CORNELL ASTRONOMICAL SOCIETY NEWSLETTER

ISSUE 22 • DECEMBER 2024

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LETTER FROM THE PRESIDENT

Hello fair astronomers! Apologies for missing the newsletter last month, but we have had many fun adventures up at the Observatory over the last 2 months. This edition will cover a number of topics from the amazing northern lights that were visible in the Ithaca area in mid-October, to a recap of all the festivities for Professor Carl Sagan's 90th birthday, to our venture into the maintenance of our dear telescope Irv. We will also see entries about science fiction and other Astronomical/Physics happenings of late.

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It has been a busy couple months up on the hill. We have concluded our fall semester lecture series with the final one a few weeks ago covering all the amazing student research done in CAS. We also had our Halloween party, the theme: Space Wizards, and as I mentioned would be one of the article topics, we had a beautiful view of the Northern Lights over Fuertes and off campus. We have also made several trips to HBO and welcomed a number of alumni back to the Ithaca area over the last few weeks.

As we head into finals season and the rest of the holidays, our beloved observatory will be closing for a few weeks, but we are looking forward to seeing you all in 2025! From our CAS family to yours, we hope that you had a wonderful Thanksgiving, and wish you all the best for your holiday season!

Erik Payton
President

Aurora Borealis behind the Fuertes Observatory
Credit: Elina Stengle

SOLAR STORM CHASERS: THE OCTOBER 10TH AURORA BOREALIS

BY ELLA MANSFIELD

For the past couple of months, the world has been flooded with reports of the aurora borealis, also known as the northern lights, spotted as far as the southern United States. Typically confined to the far north in areas such as Alaska or Iceland, the aurora appearing in this much of the world is indeed a rare opportunity for sky-watchers and scientists alike.

The aurora borealis is a phenomenon that occurs when material from the sun is flung toward Earth and interacts with our planet's magnetic field and atmosphere. The Earth's magnetosphere acts like a protective shield that keeps the sun's powerful radiation from harming us down here on the surface. Particles from the sun can become trapped in it, interact with elements in our atmosphere, and then illuminate the sky in a brilliant light show for all of us to enjoy.

The Aurora Borealis
Credit: Marquice Sanchez-Fleming

Our sun is currently in the maximum of its eleven-year solar cycle. That is, the surface of the sun is a lot more active than in recent years. It is important to note that this activity is a part of the sun's natural behavior and is nothing to be concerned about. In fact, this high level of activity is a wonderful opportunity for scientists to gather more information about how the sun works! During this period of heightened activity, more sunspots can be observed on the sun's surface, and more material is being flung toward Earth, resulting in more frequent auroras. When our planet's trajectory coincides with the trajectory of one of these mass ejections, we are then showered with material, which is known as a 'solar storm'.

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On the night of October 10th, 2024, the Earth experienced a particularly strong solar storm. A storm so strong, in fact, that the northern lights were visible to the naked eye all over the USA, including here at Cornell in Ithaca, New York. Reports came from all over Cornell's campus detailing a vibrant pink sky, and many students, including a cohort of Cornell Astronomical Society members, traveled far away from Cornell's campus to darker areas in hopes of catching the aurora in even more detail.

Aurora Borealis
Credit: Andrew Lewis

Aurora Borealis from West Campus
Credit: Claire Cahill

That night, there were four main 'substorms,' or periods when the lights were more intense. As we traveled farther from campus around midnight, the third substorm was just beginning to ramp up. Once we found a spot far from bright buildings with an ample view of the sky next to a random field in the middle of nowhere, we all pulled over on the side of the road. When we emerged from the warmth and safety of our cars, the sight we were met with was fantastic. What were once faint red and light green hues now shifted into turquoise currents on the horizon as a background for beams that shot up into the sky, nearly piercing the starry band of the Milky Way sprawled out across the dark void of the cosmos. The aurora borealis was something that many of us never thought we would witness, but it was now directly in front of us. The scene was just us, the empty road, and glowing green hues dancing in the sky. For many of us under the stars that night, seeing the aurora for the first time, all together, has become a core memory.

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CAS members in front of the Aurora Borealis! Front Row, Left to Right: Jack Qualkenbush, Gillis Lowry Back Row, Left to Right: Andrew Lewis, Ella Mansfield, Ben Jacobson-Bell, Abigail Bohl, Erik Payton, Treyton Grahn, Connor Rosenthal, Christopher Brown.
Credit: Erik Payton

CAS member silhouettes in front of the Aurora Borealis
Credit: Abigail Bohl

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Long Exposure photograph with the Aurora Borealis and last year's President Gillis Lowry
Credit: Andrew Lewis

We spent about forty minutes capturing long-exposure photos of the lights, which turned out far more vibrant than what was visible to the naked eye. Modern cameras can capture and process light over a period of time, resulting in higher-quality pictures that contain far more detail. Most photos you see will likely show a lot more detail than what one would see in real life this far south. Newer phones tend to take better pictures, and most recent models are capable of capturing not only the aurora borealis but also other sights such as the Milky Way band in great detail or even clear photos of the Andromeda galaxy. Everybody should be encouraged to try and take thirty-second exposure with their phone on a clear night and see what can be captured!

Solar storms are not the easiest things to predict far in advance, but this period of solar activity will still last a while longer. So, if you missed the storm on the night of the 10th, do not lose hope. There exist many good [aurora forecasts] online, which are helpful resources for planning the day before attempting to go and see the lights at night. Happy aurora-chasing!

Stunning photo containing the aurora borealis, Milky Way band, and Andromeda Galaxy
Credit: Erik Payton

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Photo of the aurora taken with an older phone camera
Credit: Ella Mansfield

Photo of the aurora taken with a newer phone camera
Credit: Erik Payton

COMET C/2023 A3 TSUCHINSHAN-ATLAS

BY SHANE KUO

On October 12th, 2024, as many of us left Cornell homeward bound, a cosmic visitor also began its over 200,000-year-long journey home to the outer solar system. At its peak brightness just a few days before, the long-period comet C/2023 A3 Tsuchinshan-ATLAS reached an apparent magnitude of -4.9, where smaller numbers represent brighter objects, and briefly became the third-brightest object in the sky, behind only the Sun and Moon. As we returned to Cornell and classes began again, the notoriously fickle Ithaca weather finally cooperated, and we were greeted with a striking view of the Comet as it blazed a trail across the evening sky.

Comet C/2023 A3 Tsuchinshan-ATLAS
Credit: Elina Stengle

Comet C/2023 A3 Tsuchinshan-ATLAS
Credit: Jerry Wang

Despite its somewhat unflattering name, this scientific designation has quite a bit of information to unpack. Comet names have historically come from the year they were first seen or the name of the person who discovered them. A few notable examples are Halley's Comet and Comet Hale-Bopp, some of the brightest comets of the last hundred years. Some aspects of these historical names still exist in this more modern naming scheme. The "2023" part represents the year of the first observation, whereas "Tsuchinshan-ATLAS" refers to the two observatories (the Purple Mountain, or Tsuchinshan, and the Asteroid Terrestrial impact Last-Alert System, or ATLAS, observatories) that independently discovered the comet on January 9th and February 22nd, 2023. However, there is a bit more to this name than only this; the "C/" tells you that the comet it refers to is a long-period comet with an orbit that takes over two hundred years to complete, and the "A3" means that C/2023 A3 is the third comet discovered in the first half of January.

