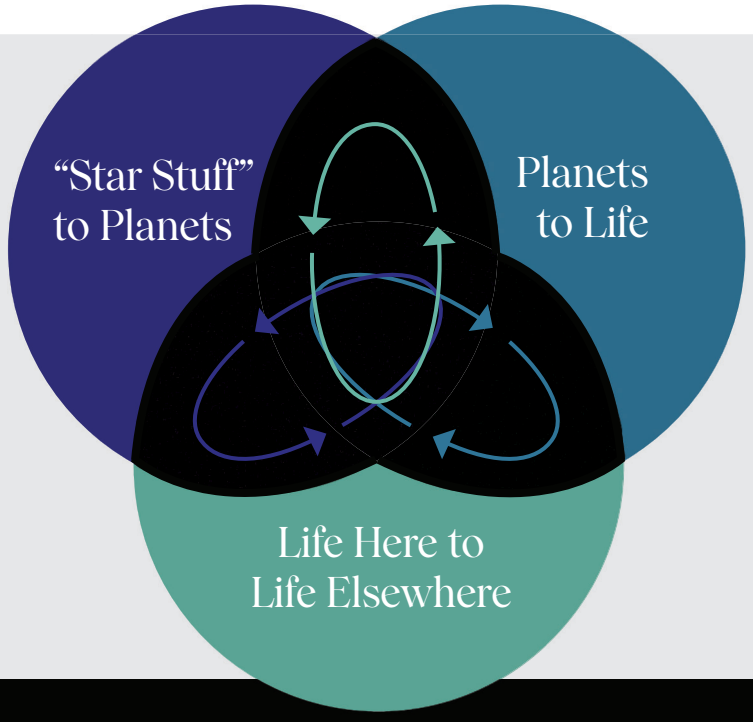
CARNEGIE SCIENCE

Blueprint for Discovery

Carnegie Science is an incubator for independent, interdisciplinary research that transcends scales—linking **genomes** to **ecosystems** and **planets** to the **cosmos**.

Humanity's greatest scientific mysteries will require researchers to think across time, space, and disciplines. We are committed to empowering top investigative minds to boldly pursue an unparalleled understanding of the natural world. Our broad expertise—underpinned by independence, agility, and a collaborative spirit—positions us to lead the research community in studying the nexus of life, our planet, and the universe. Our unique scientific framework—connecting universal building blocks to planet formation and the evolution of life—taps into Carnegie's tremendous potential for transformative discoveries that will unlock the secrets of the universe.

AT **CARNEGIE SCIENCE**,
WE CONNECT
BIG
SCIENTIFIC IDEAS
IN UNEXPECTED WAYS

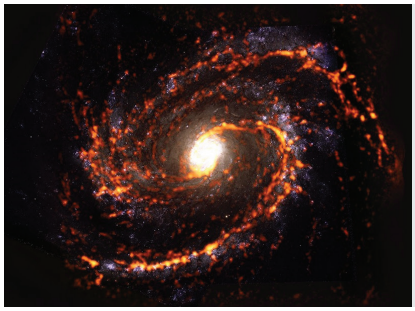


The boundless creativity of our scientists, coupled with cutting-edge technological advancements—from all-sky astronomical surveys to rapid gene sequencing—are driving breakthroughs that bring a comprehensive understanding of the cosmos within reach."

— JOHN MULCHAEY | CARNEGIE SCIENCE PRESIDENT

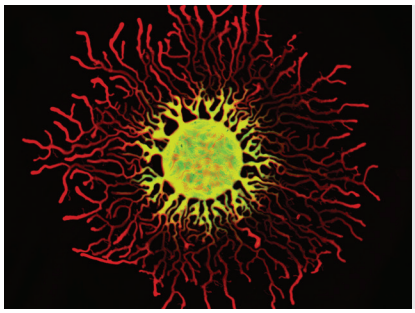
Carnegie Science investigators are at the forefront of exciting new research directions that will unlock our ability to answer these fundamental questions:

HOW DID WE GET HERE? & ARE WE ALONE?



OUR ASTRONOMERS are advancing a new understanding of cosmic processes, from the synthesis of "star stuff"—the raw materials from which everything in the universe is constructed—to the formation and evolution of stars and galaxies. Their discoveries build connections between the origins and evolution of structure in the universe across scales—from galaxy clusters to planetary systems.

OUR EARTH AND PLANETARY SCIENTISTS are enhancing our understanding of how planets are born around young stars and can develop into dynamic celestial bodies that are capable of supporting life. Their research probes the origins of life on Earth and expands our knowledge about the many ways its diverse biosphere and geosphere interact.



