

SLAC Science

Astrophysics and Cosmology

To explore the birth of the universe, the formation of stars and galaxies and the fundamental structure of space and time, SLAC researchers develop cutting-edge technologies for sensitive experiments located deep underground, on the surface and in space.

Top National Priorities

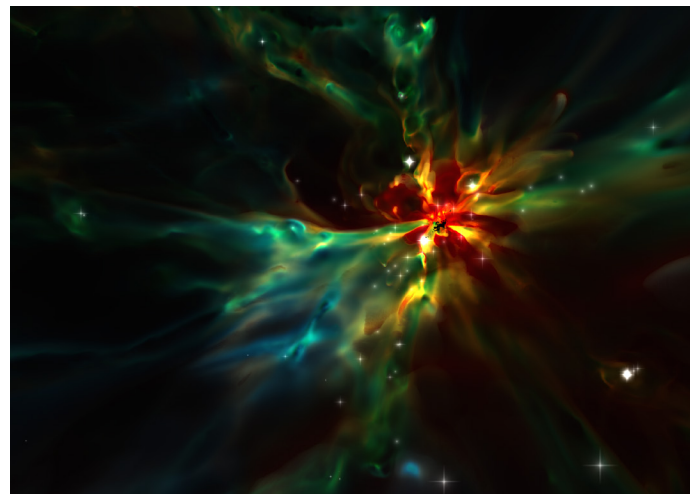
SLAC's astrophysicists and cosmologists pursue research in areas identified as top priorities for U.S. high-energy physics for the next decade. They want to understand our universe – from its smallest constituents to its largest structures. Several of these research topics are also covered by SLAC's particle physics program.

The Early Universe

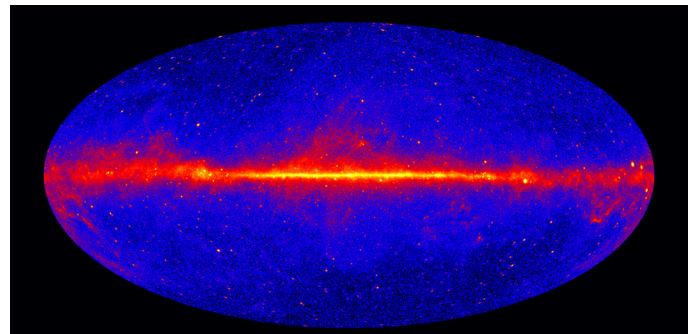
Our universe was born 14 billion years ago in the Big Bang and has been expanding ever since. But what exactly happened in those very first moments? Many researchers believe that the infant universe underwent a period of exponential growth, or inflation, when the cosmos was only a trillionth of a trillionth of a second old. Scientists search for signs of inflation in the oldest observable light, which covers today's sky as faint microwave radiation known as the cosmic microwave background (CMB). SLAC researchers and others have developed the sensitive BICEP and Keck Array microwave telescopes at the South Pole to look for inflation's fingerprints.