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Image of the Comet through an 6-inch Dobsonian Reflector
Credit: Claire Cahill

Long-period comets spend most of their time far from the sun in the Kuiper Belt or the Oort Cloud, a hypothetical spherical cloud of comets that exists well outside Neptune's orbit. C/2023 A3 was no different. The comet has a roughly 110 million-year inbound orbital period, meaning that the last time it was close to the sun was around 110 million years ago when dinosaurs still roamed the earth and the first Tyrannosaurus Rex had yet to be born. However, the first detection of the comet was less than two years before it would make its closest approach to the sun. As observatories worldwide made more observations of the comet, astronomers could refine their estimated value of the eccentricity of the comet's orbit, which measures how circular a particular orbit is. This particular comet had an eccentricity of around 0.99998 on its way toward the sun and 0.9998 as it left. This means that its orbit is barely an ellipse, meaning C/2023 A3 is in an orbit that will take it far from the sun before returning. As its eccentricity is so high, the gravitational pull of some of the planets could kick the comet out of the solar system entirely. It is also possible that the measured eccentricities are slightly off. Estimates of the orbital period could be vastly different from their true values, and we could even be wrong as to whether it started off orbiting the sun and if it will continue to do so.

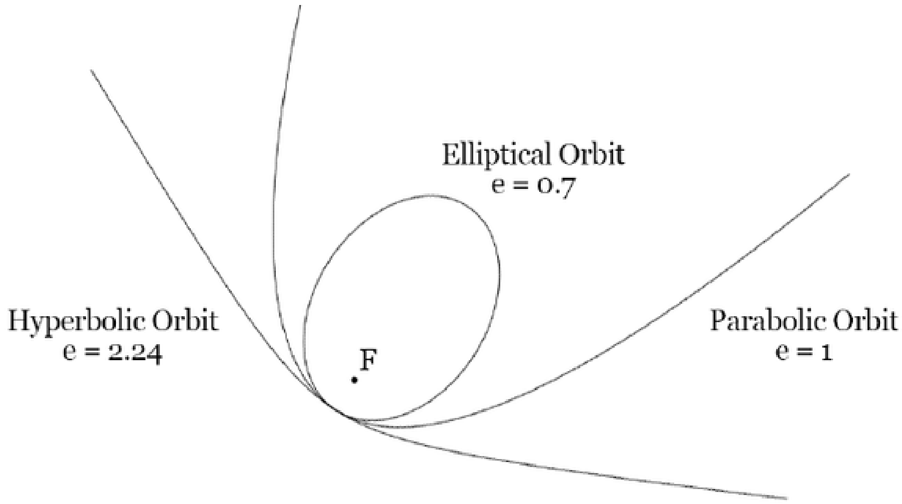

Diagram showing different types of orbits based on their eccentricity, e
Credit: Toni Engelhardt

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Within a week of the ATLAS telescope discovering C/2023 A3, astronomers predicted that the comet would reach a peak apparent magnitude of 3. In June 2024, the IAU proposed that forward-scattering, where sunlight is slightly bent as it travels through the comet's tail, could increase its brightness by 1 magnitude. However, on October 9th, 2024, the comet was observed to reach a magnitude of -4.9, over a hundred times brighter than predicted, making it one of the brightest comets of the last century. As the comet would only be three degrees away from the sun at this point, we felt uncomfortable pointing our telescopes at the Fuertes Observatory at the comet until it was further from the sun.

Comet C/2023 A3 Tsuchinshan-ATLAS
Credit: Claire Cahill

Image of the Comet through a 14-inch Obsession Reflector
Credit: Claire Cahill

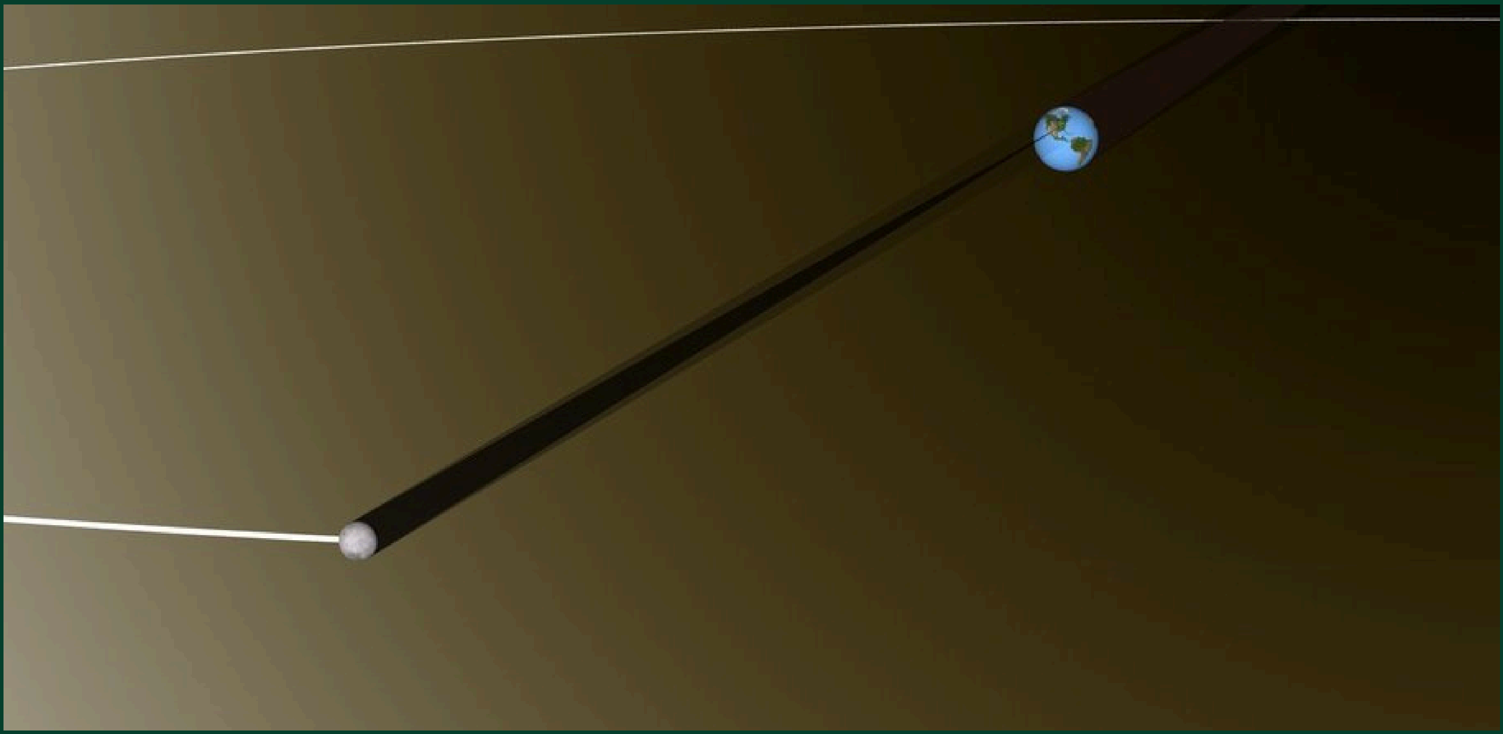
On Friday, October 18th, everything finally aligned for CAS. The last few days had barely any clouds in sight, and many CAS members headed to the observatory on Wednesday and Thursday to view the comet. On the day of the open house, many of us looked fearfully at the sky to see if any clouds would block our view of the comet that night. However, as compensation for our overcast April 2024 total solar eclipse in Rochester, the skies stayed clear. That night, CAS opened the observatory an hour early to give visitors the best chance of seeing the comet. As the sun finally set behind the hills and the vibrant oranges of dusk faded to black, CAS members and our hundreds of visitors were granted a wonderful view of the comet as a streak of light painted across the western sky on one of the busiest open houses of the semester. We're all grateful that we could see the comet and share the beauty of the cosmos with visitors here at the Fuertes Observatory. Whether you visited the Fuertes Observatory or not that night, I hope your comet-viewing experience was as enjoyable as it was for us.

