CORNELL ASTRONOMICAL SOCIETY NEWSLETTER

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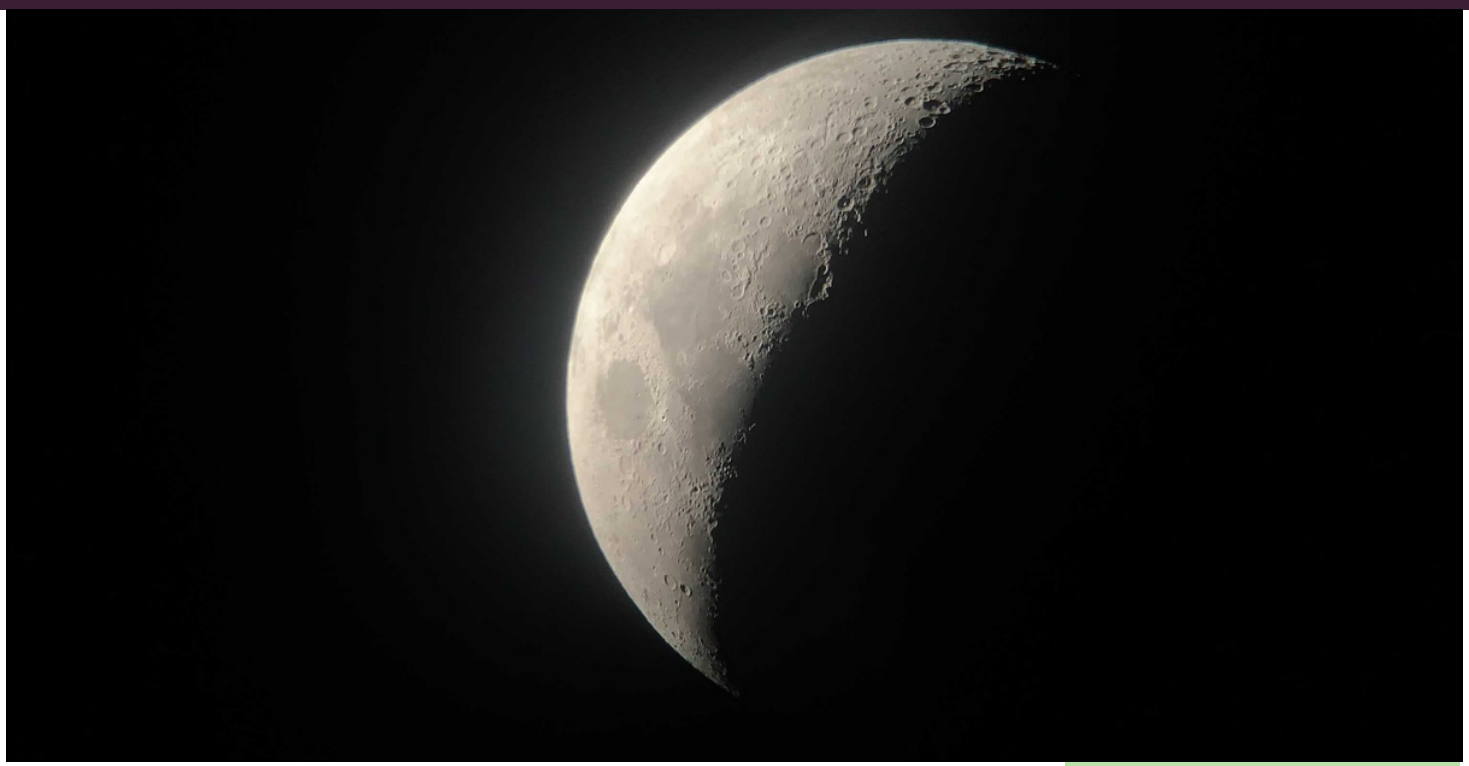


LETTER FROM THE EDITOR

Greetings readers! On behalf of the talented team of writers and photographers that made this newsletter possible, I am excited to welcome you to the tenth edition of the CAS newsletter! In this milestone issue, we reflect on the similarities between Saturn's moon Mimas and a popular brand of chocolate and investigate volcanoes on Venus. We also feature articles that explain the physics behind Doppler shift, and how we can use photometry for asteroid observations. In addition, we have included some lovely photographs of the Moon taken by CAS members this month, despite the ever-persistent rain and clouds. Thank you for reading, and I hope you enjoy this newsletter as much as I do.

In regard to CAS, this past month marked the start of our Spring Lecture Series, which you can read more about on the next page. On April 14, we will be hosting Yuri's Night to celebrate the 62nd anniversary of the first person in space, Yuri Gagarin. We hope to see you there!

Abigail Bohl, Editor In Chief

TABLE OF CONTENTS

LECTURE SERIES

BY BEN JACOBSON-BELL

What better way to close out two full months of cloud-beleaguered open houses than with a warm, cozy indoor lecture series spanning a universe's worth of astronomical topics?

The middle of the semester brings us just past the middle of our lecture series: four installments are behind us, and two are yet to come. Professor Yuval Grossman kicked things off in early March with a talk on matter, antimatter, and the universe's apparent preference for one over the other. Professor Shami Chatterjee spoke the following week about gravitational-wave astronomy—where the field is now, how we got here, and where we're going.

