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
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.