THE ASTRONOMICALLY LARGE IN THE UNIVERSE

BY TREYTON GRAHN

The night sky is a beautiful, mysterious, and absolutely enormous place. Many of us, fueled by curiosity, have looked up to the stars, wondering how large the vast expanse of space truly is and what secrets it holds. Let me take you on a journey, exploring the largest things our universe has to offer, and together we'll seek to answer some of the burning questions many of us have asked.

Our journey begins here on Earth, wherever you are reading this. As Carl Sagan once put it: "everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives" here on Earth, on this "pale blue dot" we call home. Nearly all of human history lies here on Earth. But to understand the broader story of our place in the universe, we venture to the Moon: the most prominent feature in our night sky and our most significant planetary satellite. The Apollo missions marked the first and only time humans extended their reach beyond Earth between 1968 and 1972, when 24 men went to the Moon and 12 walked on the lunar surface. These men took an approximately 230,000 (370,000 km) mile journey away from Earth—a distance so vast it would be like driving around the entire planet 10 times.



Unlike most illustrations of this kind, in this graphic, the Earth and the Moon are to scale. The Sun is off-screen to the left, about 400 times farther than the Earth-Moon distance and roughly twice as big as the Moon's orbit.
Credit: [NASA's Scientific Visualization Studio]

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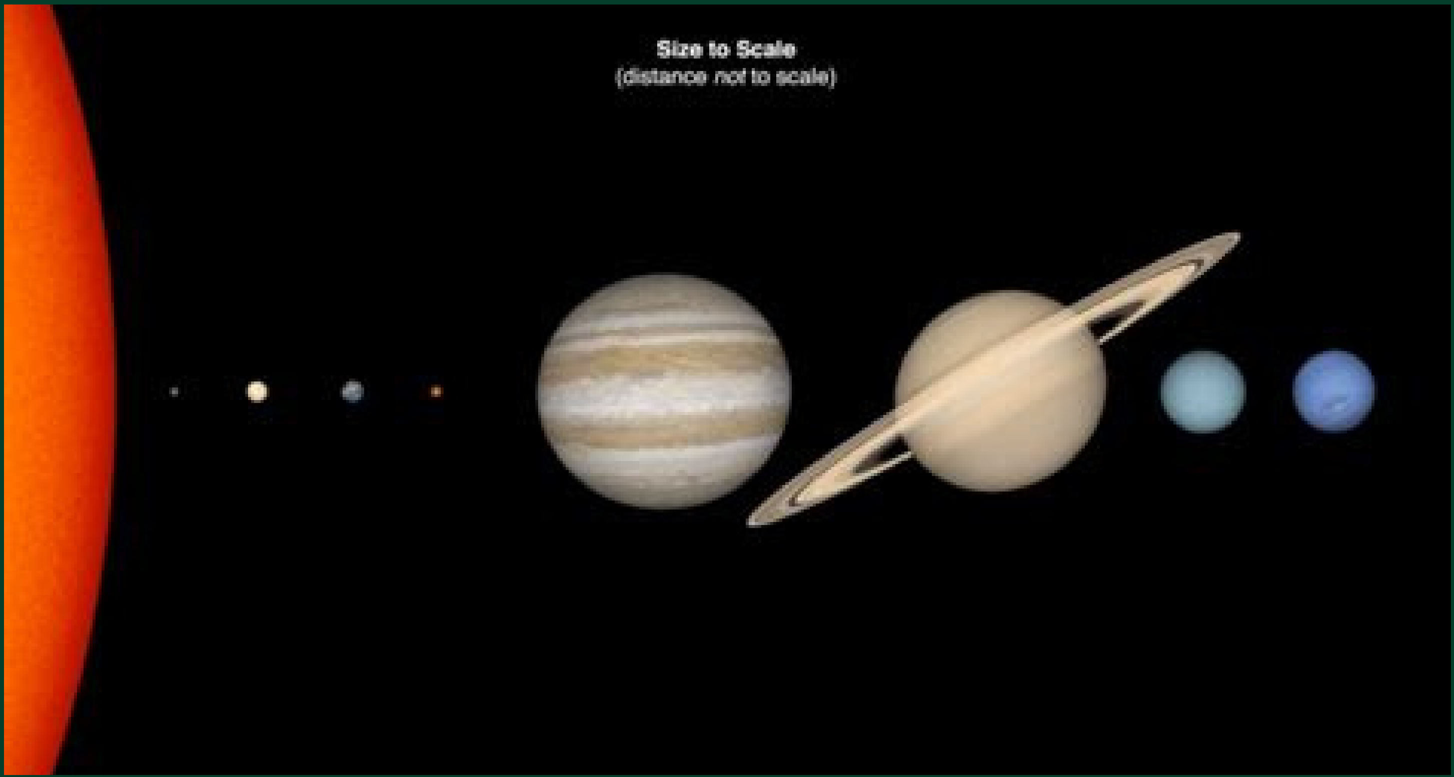
Life would certainly never have existed here without the Sun—the blazing ball of fire that provides the energy, light, and heat crucial for our survival. The Sun is by far the largest object in our solar system. How big is it? Imagine the Sun as a container; filling it would require more than 1,000,000 Earths! If you could somehow place one Earth in this container every single second, it would take you about a week and a half working nonstop to completely fill it! As for how far away the Sun is: If you drove at 60 mph (100 kph), it would take you 177 years to get there. That Sun you see every day —the same one that can hurt your eyes to look at here on Earth—is 93 million miles away!

The most mind-boggling part of this journey has yet to come. To venture further, we'll need a much larger measuring stick: light. How fast is the speed of light? Remember that 177-year car trip to the Sun? We'll call this distance from the Earth to the Sun an Astronomical Unit (AU), which will be useful later. Light can travel this distance in about 8 minutes! That's right—the light you see from the Sun, millions of miles away, only took 8 minutes to reach your eyes from its surface. Light moves very, very fast. In fact, it moves at almost 300,000 kilometers per second in empty space, the speed limit that Einstein set for everything in our universe.



A comparison of the sizes of planets in our Solar System. Note that the distances are not to scale, nor do the planets form a straight line.
Credit: NASA/JPL

With this benchmark, we can define some absolutely gigantic distances. A light second, the distance that light travels in one second in empty space, is about 300,000 kilometers. A light minute is almost 18 million kilometers. Now, let's zoom out even further. Jupiter is roughly 43 light minutes away, and Saturn is about 1.3 light hours away! This is already almost 10 AU! Going further, we find Uranus at 2.7 light hours and Neptune at 4.7 light hours away. We're now nearing the outer edges of our outer solar system, nearly 30 AU away from the Sun.

