Science Journeys

SAM ROSE

presents

Cosmic Fireworks: How Astronomers Explore the Changing Sky

MEET
Sam Rose


Young Sam

Sam Rose is a graduate student in astronomy at Caltech advised by Professor Mansi Kasliwal. Sam spends her days (and many nights!) investigating the spectacular explosive deaths of stars and how their remnants go on to form the next generation of stars and planets. Using telescopes on Palomar Mountain, just three hours from Pasadena; on Maunakea located on the island of Hawai'i; and on the James Webb Space Telescope way out in space, Sam attempts to understand what happens to different stars at the ends of their lives as well as how they spend their afterlives.

Sam was raised in the San Francisco Bay Area, where she also attended UC Berkeley for her undergraduate degree. Having fallen in love with the night sky after seeing the planet Saturn through a small telescope as a middle school student, Sam majored in physics and astrophysics, and came to Caltech to pursue a PhD in 2022. When not doing astronomy, she enjoys reading cheesy science-fiction novels, spending time at the beach ... and reading cheesy science fiction at the beach.

Explore the Science

Astronomy • Astrophysics • History

The universe evolves over the course of billions of years—a timescale almost incomprehensible when compared to human lifespans. But there are some things in the night sky that happen on much shorter timelines. Spectacular explosions of dying massive stars, changing brightness of older stars, and visiting objects from the outer edges of our solar system are all examples of changes in the sky that happen over the course of weeks, months, or years. We call these events, which cause new sources of light to appear and disappear in the sky "astronomical transients." Astronomers still don't know everything there is to know about the stars and other objects in the sky, so they use giant telescopes and other scientific methods to study the sky nearly every night!

Join Caltech graduate student and astronomer Sam Rose as she explores the history of astronomical transients: from the observations of an exploding star by Chinese astronomers in 1054 CE; to the search for comets in the 17th, 18th, and 19th centuries; to the first large-scale surveys of the sky on photographic plates from Mount Wilson and Palomar observatories starting 80 years ago; to the modern technology used at observatories today.

As a member of the Zwicky Transient Facility (ZTF) collaboration, Sam spends her days and nights searching for and studying these cosmic fireworks. Sam will show how members of the ZTF collaboration use different telescopes to find and classify the thousands of astronomical transients discovered every year.

Terms to Know

- **Asteroid -** A small rocky object that orbits the Sun. Large numbers of these are found in the asteroid belt between Mars and Jupiter as well as across our solar system.

- **Astronomical transient -** A source of light in the sky that changes over time. This can mean that it is moving relative to background stars (such that it appears in a new place in the sky) or that the light source itself is getting brighter or fainter.

- **Atomic fission -** Nuclear reactions occur when the particles inside the nucleus of an atom—protons and neutrons—interact. Fission is a reaction in which a nucleus breaks apart to form two or more smaller nuclei. Energy is released in the process.

- **Atomic fusion -** A nuclear reaction in which lighter atomic nuclei combine to form a heavier nucleus. This process can also release energy.

- **Comet -** An object made of ice and dust from the outer solar system. When such an object comes close to the Sun, it forms a long tail of dust and gas particles.

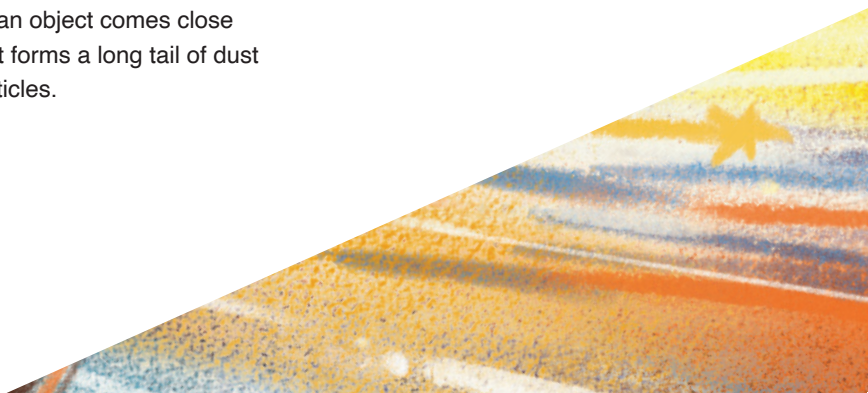
- **Galaxy -** A collection of millions or billions of stars, as well as gas and dust, which is held together by gravity. Earth's Sun is one of 200 billion stars in the Milky Way Galaxy.

- **Planet -** An object that orbits a star and is large enough to become approximately round under its own gravity. In order to be considered a planet, the object must control the gravity of its nearby surroundings, unlike a dwarf planet (like Pluto).

- **Spectroscopy -** Studying light by splitting it up into its component colors.

- **Star -** A massive ball of gas that is held together by gravity and releases energy, especially in the form of light, through the process of atomic fusion. The closest star to Earth is our own Sun, which weighs more than 333,000 Earths!

- **Supernova -** An extremely bright explosion of a star. For a few weeks, a single supernova can outshine an entire galaxy of millions of stars.



Continue the Conversation

Make a Pocket Solar System

Our solar system is vast, and there are great distances between the planets. How vast? Make a scale model with paper to find out.

1. Take a strip of receipt paper 1 meter long and draw a circle to represent the Sun at one end and a rectangle to represent the Kuiper belt on the other.
2. Fold the paper in half lengthwise to crease, then draw a circle on the crease line to represent Uranus.
3. Refold paper in half and then in half again so it is divided into fourths. Draw Saturn on the crease to the left of Uranus and Neptune on the crease to the right.
4. Fold the Sun to meet Saturn, and draw Jupiter on that new crease.
5. Fold the Sun to meet Jupiter, and draw the asteroid belt on that new crease.
6. Fold the Sun to meet the asteroid belt, and draw Mars on that new crease.
7. Fold the Sun to meet Mars, then fold that folded section in half again. On those three new creases, draw Mercury, Venus, and Earth (left to right).

You now have a scale model of the solar system where the 1-meter paper represents 50 astronomical units (AUs) of physical space. (One AU is the average distance between the Sun and Earth.) Now, try these questions:

1. Where does Halley's comet spend its time when it is not visiting the inner solar system? Add it to your model!
2. The moons Io, Europa, Ganymede, and Callisto were first observed by Galileo Galilei in 1610. Look up which planet they orbit and add them to your model. Then, look up some other moons!
3. The nearest star to our Sun is Proxima Centauri. It is located 4.25 light-years away. If you wanted to add it to your model, how long would your piece of paper need to be? (4.25 light years = 270,000 AU)

Scan to view instructions and resources for this activity

Credit: The National Informal STEM Education Network/The Science Museum of Minnesota and Sam Rose

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ANSWERS:

1. Halley's comet spends its time in the Kuiper belt.
2. The Galilean moons orbit Jupiter. Sam's personal favorite moons include the Earth's Moon; Enceladus and Titan, which orbit Saturn; Triton, which orbits Neptune; and Titania, which orbits Uranus.
3. To add Proxima Centauri, you would need a paper nearly 3.5 miles (5,400 meters) long!

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