Dark Matter

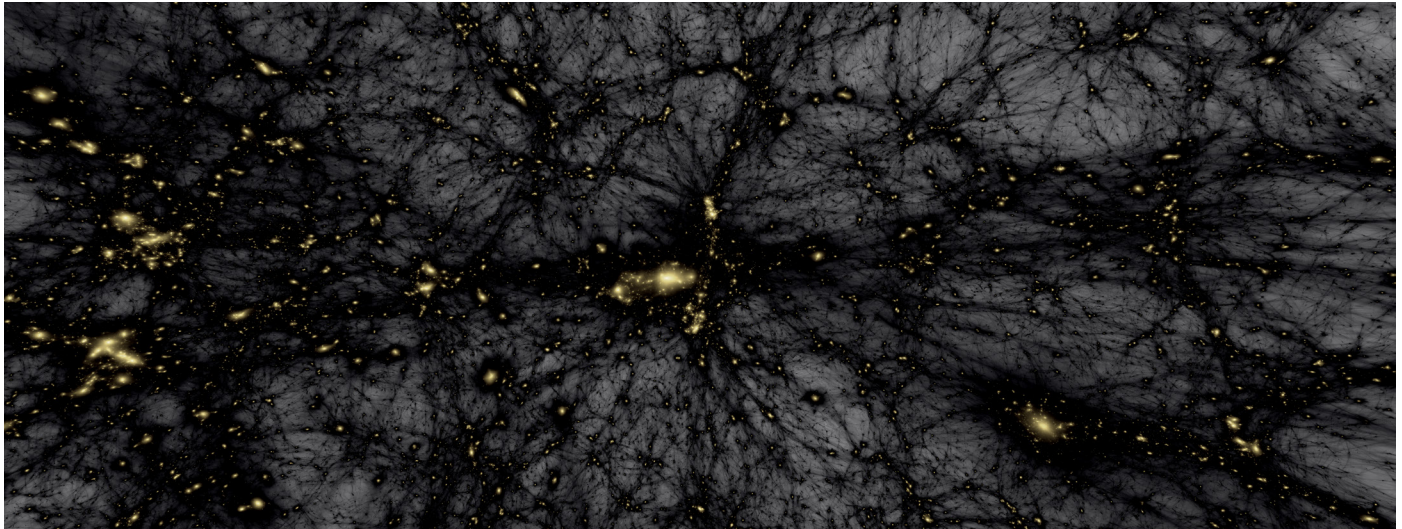
One of the biggest mysteries of modern science is dark matter – an invisible form of matter that affects the rotation of galaxies and bends the path of light. Scientists don't know yet what dark matter is made of, but they carry out a number of experiments to find out more. SLAC researchers use the Fermi Gamma-ray Space Telescope, which orbits the Earth at 350 miles altitude and whose main instrument was assembled at SLAC, to search



Above: Visualization of a small galaxy in the early universe. (T. Abel, R. Kaehler, J. Wise /KIPAC) Below: All-sky map of gamma-ray sources created with data from the Fermi space telescope. The extended bright structure at the center is our Milky Way. (Fermi-LAT Collaboration)



for signatures of hypothetical dark matter particles reaching us from space. SLAC is also involved in four sensitive underground experiments that hope to catch a glimpse of the elusive particles: SuperCDMS (Minnesota), LUX (South Dakota) and their planned successor experiments SuperCDMS-SNOLAB (Canada) and LUX-ZEPLIN (South Dakota).



Dark Energy

In the late 1990s researchers discovered that instead of slowing down as previously believed, the universe is actually expanding at an ever increasing rate. But what causes this acceleration, whose unknown driving force is dubbed “dark energy?” Scientists study dark energy by looking at how the distribution of galaxies changes the farther they are out in the universe. This is done in deep astronomical surveys that photograph large portions of the sky in unparalleled detail.

SLAC is taking part in the current Dark Energy Survey (DES) and is building a 3.2-gigapixel camera – the world’s largest – for the future Large Synoptic Survey Telescope (LSST), which will begin taking data in the early 2020s.

Putting It All Together: Cosmic Evolution

At the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), researchers from SLAC and Stanford bring the resources of modern computational, observational and theoretical science to bear on our understanding of the universe. They develop theories for the evolution of the cosmos – from the Big Bang to the formation of the first stars and galaxies to the complex structures we observe today – and test them against a wealth of experimental data.

At KIPAC’s Visualization Lab, scientists turn this information into stunningly beautiful full-color, high-definition 3-D videos that help researchers understand their data and inspire and educate the public at planetarium shows.

Above: Visualization of a web of dark matter, which is believed to be linked to the formation of visible structures in the universe. (T. Abel, C. Emmart, O. Hahn, R. Kaehler/KIPAC) Below: Rendering of the 3.2-gigapixel camera of the future Large Synoptic Survey Telescope. The camera, under construction at SLAC, will be the size of a small car and weigh more than 3 tons.