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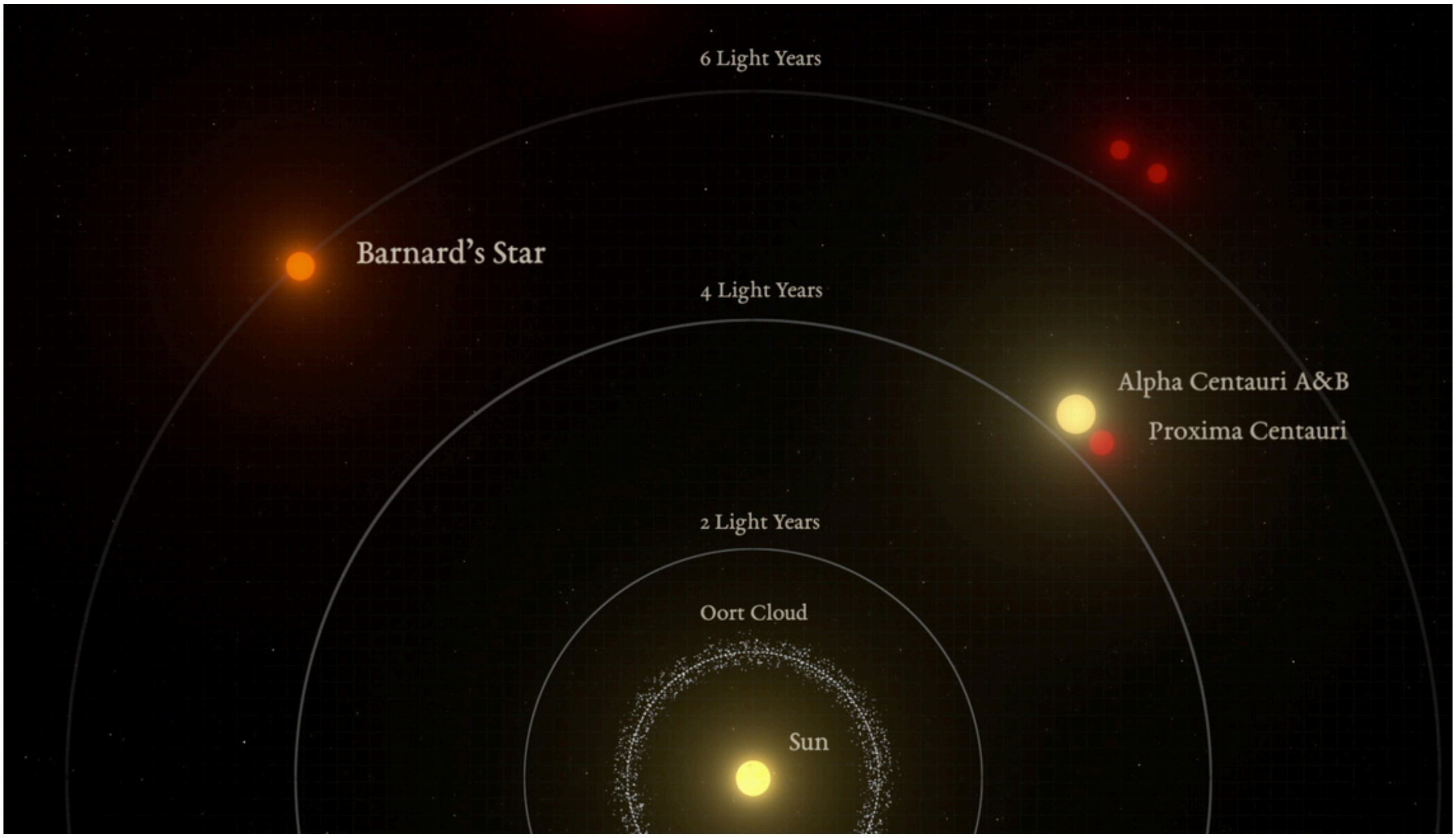
Imagine a meter stick with the Sun at one end and Neptune at the other. Where would Earth be on this meter stick? Remember how vast the distance from Earth to the Sun is—1 AU, or that 177-year car ride? That car ride places you at roughly the 3-centimeter (cm) mark on the 100-centimeter meter stick. The journey to Neptune requires going the other 97 centimeters in the other direction. And there it is: the solar system. I want you to take a moment and really think about the scale of this place. Now, brace yourself—because things are about to get much, much bigger.

Most of those little white specks you see in the night sky are other stars. Some are larger than our Sun and some are smaller. Our Sun is more or less average in size. Which star is closest to our Sun, and how close is it? That would be Proxima Centauri. Despite being the closest star that's not the Sun, Proxima Centauri is not remotely close at all. "Close" is a relative term at this point. At a human scale, Proxima Centauri is so stupendously far away that it can be hard to wrap your head around, but in the context of the entire universe, it is right in our cosmic backyard.



Graphic representation of the relative distances between the nearest stars and the Sun.
Credit: [IEEC/Science-Wave – Guillem Ramisa]

Let's revisit that meter stick analogy. We humans on Earth are three cm along this incomprehensibly large meter stick, and Neptune is almost a meter stick length away. Then at this scale, Proxima Centauri would be about 8,000 meter sticks away. That is roughly 4.2 light-years away. Light that reaches us from the Sun in just 8 minutes, an already incredible distance away, takes more than 4 years to get to us from Proxima Centauri. That is just one speck in the night sky; the closest speck. To think that there are so many other white specks out there, even further away is incredible. Let's take another leap forward in our cosmic journey.

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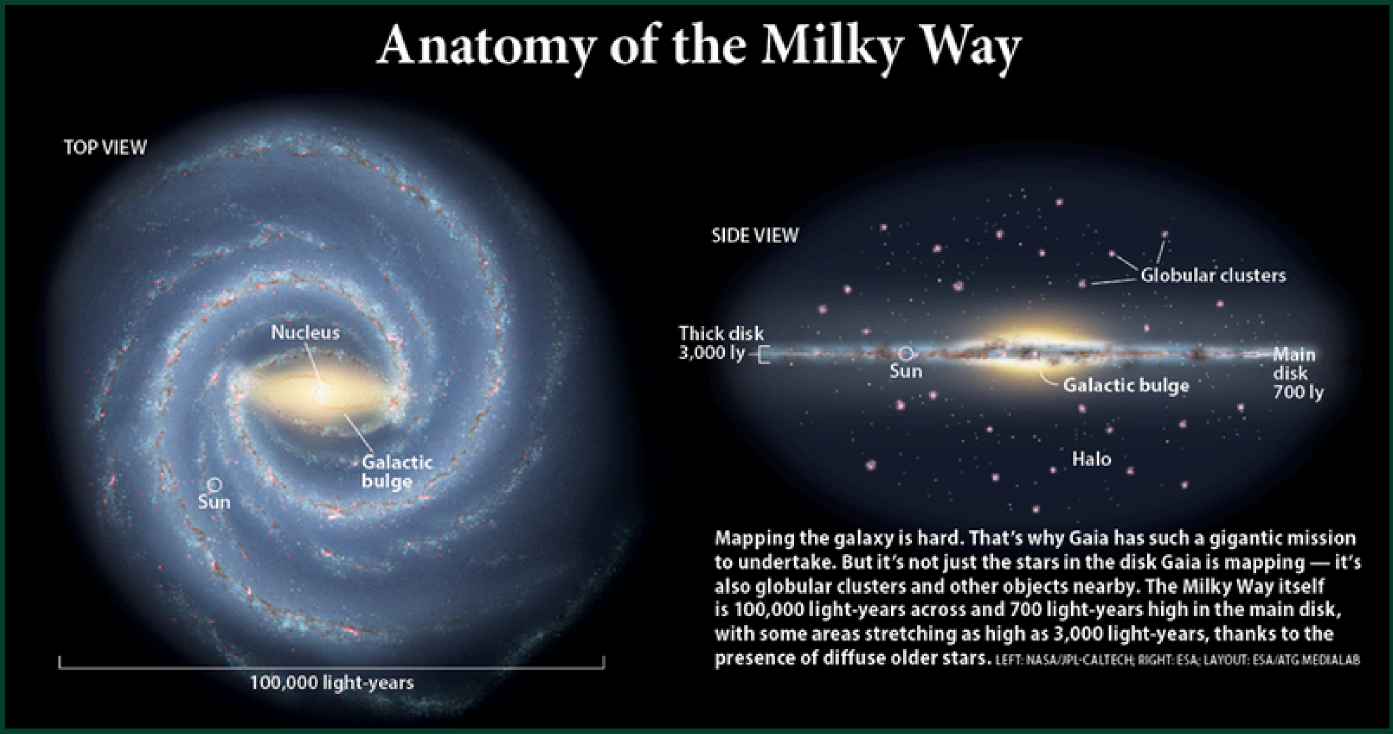
All of those other specks in the night sky are part of the Milky Way galaxy (except for a few we will get to later). Galaxies are an incredibly massive collection of about 100 billion stars on average. What does a billion really mean? A billion is a 1 followed by 9 zeros (1,000,000,000). This number is so large your brain cannot properly comprehend it. Let's try a thought experiment. Imagine 1 billion grains of sand. If you were to fill a cube, where each side is the length of a standard meter stick, 1 billion grains of sand would fill it. Now, if you were to take each grain of sand and put it into the cube one at a time, at a rate of one grain per second (just like the Sun analogy we did earlier), it would take you nearly 32 years to finish. This alone is mind-boggling. Perhaps even more mind-boggling is that the Milky Way has an estimated 200 billion stars in it. Each star in it is effectively as large as our Sun, an already unfathomably large object, and is just one grain of sand in our 200 cubes of sand.

