bulbs in Central Falls, RI. Later, tungsten became the most commonly used filament material. A low wattage light bulb would have cost 40 cents then, equivalent to 13 dollars today. These prices were after mass production greatly lowered the cost. Tungsten incandescent bulbs are currently being replaced today by more efficient LED lamps.

An advertisement for the new, more efficient, tungsten lamp. Credit: Providence Journal, Jan. 18, 1910.

A modern LED lamp that is designed to look like it has an early incandescent style filament. It uses about 4 watts.

Edison's company had the exclusive rights to sell the patented Nernst lamp invention in America. A sign like the one shown here would have been found in places like hotel rooms. It would alert the guests, who might be from out of town, that the lamps had been upgraded from the type that is started with a match to one that automatically starts. The switch was shaped like the valve on the early gas lamps. Turning the key shaped switch starts the electric light. Someone would literally "turn" the key on. After turning on a Nernst lamp, it would take about a half of a minute to get hot enough to reach full brightness. It was more convenient, but no less time-consuming, to start than holding a match to the rod.

– Michael L. Umbricht

(Except where otherwise noted, photographs are by the author.)

FAREWELL TO TWO OF CLEAR SKIES'S HARDEST WORKERS

Indigo and Kate have spent many hours giving us the beautiful magazine you all have read. Kate is moving on to grad school, and Indigo's senior schedule will be overwhelming.

Pictured left to right: Kate, Indigo, and Francine.

However, Indigo has stated she will be available on an infrequent basis to assist our newest layout editors, Ina and Shaliz. Best to all of you.

In addition, Ladd is losing several of their dedicated open house team. In this picture, Alexander Green, Mahmoud Hallak and Finnegan Keller are graduating seniors. Only Ryan Seeb will be returning, but in the spring, after studying abroad this coming fall.

For information about upcoming events at Ladd Observatory, please visit ladd.eventbrite.com.