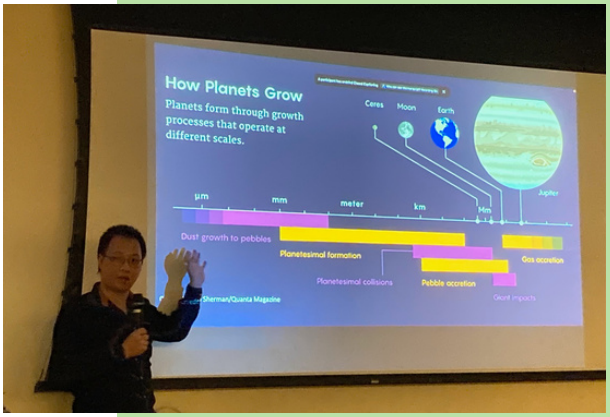


Image of Dr. Li's Lecture

In mid-March, Dr. Rixin Li gave a lecture on minor planets in the Solar System, including asteroids, comets, and dwarf planets, and their role in the development of larger systems. And, finally, we tried something new to close out the pre–spring break portion of the series: in small groups organized by field, a few CAS members gave lectures on their own research, emphasizing opportunities for students to get involved in Cornell's Department of Astronomy.

Our lecture series finishes in April with two more talks scheduled for the two weeks following spring break. Join us on April 14 for a special Yuri's Night lecture by Professor Mason Peck, director of Cornell's Space Systems Design Studio, on the future of space travel; and join us again on April 21 for Stella Ocker's discussion of the interstellar medium, the tenuous gas between stars, and how it affects astronomical observations. We hope to see you there!

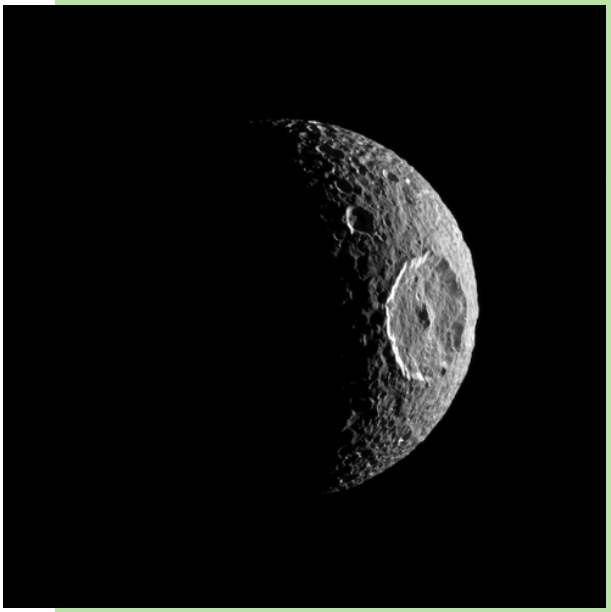
Register for Yuri's Night!

MIMAS

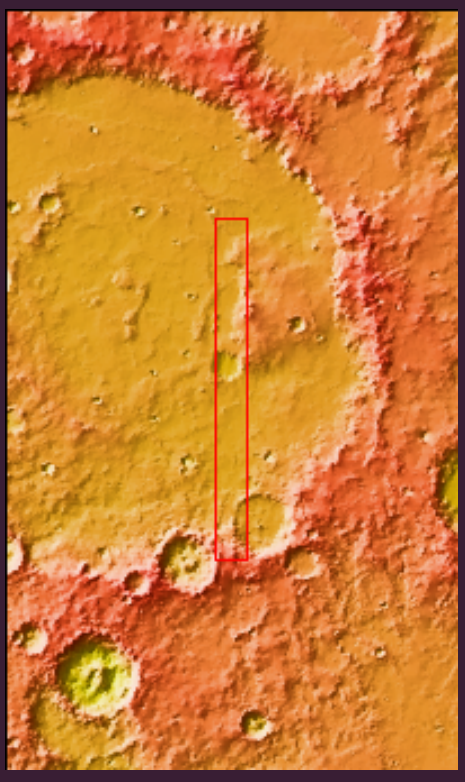
BY JUSTINE SINGLETON

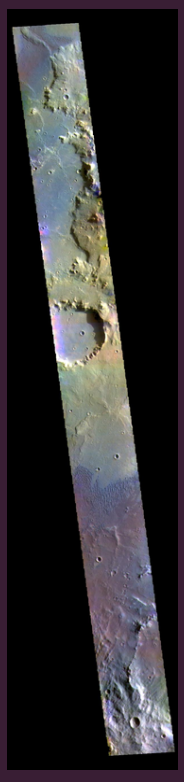
Picture this: You are unwrapping a familiar chocolate truffle, one with its trademark circular indent. Maybe it reminds you of a certain cinematic spaceship. Or maybe it reminds you of Mimas.