Now, how long would light take to travel from one end of the Milky Way to the other end? It would take about 100,000 years. The Milky Way is 100,000 light-years across, a distance so large it is impossible to grasp to any real degree. The best chance any human has of understanding the scale is through thought experiments like these. Relating these crazy distances to something a little more tangible. The problem with such large scales is that these analogies are becoming abstract too. We are still going to try though! Let's venture even further.



The Anatomy of the Milky Way. The thin disk (labelled 'main disk') is much smaller than the larger thick disk. Credit: NASA/JPL Caltech, Right: ESA, Layout: ESA/ATG Medialab.

Remember those few white specks in our night sky I mentioned earlier that are not part of the Milky Way galaxy? One of those specks is one of the furthest objects visible to the naked eye: The Andromeda Galaxy, an entire galaxy just like the Milky Way. At an astonishing 2.5 million light years away, Andromeda is about twice the size of the Milky Way, yet it appears as just a tiny dot in our night sky. This is our closest galactic neighbor, similar to how Proxima Centauri is our closest stellar neighbor. With this perspective let's make our way to the final stop on our cosmic journey outward, all the way out to the edges of the observable universe.

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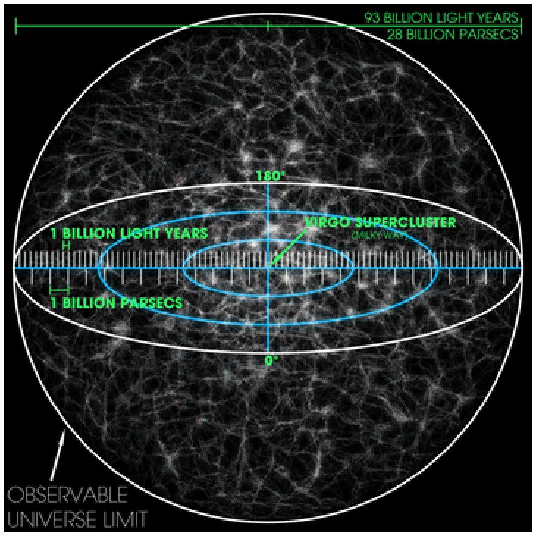
The sheer size of the observable universe is why so many astronomers and astrophysicists fall in love with space and the universe. There is so much room for mysteries and unanswered questions, like a cosmic puzzle that thousands of astronomers have been solving since the dawn of astronomy a couple hundred years ago. The fascinating thing about this puzzle is that with each new piece put in place, it seems that more unsolved pieces seem to reveal themselves, unveiling a larger puzzle than previously thought. With a space so big, do we even know for sure how large it is? Or how many galaxies there are in it? Not very precisely. These numbers are the best estimates of today but are not incredibly precise. What we do know is that these final numbers that I am going to present are pretty close to the actual size and actual number of galaxies. The universe contains roughly 200 billion galaxies. That number may look familiar because it is roughly the number of stars in the Milky Way! Take each star in the Milky Way: each of those grains of sand, and make those grains of sand an entire galaxy, each with about 100 million stars. That is a reasonable approximation for the amount of stuff in the universe. Of course, there is much, much more to the universe than just stars. There are so many other phenomena that keep astrophysicists busy. To explain all that we know of would take hundreds more pages!

So we know how much stuff there is, but how big is the universe itself? How big is the space that contains everything that we have ever seen? Here is the number you have been waiting for: 93 billion light years, which combines the two incredibly large ideas we have developed. Fill up that container with a billion grains of sand 93 times. Each time you put a grain of sand in the box, imagine 1 light year, a distance so large itself that it is difficult to comprehend. If you laid out all these grains of sand end-to-end, they could wrap around the entire Earth twice. By combining these two ideas we can arrive at the approximate size of the universe.

A ball 93 billion light-years across is everything that we have ever seen happen out there in space. A size so large that it is probably impossible to run out of pieces to the ever-expanding cosmic puzzle. The universe is truly just a fascinating place. Here we are on Earth, admiring its vastness from one of the 200 billion galaxies out there, orbiting one of the 200 billion stars in that galaxy, on, as Carl Sagan aptly put it, our little "mote of dust suspended in a sunbeam".

And just like that, we are back from our cosmic journey with a newfound appreciation for the universe's unimaginable scale. The feeling of being so small compared to the largest the universe has to offer is a humbling one. But don't fear, just as there is the astronomically large in the universe there is the microscopically small. However, that is a journey that we will embark on in the next edition of the CAS newsletter. For now, let yourself marvel at the incredible and nearly endless possibilities that the universe has to offer. Every star, every galaxy, and every cosmic phenomenon tells a story that stretches across unimaginable distances and time. All you have to do is look up. And with that, see you next month!



A map of the scale of the Observable Universe.
Credit: [Andrew C. Colvin]

THE TWILIGHT ZONE REVIEW SEASON 1 EPISODE 7: THE LONELY

BY IONA LESLIE

The Twilight Zone was a speculative fiction anthology television series that ran from 1959 to 1964. Written by Rod Serling, it often tackled societal issues of the day through the lens of science fiction and fantasy. Influenced by the Space Race, The Twilight Zone came back to the concept of space travel and what might exist in the areas of the universe we have yet to explore again and again.

Alicia and James
Source: The Twilight Zone (1959)

The episode, “The Lonely”, follows a man, James Corry, sentenced to 50 years of solitary confinement on an asteroid for a homicide he claims to have committed in self-defense. His only human interaction is with the astronauts who visit him for resupply missions every three months. His only entertainment comes from whatever Captain Allenby, the commander of the astronauts, is kind enough to bring him. Corry is going slowly insane from loneliness, having been confined to the asteroid already for four and a half years. It is then that Allenby brings him a new gift: a robot in the form of a woman named Alicia.

Corry’s life turns around as he and Alicia develop a close relationship. However, Allenby’s spaceship returns earlier than expected with the news that Corry has been pardoned and can return to Earth. He can only bring 15 pounds of luggage because they are transporting other previously incarcerated men as well, and they don’t have enough room on their ship. Corry states that he has no material possessions he cares about and excitedly goes to summon Alicia when Allenby reminds him that she is not human and that there is no room for her on the ship. Corry has forgotten that she was classified as an object, and never even considered that they wouldn’t have accounted for her. After Corry argues with the astronauts on the basis of her personhood, Allenby shoots Alicia in the face, leaving a mess of circuit boards behind and taking Corry home.

