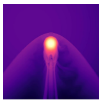
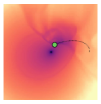
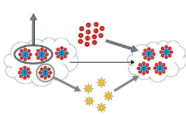


As two white dwarf stars dance around each other, exchange of mass causes one of them to explode as a supernova that briefly outshines a galaxy. The companion star, which is modeled in the simulation shown here, survives the explosion. It is flung off at a speed fast enough to escape from the Milky Way, never to return. ***By Sunny Wong, Carnegie Theory Postdoctoral Fellow.***

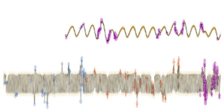


The merger of a star (orange and pink) that is 13 times the mass of the Sun with its smaller companion star (green dot), which is 5 times the mass of the Sun. The outer layers of the bigger star start to drift free of the star's gravitational pull as the companion star spirals deeper and deeper into it. This shows a 3D rendering of the density of the two stars in the process of merging. ***By Samantha Wu, Carnegie Theory Postdoctoral Fellow***.

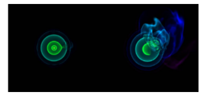
A gallery of Hubble Space Telescope images of strong gravitationally lensed galaxies from the AGEL survey. Each panel shows a massive galaxy that happened to have another galaxy precisely behind it. Each of these massive galaxies bends and magnifies the light from the galaxy behind them through gravity, producing the arcs. As it takes time for the light from faraway galaxies to travel to us, the magnified images of the background galaxies captures what they looked like in the early universe. These lensed galaxies were found using machine learning techniques and confirmed via spectroscopic observations taken by telescopes on Earth. ***By Keerthi Vasan, Carnegie Postdoctoral Fellow***.



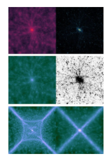
When stars form and die, they produce elements like iron and nickel, what astronomers call "metals." Thus while we might expect a galaxy's "metallicity" to go up after stars form, this is not always the case. This cartoon shows one step of evolution in a model, where stars form from a cloud of gas (bottom), ejects material in an outflow (right), accretes fresh gas (top), and gains metals from the new stars (left). The influx of relatively pristine, metal-free gas dilutes the metals that form, allowing the galaxy to evolve while its metallicity stays the same. ***By James Johnson, Carnegie Theory Postdoctoral Fellow***.



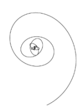
One way to detect the presence of planets orbiting other stars is to measure the velocities of those stars repeatedly over time and look for variations. Stars and planets effectively orbit each other, so if a planet is present, it perturbs the velocity of the star in a periodic way and can be detected with very precise measurements. This plot shows velocity measurements of a star over about 15 years. The squiggly line is a model that fits the data well enough to show that there are two planets orbiting the star, one that is about 20 times the mass of Earth, and one that is 3.5 times the mass of Earth. The velocities in red and purple were measured via the Planet Finder Spectrograph, designed and built at the Carnegie Observatories. The total variation in velocity is about 20 meters per second, or 45 mph. The precision of each individual measurement is less than 1 meter per second, slower than typical human walking speed. ***By Jeff Crane, Carnegie Staff Scientist***.



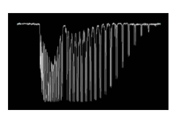
The merger of a star 13 times the mass of the Sun with a smaller companion star, which is 5 times the mass of the Sun. The outer layers or "envelope" of the bigger star starts to drift free of the star's gravitational pull as the companion star spirals deeper and deeper into it. This shows a 2D cross- section of the density of the two stars before (left) and during (right) the unbinding of the bigger star's envelope. ***By Samantha Wu, Carnegie Theory Postdoctoral Fellow***.



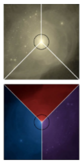
Cosmological simulations typically consist of a large box filled with matter that interacts through gravity and other forces. If we want our simulations to match reality, we must remember that the box does not exist in a vacuum; it should act as a window into the larger Universe. Neglecting this fact can produce some very unrealistic results! Above is a simulation designed to produce a Milky Way-sized halo, consisting of gas and dark matter. On the left, the geometry of the box is clearly imprinted on its contents, while on the right, the box contains a galactic halo that more closely matches observations. ***By Jimmy Wen, USC graduate student***.



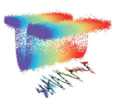
A dark matter subhalo spirals into the center of the host halo due to dynamical friction. The orbital track is drawn from a high-resolution numerical simulation. ***By Sten Delos, Carnegie Theory Postdoctoral Fellow***.



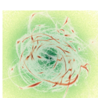
When we are trying to look at faraway galaxies from the ground, we have to look through the Earth's atmosphere. We often think of the sky as being very transparent, but it actually heavily absorbs reddish colors due to oxygen molecules, making it hard for us to see anything in space that emits light at those wavelengths. This image shows the light absorbed by the oxygen in the atmosphere near wavelengths of 760 nanometers. The very weak lines buried within are due to the ^{18}O isotope—in other words, an O_2 molecule made up with a ^{18}O atom and a ^{16}O atom. ***By Andy McWilliam, Carnegie Staff Scientist***.