Saturn's moon Mimas appears similar to the truffle mainly due to a large impact crater on its side. Known as the Herschel crater, it stretches 80 miles across, a third of the moon's diameter. You remember that Mars also has a crater called Herschel, and that you should be careful not to confuse the two. The Mimantean Herschel crater is thought to have been formed from an impact that nearly broke the entire moon apart. It also has a mountain in the center called Herschel's peak, which is nearly as tall as Mount Everest. The crater on its chocolate counterpart, on the other hand, is completely even all the way across.



Cassini spacecraft image of Mimas
Credit: NASA/JPL/Space Science Institute





False color image of part of the floor of Mars' Herschel Crater | Credit: NASA/JPL-Caltech/ASU

Unlike the smooth surface of the candy, Mimas' surface is heavily cratered – more like a Ferrero Rocher than a Lindt Lindor. It also has chasmata, similar to chasms on Earth. These long, deep grooves are on the opposite side of Mimas from the Herschel crater, which has led to hypotheses that they were formed from the same impact that formed the crater.

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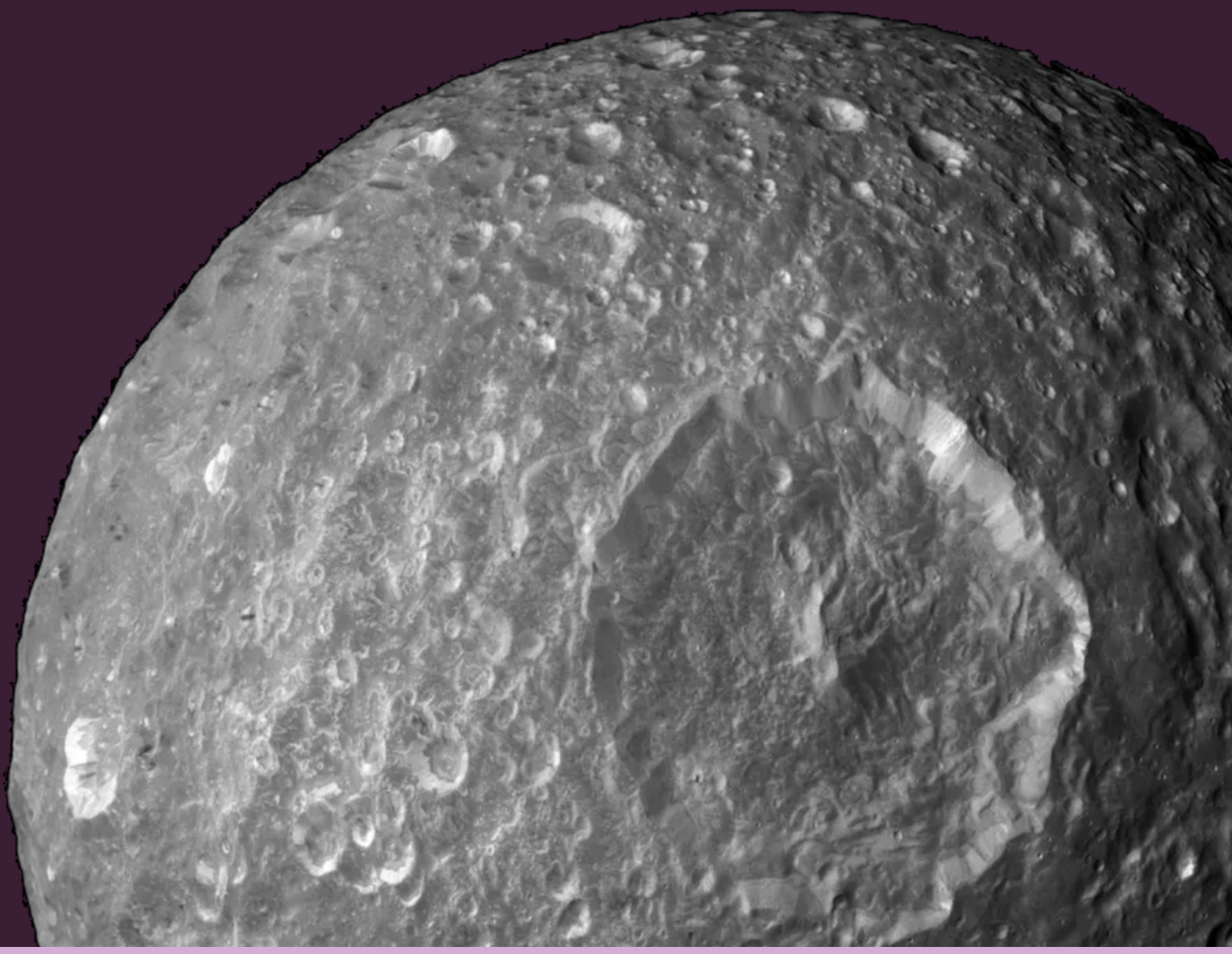
You bite the truffle and break through a layer of solid chocolate into the creamy ganache center. The comparisons to Mimas might be more than just surface level. The Saturnian moon's crust is mostly ice, but there is possible evidence for liquid water underneath. Based on simulations, Mimas' crust must have been thicker than it is now for the entire moon to have stayed together during the Herschel crater impact. If the layer of ice has been thinning over time, some of it has turned to water and is still below the surface. You consider this for a moment. That would make Mimas similar to its sibling moon Enceladus, which has a subsurface ocean, despite their different surface features. In fact, Mimas has no signs of geologic activity like other ocean worlds. If it really does have water, there might be other moons with hidden oceans as well.