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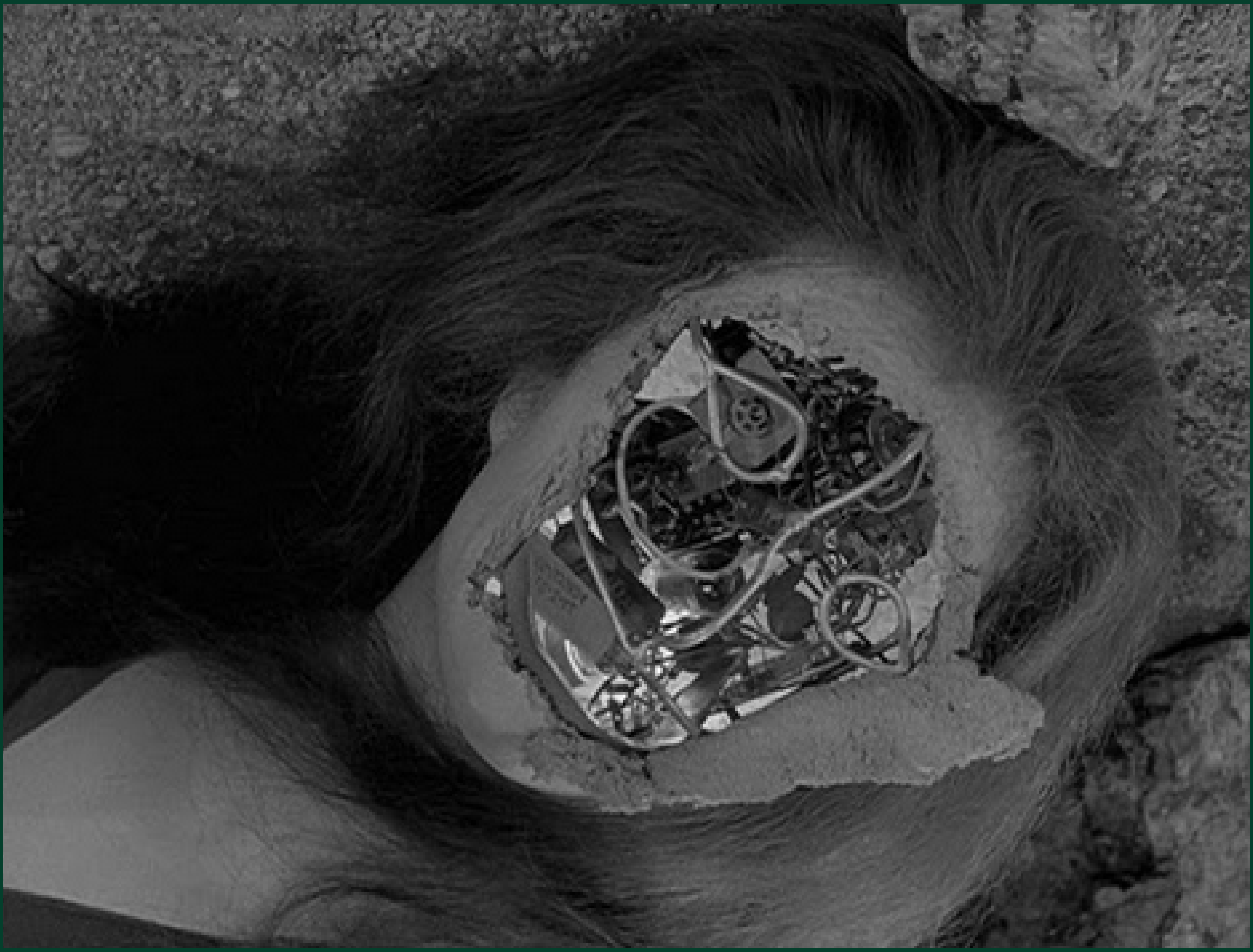


Alicia’s face after being shot by Captain Allenby
Source: The Twilight Zone (1959)

This episode presents the cruelty of solitary confinement, using space to demonstrate the oppressiveness of Corry’s loneliness. The episode also asks what it means to be human, and more specifically, what it means to be a woman. Alicia proves her humanity by feeling pain and emotion. When the astronauts force Corry to leave her behind, he shouts that she’s a woman. The assertion of her womanhood over her humanity may not be intentional, but it fits within the episode. She is a product created in the image of a woman for the use of a man, and she is later destroyed by men who do not see her as worth the weight she would take up in cargo. Corry was unjustly imprisoned for his crime and released with a pardon. Alicia was created to be imprisoned and she was killed when no longer needed.

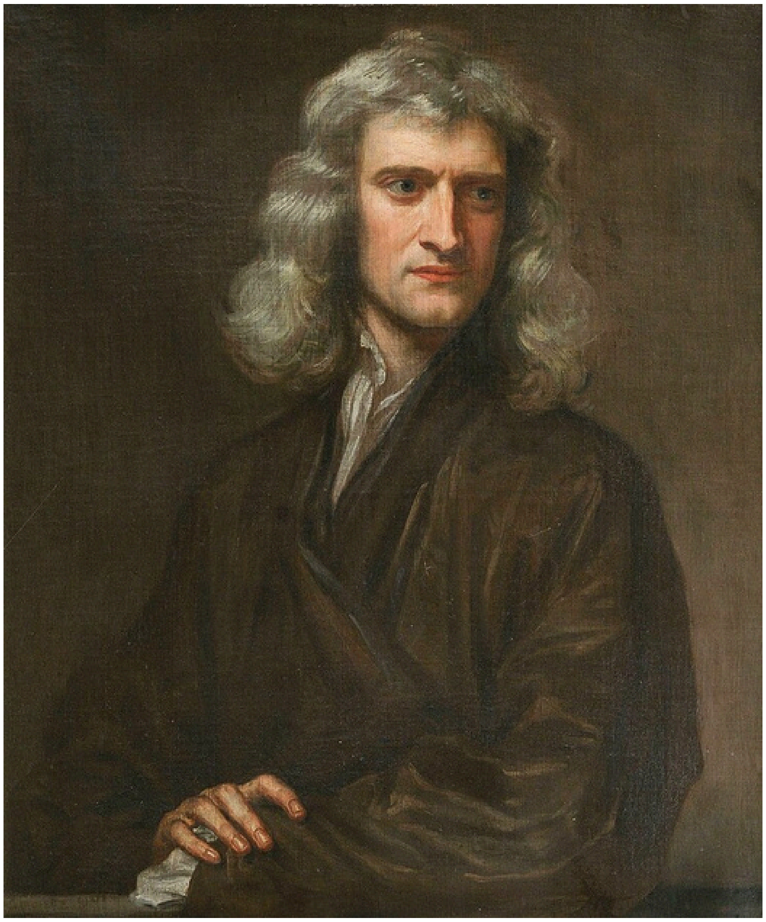
The Twilight Zone uses space in this way many times throughout its five-year run. Check out next month’s newsletter for another Twilight Zone review.

THIS MONTH IN SCIENCE: DECEMBER: ISAAC NEWTON

BY BOBBY KING

NEWTON'S LIFE AND WORK:

Born on Christmas Day 1642, Isaac Newton not only revolutionized our scientific understanding of the world but also made enormous contributions to the fields of economics, philosophy, geography, and theology, among others. Initially an undistinguished student, Newton rapidly grew to become a leading expert in mathematics and physics, earning his B.A. and M.A. from Cambridge in 1665 and 1668, respectively. In 1672, he was elected a Fellow of the Royal Society–an organization he would later be elected president of. In 1669, just a year after completing his master's degree, Newton was elected the second Lucasian Professor of Mathematics at the University of Cambridge–a position later held by Sir George Gabriel Stokes, Paul Dirac, and Stephen Hawking. Having laid the foundation for all modern physics and mathematics, Newton's legacy has left a tremendous mark not only on science but on all of academia.



