Student Profile: Kaley Brauer PhD '23

by Sandi Miller

PhD '23 Computational Astrophysics (Frebel Group)

Kaley Brauer is using high-performance computing simulations and theoretical models to uncover new details about how galaxies form (including the origin of the Milky Way), as well as the astrophysical origins of heavy elements—with a focus on the smallest, earliest galaxies that merged into the Milky Way throughout cosmic time.

Kaley originally wanted to be a scientific illustrator, until she took a cosmology class at Brown University. As a graduate student at MIT, she was a Whiteman Fellow in her first year and a US Department of Energy Computational Graduate Fellow for the next four. Kaley recently completed her PhD under advisor Professor Anna Frebel at the MIT Kavli Institute for Astrophysics and Space Research, and will combine her interests in design and cosmology with an NSF Graduate Fellowship to carry out a program of research and education at the Harvard-Smithsonian Center for Astrophysics. Her research focus will be on how stars formed in the earliest galaxies by producing cosmological simulations of dwarf galaxies with individual stars, detailed chemical yields, and highly resolved metal mixing. For her outreach efforts, Kaley will be writing and illustrating a series of astronomy books to be distributed to Boston-area elementary schools and organizing a weekend space summer camp for middle school girls.

Kaley, how were you able to combine your two loves, art and physics, at MIT?

Art is a vital way to both communicate information and engage audiences, two things that are incredibly important in science. This is especially important for concepts in physics and astronomy where we lack natural intuition. Mathematical equations are necessary to create physics models, but nothing makes the average person's brain turn off faster than a page of math. If you show someone a beautiful visualization, though, you can communicate the same information much more effectively.

Scientists benefit from artistically visualizing models, as well. Years ago, I studied effective ways to visualize complicated atomic and molecular systems. These visualizations were for scientists. As humans, we all enjoy beautiful visualizations and often learn more quickly from viewing pictures and videos than from reading equations. Now, as an astrophysicist, art is an important way for me to understand and communicate my results.

In my office, I hang my paintings inspired by my research. The painting I've shown here depicts two galaxies merging: you can see tidal tails of gas and stars caused by the interactions between the two galaxies. Mergers like this take hundreds of millions of years before the galaxies ultimately coalesce into one larger galaxy. This is the primary way galaxies, including the Milky Way, grow. These paintings have repeatedly sparked conversations throughout the years and helped me communicate my work to anyone who passes by.

How does your research benefit from art?

I am lucky that my current astrophysics research lends itself to beautiful visualizations and artistic interpretations. In my research, I produce cutting-edge simulations of early galaxy formation. The most effective

Kaley Brauer PhD '23 with her painting depicting two galaxies merging. "You can see tidal tails of gas and stars caused by the interactions between the two galaxies," she says. Paintings such as this "have repeatedly sparked conversations throughout the years and helped me communicate my work to anyone who passes by."

way to interpret the simulations is to create videos of the stars forming and galaxies merging over time. Without carefully produced visualizations, it would be extremely difficult to understand the implications of our models. For example, by creating visualizations of gas composition and star particles, we can intuitively learn where and how stars are forming. The colors, angles and layout of the visualizations are all important artistic aspects that affect how efficiently we can analyze and understand our results.

Galaxies are beautiful. The beauty of astronomy is part of what drew me to it. I enjoy using its beauty to draw others to astronomy as well. At scientific conferences, beautiful images and videos help keep the interest of the other scientists who have already watched 15 talks that day. At outreach events with the general public, the visualizations and art help show non-astronomers the beauty of astronomy and inspire them to learn more.

Why write and illustrate an astronomy children's book?

Children are the future of science. Throughout my time at MIT, I deeply enjoyed volunteering time to teach elementary and middle school students through organizations like MIT Spark, Citizen Schools, Adopt-a-Physicist, and others. Compared to the grind of debugging research, teaching children about astronomy is incredibly fulfilling. Kids love space, and I love talking to kids about space.

In high school, I wanted to become an illustrator, and wrote and illustrated children's books for competitions. Art has not been my focus ever since I began studying physics, but I still love it and frequently paint and draw in my free time. Creating an astronomy children's book is a dream of mine, and I am so excited that my NSF Graduate Fellowship is supporting this project. The plan is to write the first book and freely distribute it to Boston-area elementary schools through a series of outreach events. After this book is complete, there are plans for additional books, perhaps with my PhD advisor Professor Anna Frebel.