As you savor the last of your treat, you think about how strangely similar it was to Mimas. One little indent in a piece of candy resembles a crater from a collision that had a large impact on a moon orbiting a planet over 800 million miles away. That was a pretty sweet coincidence.



VOLCANIC VENUS

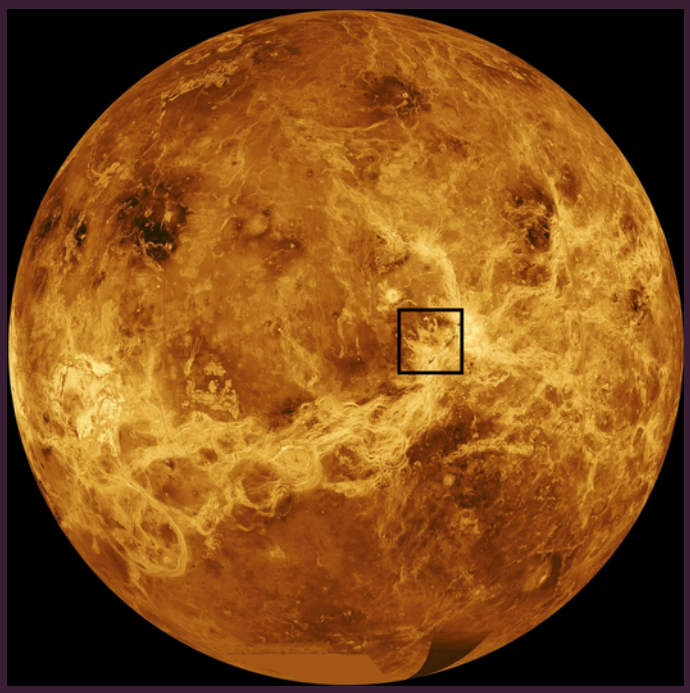
BY GILLIS LOWRY

Mars rovers may be all the rage these days, but Venus was the first planet our spacecraft ever visited. When the first Venus missions were planned, all we could see from Earth were its swirling clouds. Might these clouds hold liquid water, raining down into a lush surface teeming with life?

We may have landed on Venus first, but there's a reason we rarely go back. Any spacecraft that ventured beneath the sulfuric acid clouds lasted no longer than an hour before succumbing to pressure 100 times that of Earth and temperatures hot enough to melt lead. There were volcanoes, but no signs of eruptions. There was a toxic atmosphere filled to the brim with CO2. Venus wasn't just far from supporting life—it didn't seem similar to Earth at all.

For decades, we've limited our Venus missions to spend more time on the slightly-more-Earth-like Mars. But evidence now proves that Venus may be more similar to Earth than we thought—its volcanoes may not be so dormant after all. For the first time, astronomers have found signs of recent volcanic activity on Venus, with lava flows as dramatic as Hawaiian volcanoes on Earth.

NASA's most recent mission to Venus took place thirty years ago. But even thirty-year-old data continues to prove valuable. For over 200 hours, University of Alaska Fairbanks professor Robert Herrick pored over old Magellan mission data, manually searching for any changes in the pictures. At last, he noticed a site near volcano Maat Mons that seemed to have changed.



The clouds of Venus have been stripped away to reveal a surface riddled with over a thousand volcanoes. Recent volcanic activity was detected at Maat Mons, in the center of the black square
Credit: NASA/JPL-Caltech