Portrait of Sir Isaac Newton
Credit: Isaac Newton Institute/Godfrey Kneller

Newton was born in Lincolnshire, England, and was raised by his mother and stepfather–his father having died before his birth. A young Newton was educated at The King's School–a local grammar school–but after losing his stepfather, Newton's mother pulled him out, attempting to make him into a farmer. Newton hated this profession, but after some persuasion from the school's master, Newton's mother let him back in. Newton subsequently studied at the University of Cambridge, and shortly thereafter formulated his theories of calculus and gravitation–theories that transformed our fundamental understanding of the world.

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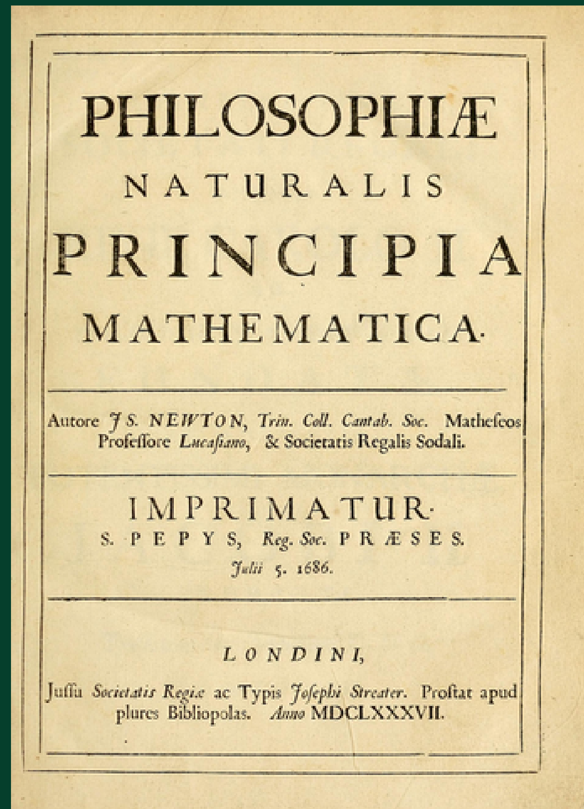
Newtonian gravity, summarized in the legendary equation

$$F_g = \frac{Gm_1m_2}{r^2}$$

Was perhaps Newton's greatest contribution to human knowledge. This simple, elegant equation shows that the force of gravity an object experiences–in other words, how much of a "pull" it feels–increases fourfold for each time the distance between two objects is halved. Moreover, Newton showed that everything with mass–no matter how far apart–experiences a gravitational force from everything else with mass. To summarize, everything in the universe with mass exerts and experiences a gravitational force on everything else in the universe with mass! Newton's findings were published in his 1687 book Philosophiæ Naturalis Principia Mathematica.



PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA.

Autore *J S. NEWTON*, *Trin. Coll. Cantab. Soc.* Matheseos Professore *Lucasiano*, & Societatis Regalis Sodali.

IMPRIMATUR.
S. PEPYS, *Reg. Soc.* PRÆSES.
Julii 5. 1686.

LONDINI,

Jussu *Societatis Regiæ* ac Typis *Josephi Streater*. Prostat apud plures Bibliopolas. *Anno* MDCLXXXVII.

Title page of the 1687 first edition of Philosophiae Naturalis Principia Mathematica, by Isaac Newton.
Credit: Bern Dibner/Internet Archive

Newton's apple tree outside Trinity College
Credit: Chadwick/Geograph

Whether or not Newton came up with this brilliant idea after an apple fell on his head is uncertain, but it stands as one of the most brilliant–and useful–formulations to ever exist. Only extremely minor inconsistencies were observed to take effect with this theory–inconsistencies finally resolved in 1915 with Einstein's formulation of General Relativity. Even today, we do not fully understand gravity or what generates it, and scientists today continue the search to fully understand this incredible force.

Newton continued to do significant research in a variety of fields into his later life, including optics (physics of light), mathematical analysis, and philosophy. Newton invented the dispersive light prism (a prism that separates white light into the visible spectrum) in 1666 and the reflecting telescope–a technology still used in modern astronomy–in 1668. Later in life, Newton took on a number of governmental roles, including the Master of the Mint. Newton was knighted in 1705 and continued his academic efforts well into his old age, and died in 1727.

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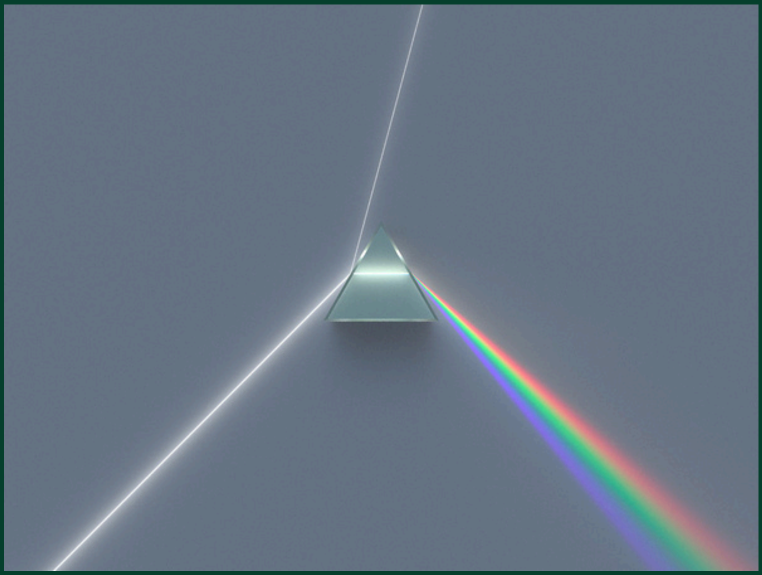

Refraction of light by a prism. A prism disperses rays of different colors. The ray of violet light is refracted more than the ray of red light.
Source: Spigget

Replica of Newton's first reflecting telescope made in 1668 and now in the possession of the Royal Society of London. Made for the Science Museum in 1924 by Mr F.L. Agate
Credit: The Science Museum UK

Even today, as every freshman physics student knows, Newton's formulations of classical mechanics and calculus are the groundwork for describing the universe. It is easy to dismiss old discoveries with the exciting new developments we see in the news today, but it is important to always remember where these ideas come from and how much time and effort it took for generations of scientists to arrive at our present understanding of the universe. Physics is a continuous science where we must build off of foundations laid by those before us. In fact, it was Newton who first said that he was "standing on the shoulders of giants." And all science today stands on the shoulders of Newton.

The Sombrero Galaxy, a massive collection of stars held together by gravity.
Credit: NASA and The Hubble Heritage Team (STScI/AURA)

Galaxy Merger between galaxies NGC 2207, IC 2163
Credit: ESO

CLEANING THE IRVING PORTER CHURCH REFRACTOR TELESCOPE CLOCK DRIVE

BY ERIK PAYTON

For the first time since the Mike Roman era, we have embarked on some maintenance of our beloved Irving Porter Church Refracting Telescope. One of the main attractions of our telescope, especially on cloudy nights, is the clockwork governor. The governor shown here is a wonderful piece of equipment that allows the telescope to track accurately across the night sky. While many modern telescopes utilize electric motors and computers, Irv has a mechanical tracking system that is not that different from an antique grandfather clock. As there are numerous moving parts in the telescope, it requires upkeep periodically.

To ensure the smooth operation of these mechanisms, there is lubrication at all of the moving parts. In grandfather clocks and Irv's governor, routine maintenance is key to prolonging the life of the machinery. Over time, especially for the governor that is exposed to condensation, dust, and other elements, keeping them clean is of the utmost importance. Dust and debris get into the oil that lubricates the motion, and ends up providing undesired friction and wear into the system. For anyone who has visited the observatory and seen us start the governor, in the last year or so, we often have to give the governor a little "kick" to get it moving, when ideally it should start up on its own. The primary reason for this is the accumulation of debris in the lubricating oil. Cleaning of grandfather clocks is needed every 5-7 years, and it has been much longer than that for our beloved Irv!