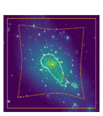
Imagine slipping on a pair of glasses that let you see a galaxy's dark matter. These images show what you'd see: each galaxy—a tiny speck at the center of the black circle—lives in a vast clump or "halo" of dark matter. Note that on the top right, there are a lot of bright specks. These are even smaller dark matter "subhalos" inside the main halo, which often host their own tiny "dwarf" galaxies. There are fewer subhalos on the top right and none in the triangle section below. Each of these sections assumes the as-yet mysterious dark matter particle has a different mass. The top right assumes that it is massive (>10x more massive than a proton), the top left assumes it's much less massive (150,000x less than a proton), and the triangle even less (300,000x less). This demonstrates one of the oldest methods astronomers have used to determine the mass of the dark matter particle: simply counting dwarf galaxies. The bottom is a mirror image of the same halo with each dark matter model displayed in a different color. ***By Stacy Kim, Nashman Postdoctoral Fellow***.



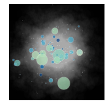
We can infer the presence of an exoplanet by measuring the brightness of its star (aka flux) over time. If the exoplanet passes between us and the star it orbits, the drop in brightness tells us about the size of the planet. If we know the size of the planet at multiple colors (as shown here), we can determine what's in its atmosphere!
By Jason Williams, Carnegie Postdoctoral Fellow.



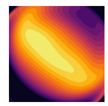
Our Milky Way galaxy is orbited by many dense clumps of stars bound together by their own gravity. We call these "globular clusters." The Milky Way can be a dangerous place for such clusters to live—this shows a simulation of a hundred clusters in the Milky Way that have been torn apart into thin "streams" of stars by the strong gravitational forces at the center of the Milky Way over the past 2 billion years. ***By Nondh Panithanpaisal, Caltech-Carnegie Postdoctoral Fellow***.



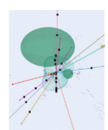
The colourful background shows a computer simulation of a massive cluster of galaxies. The brightness and colour represent how much matter (mostly dark matter) is present, with the brighter regions having higher density. The white lines (known as "critical curves") mark where the gravity of the cluster bends light from background galaxies so strongly that their images become highly distorted or even multiply imaged, a phenomenon known as "gravitational lensing". The red lines mark related boundaries, called caustics, that live in the background sky. Galaxies that—in the absence of lensing—would appear along a caustic, instead appear along the corresponding critical curve. Together, these lines indicate the "lensing power" of the simulated cluster, how its gravity would affect the appearance of background galaxies. For observed galaxy clusters, we can use this lensing effect to map out the distribution of dark matter within them. ***By Andrew Robertson, Carnegie Postdoctoral Fellow***.



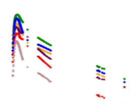
The Milky Way is home to many smaller "dwarf" galaxies that orbit it. This shows a simulation of the Milky Way and its satellite dwarf galaxies. The gray shows the Milky Way's dark matter, which dominates its mass. The light blue and green circles denote satellite galaxies that are lit by stars. These small satellite galaxies eventually merge to form larger galaxies, and are the building blocks of the universe. ***By Sachi Weerasooriya, Carnegie Postdoctoral Fellow***.



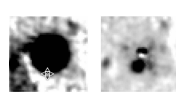
For telescopes to generate beautiful, crisp images, their lenses and other optical parts must be precisely aligned. This simulation shows what happens to the image quality when that goes wrong, in a worst-case alignment scenario. The colors show how the width of a star would vary across the field of view of the Giant Magellan Telescope (GMT) Commissioning Camera. The camera demands high fidelity image quality to verify the performance and maximize the utility of the ground-layer adaptive optics system at GMT. ***By Jack Piotrowski, Matt Johns Instrumentation Postdoctoral Fellow***.



Pulsar sightlines puncturing through the Local Bubble, a region of hot gas surrounding our Sun.
By Stella Ocker, Caltech-Carnegie Brinson Postdoctoral Fellow.



This shows the "light-curve" of a type-Ia supernova, the explosion of a white dwarf star, named 2021aefx. Each color represents a different filter through which the supernova's light was measured. The peak brightness corresponds to roughly the output of 5 billion suns! The data was taken with the Henrietta Swope 40-inch telescope at Las Campanas Observatory in Chile.
By Chris Burns, Carnegie Research Associate.



A 5-hour image taken by the Keck Cosmic Web Imager before (left) and after (right) removing the bright accreting black hole at the center of the image. The accreting black hole is so bright that it can sometimes obscure galaxies hidden behind it. Removing the black hole reveals multiple galaxies that cannot be seen otherwise. Sometimes our data analysis techniques have to catch up to the data that we have in hand and sometimes there are diamonds in the rough that we have to go digging for.
By Evan Nunez, Carnegie Visiting and UCLA UC Presidents/ Cal-Bridge Postdoctoral Fellow.