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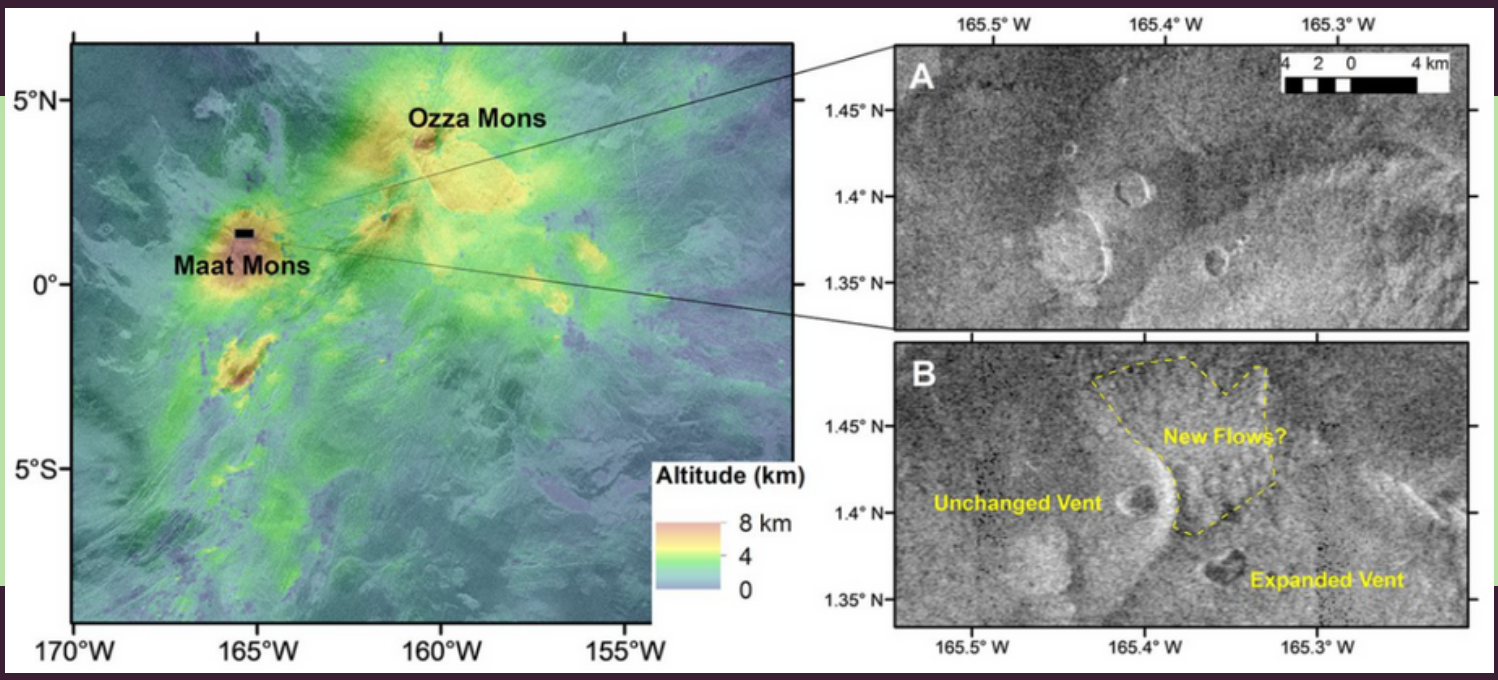


Evidence of expanded vents due to lava flows around Maat Mons | Credit: Robert Herrick and Scott Hensley

In two images taken eight months apart, a circular vent appeared to double in size and grow misshapen. Along with JPL's Scott Hensley, Herrick created computer models to test different possibilities. The only scenario that seemed to line up with the images was a volcanic eruption.

Although one piece of evidence can't tell us how common volcanic activity is on Venus, it proves that Venus is not as dormant as once thought. An active volcano on any planet helps further our understanding of planetary interiors—as well as how these interiors shape the surface and affect habitability.

Venus may not be a habitable planet today, but it serves as a case study for the search for life in the universe. Planets that travel just a little too close to their host star might end up shrouded in heat-trapping clouds, obscuring our view and smothering any life that might have called the surface home. Civilizations, too, that fly just a little too close to their suns might end up in the same situation.

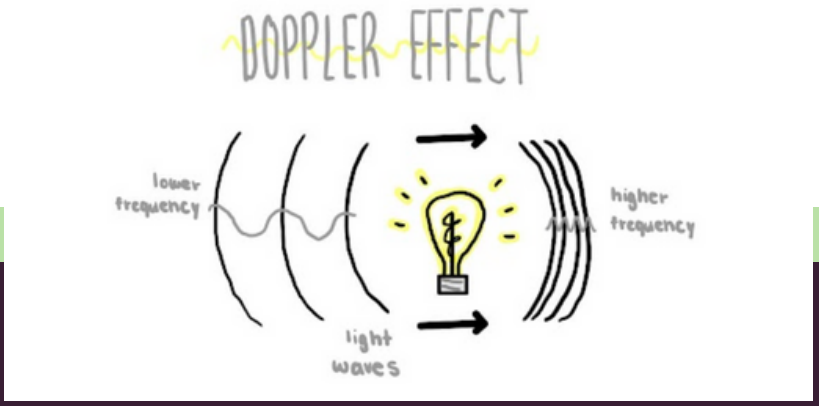
Studying the evolution of Venus, volcanoes and all, might help narrow down where this runaway greenhouse effect begins. Venus will help us define limits—both in the search for life and in the quest to keep our own planet habitable.

WHAT IS DOPPLER SHIFT?

BY ABRA GEIGER

Have you ever witnessed a fire truck speed by you? As it drove away, did you notice a change in the pitch of its siren? If so, you have witnessed the Doppler effect in sound.

The Doppler effect is a phenomenon that occurs when objects move relative to an observer while emitting sound, light, or other waves. To illustrate the Doppler effect, let us consider an example: if, say, a lightbulb was moving along a straight path at a constant, fast speed, it periodically emits light wavefronts at the speed of light, relative to itself. However, as it moves forward, the lightbulb's emitted wavefronts become closer in space as demonstrated in the figure. This causes an observer approached by the lightbulb to see higher-frequency, blueshifted light compared to what was emitted at the lightbulb. Alternatively, an observer that watches the light bulb move away will witness lower-frequency, redshifted light. We say that objects moving toward an observer are blueshifted and objects moving away from Earth are redshifted because red visible light is of lower frequency than blue visible light.