Irv's Clock Drive in 1992
Credit: [Brian Fox]

With help and guidance from telescope whisperer Mike Roman, we began the process of cleaning and servicing the governor. What goes into that process you may ask...It is actually very straightforward.

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STEP 1: CLEAN THE OIL WELLS

There are several oil wells within the governor that contain the oil that lubricates some of the bearings. Shown here are two of them. They are the little brass-colored cylinders protruding from the black plate that have screws in the end of them. When the outer cover is rotated, a small hole is revealed that is a receptacle of oil for that localized part of the governor. Under normal conditions, you would simply extract the old oil, and replace it with new using a curved tip syringe. Unfortunately given the length of time the telescope went without maintenance, the consistency was closer to that of yogurt than that of oil. In this case, we had to flush out the oil well. We used Super Lube 51004 Synthetic Oil with PTFE to flush out the crud. It is vital to use high-quality oil for this part of the job, as there is no way to ensure that all of the oil is flushed out of the wells after this step. The oil that was removed was a blackish-green color, when the new oil is nearly clear, signaling a large build-up of dirt.

Close-up of Irv's oil wells
Credit: Jack Qualkenbush

Flushing Oil that we extracted from Irv
Credit: Erik Payton

STEP 2: REPLACE THE OIL

At this point, most of the hard work is done. All that is left is to replace the oil. These wells are very small and do not take more than a few drops of oil. At the recommendation of Mike, we used Clock Oil 859, akin to the expensive wines of the oil world. There are a number of factors that must be taken into account when choosing a suitable oil to use in a clock drive. For grandfather clocks, those movements are incredibly fragile and require the thinnest of oils to operate correctly and not induce further friction, but they are generally only operated at room temperature. In the case of a telescope clock drive, they are much more robust, but also must be able to operate at sub-zero temperatures, so having an oil that will not become too viscous is paramount. This oil we chose, while quite expensive, will be a perfect combination of delicate, but also temperature-independent, for the most part. It is much more expensive than the Super Lube, but also one 3-ml bottle is more than enough for several oilings.

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STEP 3: MAINTENANCE FOR ANOTHER DAY:

That is all that goes into changing the oil in the governor specifically. There are several other places that we lubricate that are just pivots or places that the metal parts slide against each other or have ball bearings. We have a few tasks that we are saving for warmer weather including wiping down the governor with some cloth rags and mineral spirits if needed. There is a lot of oil buildup on the gears. It is quite visible between the first and second picture. We also have some maintenance to do on the mount itself. There are several spots, namely the worm gear that rotates the telescope that need to be inspected and cleaned/oiled if needed. These will all be much easier given they are even less delicate than the governor. We will just use the Super Lube for them but are saving that task for when the metal is warmer and the oil less viscous.

President and Antique Clock Aficionado Erik Payton replacing the oil in one of the wells with the assistance of club members Andrew Lewis, Jack Qualkenbush, Shane Kuo, Christopher Brown, and Marquice Sanchez-Fleming
Credit: Jack Qualkenbush

We still have a number of smaller tasks related to this to do, but we are making good progress! After talking to Bart Fried and the Antique Telescope Society, they recommended that we do this maintenance almost yearly, or at least every few years, so this will become a routine part of CAS, so that we make sure this knowledge and care is passed down for generations!

CARL SAGAN NIGHT RECAP

BY GILLIS LOWRY

I'm back! After my formal goodbye as President of this fine club last May, I stuck around Cornell as a research assistant at the Carl Sagan Institute. This allowed me to keep investigating exoplanets, but also to plan Carl Sagan's 90th birthday celebration on November 9 alongside the College of Arts & Sciences and Carl Sagan Institute Director Lisa Kaltenegger! At this point, I've finally peaked in terms of Carl Sagan events—at least until his 100th birthday in 2034...

The 90th birthday events kicked off with a [CAS lecture] by Prof. Shami Chatterjee on the Search for Extraterrestrial Intelligence, or SETI. After that, CAS held open houses on November 8 and 9, which were surprisingly clear! Even the weather gods bow to Carl Sagan's legacy. We got good views of Jupiter, Mars, and the Pleiades, and I put up massive Carl Sagan posters in the front lobby featuring my [Carl Sagan walking map]. If you aren't able to see the posters in the next few months, never fear—we'll be producing panels for the museum with the same design by the end of the school year (mark my words).

On November 9, the Carl Sagan birthday proper featured family events in the morning at the Spacecraft Imaging Facility and the Physics Bus. The main event began at 2 PM with opening speeches by Ann Druyan and Prof. Lisa Kaltenegger before diving into all sorts of talks: life on exoplanets, how to communicate science, the Voyager Golden Record's music in a modern context, bio-engineering the future, and so much more. There were a couple musical interludes, including students from Cornell Orchestras, as well as space cupcakes and apple cider in the intermission!

Speakers at the main event with space cupcakes!
Credit: Sreang Hok / Cornell University

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Even if you don't have three hours of free time to watch (or listen to, like a podcast) to the event recording, you should definitely check out Ann Druyan's opening and closing speeches. After a hectic election week, her words were a birthday candle in the dark. As were all the other speakers at the event, and as are all of us, little by little, as we share our love for science and push back the hatred and fear.

If you're interested in more Carl Sagan content, the Carl Sagan Institute will soon be posting memories of Carl Sagan from those who knew him, as well as shorter clips from the event. The Instagram and YouTube pages are the best way to stay up-to-date on these postings, as well as recent research out of the Institute.

With that, I suppose this is my second goodbye! Though maybe I'll be back in the fall for graduate school. And maybe I'll be back in ten years for an alumni feature in newsletter issue 58? We shall see!

With love,
Gillis Lowry, your lifelong devoted President

The Fuertes celebration of Carl Sagan's and Gillis's birthday on November 9! Also the return of CAS officers Shawn Hikosaka (Vice President '20-21), Chase Funkhouser (President '21-22), Annika Deutsch (President '22-23), as well as club alumni Grant Whitman and Cella Kove (class of '24)!

Last year's Vice President Ben Jacobson-Bell and last year's President Gillis Lowry at the event!
Credit: Prof. Phil Nicholson

CREDITS

CAS Officers

Erik Payton, President
Andrew Lewis, Vice President
Christopher Brown, Treasurer
Jillian Epstein, Outreach Coordinator
Shane Kuo, Editor-in-Chief
Phil Nicholson, Faculty Advisor

Contributors to this issue

Andrew Lewis
Christopher Brown
Erik Payton
Jillian Epstein
Shane Kuo
Gillis Lowry
Ella Mansfield
Iona Leslie
Treyton Grahn
Bobby King
Phil Nicholson
Jake Turner
Chase Funkhouser
Abigail Bohl
Claire Cahill
Jack Qualkenbush
Marquice Sanchez-Fleming
Elina Stengle
Jerry Wang

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Jake Turner

Sources for “Solar Storm Chasers: The October 10th Aurora Borealis”

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Sources for “Comet C/2023 A3 Tsuchinshan-ATLAS”

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Sources for “The Astronomically Large in the Universe”

1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9
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Sources for “The Twilight Zone Review Season 1 Episode 7: The Lonely”

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Sources for “This Month in Science: December: Isaac Newton”

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Brian Fox

Image Credit for “Cleaning the Irving Porter Church Refractor Telescope Clock Drive”

Sreang Hok / Cornell University

Cornell Astronomical Society (CAS) is a student-run non-profit organization founded in 1972.

Contact:
209 Cradit Farm Dr.
Ithaca, NY 14853
astrosociety@cornell.edu