The Doppler effect in light is highly relevant to astronomy because there are always objects in the sky that are moving toward or away from Earth. In astronomy, we focus more on redshift, which we refer to as "z" in our equations.

But why would astronomers care more about redshift than blueshift? This is due to the evolution of the universe. The universe is actually expanding, which means that galaxies outside of the local cosmic area appear to be spreading out and moving away from us on Earth. If you look far enough everywhere in the sky, you will notice that all cosmic objects are moving away!

By quantifying the redshift of distant galaxies, astronomers learn more about the expansion of the universe.

Another important fact to note about these distant galaxies is the time that it takes their emitted light to reach Earth. If you look at a distant galaxy of $z = 5$, the light you are seeing took billions of years to travel to Earth! Therefore, we can look into the history of the universe with high-redshift objects. Doppler shift helps us explain the past, present, and future of our universe!

CHARACTERIZING THE ASTEROID BELT

BY CLAIRE CAHILL

How exactly did the Solar System come to be? It's a big question, and one that scientists have invested huge amounts of time and resources into. The asteroid belt (or main belt), a donut-shaped ring of asteroids between Mars and Jupiter, is one area of interest in this investigation. After all, even though much of the dust that formed the Solar System has accreted into planets, the asteroid belt has remained fragmented. How can we begin to understand how the asteroid belt works, and why it hasn't also accreted into a larger body?

Asteroid 243 Ida with its moon, Dactyls | Credit: NASA/JPL

Five minute exposure of 4743 Kikuchi
Credit: Claire Cahill

Flux, the amount of light that we are able to receive from the illuminated surface of an asteroid, changes with the surface area that is facing us at a given moment. Because these asteroids are not spherical, the flux changes as the asteroid rotates, which is possible to measure with a long exposure camera. When the longer side of the asteroid is facing us, a telescope is receiving more photons than when the shorter side is facing us. As a result, the change in flux over time can be represented as a curve.

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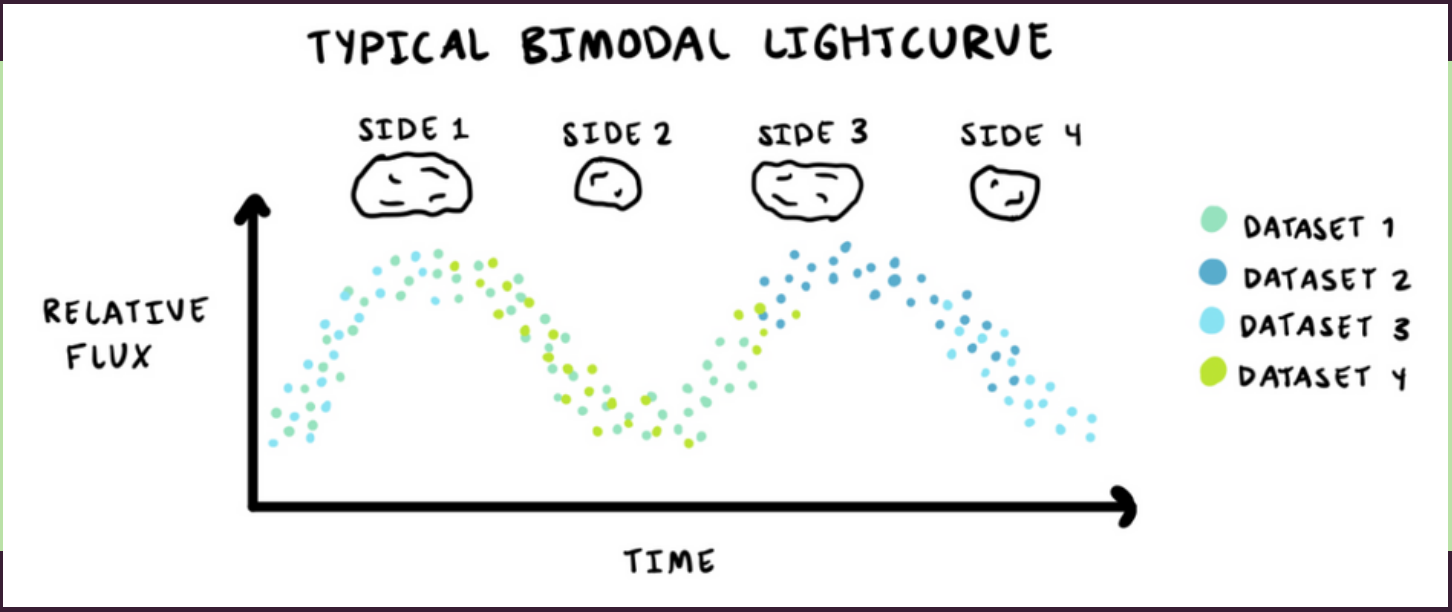


Most asteroids can be approximated as a rectangular prism or ellipsoid, so as it rotates, the first long side faces us, then the first short side, then the second long side, then the second short side. As a result, the lightcurve representing the shortest possible rotational period is often bimodal, meaning that it has two peaks and two valleys. Asteroid rotational periods are often measured this way. Because asteroids are so dim, each datapoint in a lightcurve is not an instantaneous image: often, each image is a long exposure lasting multiple minutes.

If an asteroid is imaged consistently on a time scale in the order of years, small, consistent fluctuations in the asteroid's lightcurves can be used to model some surface details as well.

Photometry finds other useful applications in astronomy besides asteroid observations. The same technique can be used to observe variable stars, confirm exoplanet candidates, and characterize other interesting phenomena like supernovae.

ASTROPHOTOGRAPHY BY CAS MEMBERS

We've had 8 cloudy Fridays this semester, but over the past few days we've gotten clear glimpses at planets and the moon!

Our planetary viewing on March 28 only saw two planets, but CAS member Claire Cahill managed to snap the right close-up moon shot through Irv. CAS members Alia Bu and Lucas Lawrence took the bottom left and bottom right pictures, respectively, through one of our 6" Dobsonians on a crazy clear Sunday night!

As we edge ever close to warm weather, out of the Ithaca winter grays, we hope the sky will open up for us!

Photo by Claire Cahill

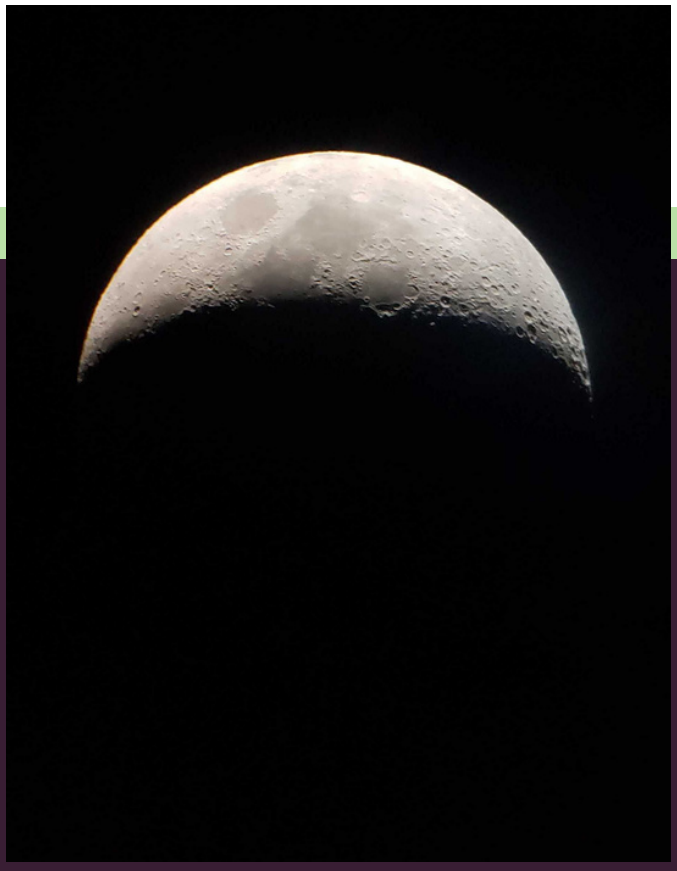


Photo by Alia Bu

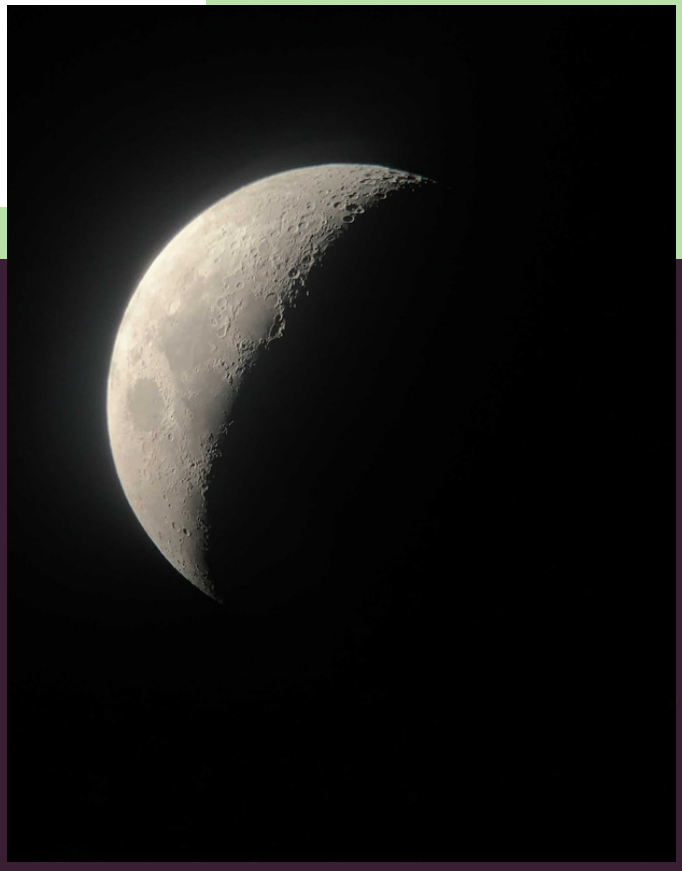
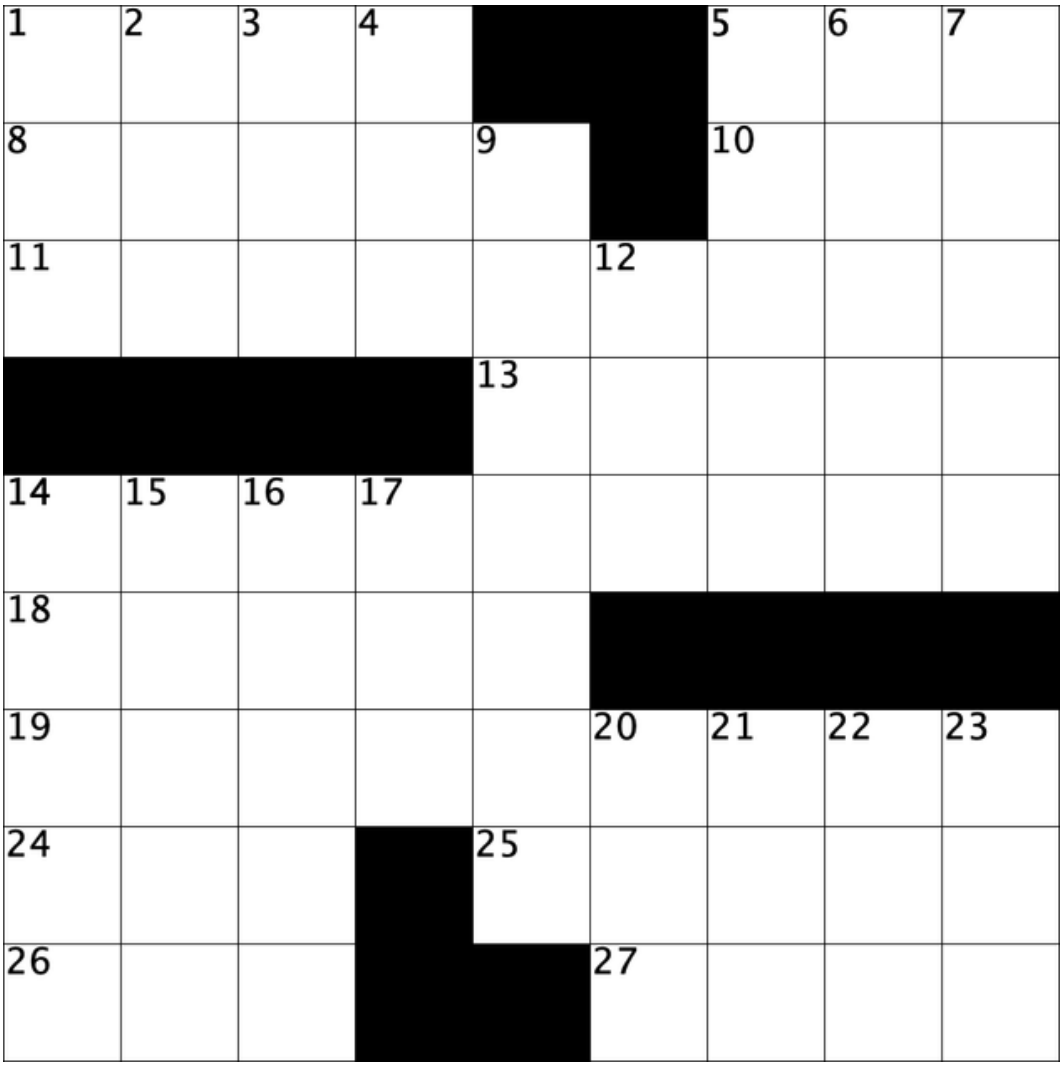


Photo by Lucas Lawrence

BY BEN JACOBSON-BELL



ACROSS

1 Potshots

5 21-and-up venue

8 Top story of some houses

10 Sch. in Baton Rouge

11 Like any of our usual observing telescopes (except Irv!)

13 Stranger, colloquially

14 Supercategory for 11-Across

18 "Um, that is to say ..."

19 Supercategory for 14-Across

24 Hebrew for "I"

25 Like an unfortunate weather forecast for stargazing

26 It's six hours behind UTC

27 Hall which houses most of Cornell's historical astronomy artifacts, other than those kept at Fuertes Observatory

DOWN

1 First mo.

2 Had, as for dinner

3 "Oh, that reminds me ..." initialism

4 Pull up a chair, so to speak

5 Eastern European pancakes

6 Carne ___

7 Type of sentence likely to be flagged in editing

9 One giving a final exam?

12 Nickname for a grandmother

14 Delta function namesake, in mathematics

15 Red sky at morning and a black cat, say

16 Suit

17 Ithaca pizza eponym

20 Publishers of this newsletter(!): Abbr.

21 Onetime material for many products now made with aluminum

22 Number of observatories on Cornell's campus

23 Bread for a Reuben

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Sources for "Mimas":

1 - 2 - 3 - 4 - 5 - 6 - 7

Image

Sources for "What is Doppler Shift?":

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

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