OUR BIOLOGISTS are exploring the interconnected web of life on Earth—underpinned by complex relationships between microbes that adapt to thrive in a range of changing environments. Their work reveals the complex array of chemical signals that are emitted from an inhabited world and could be detectable on other planets.

Thanks to Carnegie Science's hallmark freedom and flexibility, our researchers traverse disciplinary boundaries to reveal the relationships between stellar composition and planetary atmospheres and to probe the connections between the Earth's geosphere and biosphere. Their efforts are setting the stage for the detection of chemical fingerprints that could signal life on other planets.

CARNEGIE SCIENCE

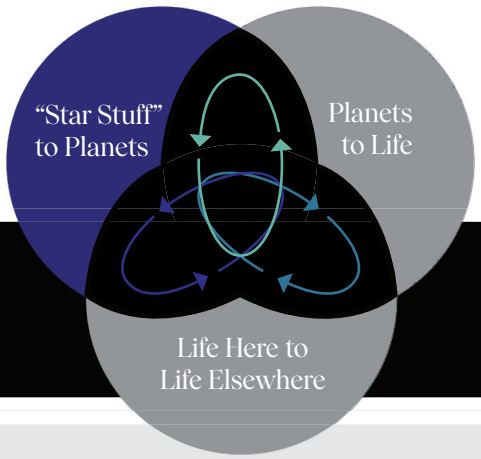
Astronomy

For more than a century, Carnegie Science astronomers have revolutionized our understanding of the cosmos. Today, new capabilities in instrumentation and computation are empowering our researchers to answer vital questions about the physics that shapes our universe and the synthesis of raw materials that **make life possible.**

Our telescopes and instruments are designed and built at our Observatories campus in Pasadena, where our astronomers and theorists work closely with our engineers and machinists to create the optical designs of the future. Carnegie Science's Las Campanas Observatory in Chile provides astronomers with access to first-in-class telescopes with views of the Magellanic clouds and the entire southern sky.

> *"No matter what we think we know, the universe will always surprise us."*
>
> ***— JOHN MULCHAEY***
> ***CARNEGIE SCIENCE PRESIDENT***

CARNEGIE SCIENCE

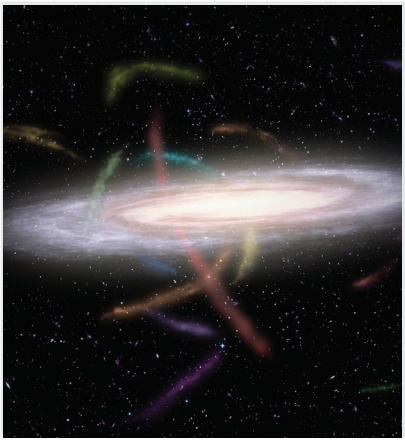


OUR RESEARCH

FIRST GENERATION OF STARS & GALAXIES

Carnegie Astronomers are using advanced telescopes like the JWST to pursue answers about star formation in ancient galaxies. Plus, new instruments under development for the twin Magellan telescopes at Las Campanas Observatory will enable breakthrough work on the universe's first structures and the rapid galaxy growth that occurred more than 10 billion years ago.

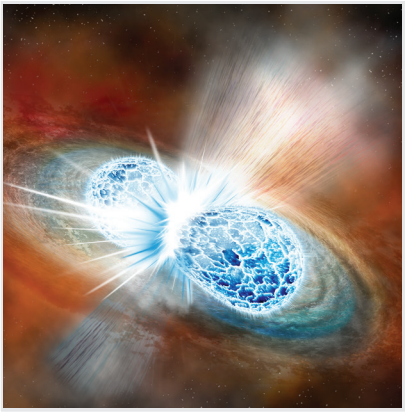
Image: *The MIRMOS spectrograph will reveal the relationship between a galaxy's birthplace and its ultimate destiny.*



EVOLUTION OF STARS & GALAXIES

Carnegie astronomer Vera Rubin provided the first observational evidence for the existence of dark matter—reshaping modern astrophysics. This mysterious material makes up more than 80 percent of the universe's mass and is believed to play a critical role in the evolution of galactic structures. Now, Carnegie researchers are using our own Milky Way as a laboratory to probe and uncover the elusive nature of dark matter.

Image: *The Via Project is building a custom spectrograph that will enable us to study the Milky Way's galactic halo at never-before-seen resolution.*



ELEMENT SYNTHESIS—COSMIC BUILDING BLOCKS

Stars and stellar explosions are responsible for creating and dispersing the rich diversity of elements that make life and everything we see around us possible. As Carl Sagan famously said, "we are made of star stuff." The study of supernovae and other so-called transient events is key to understanding the raw materials from which planets are formed and evolved.

Image: *Carnegie astronomers were the first in history to observe the explosion from two neutron stars colliding.*

DID YOU KNOW?

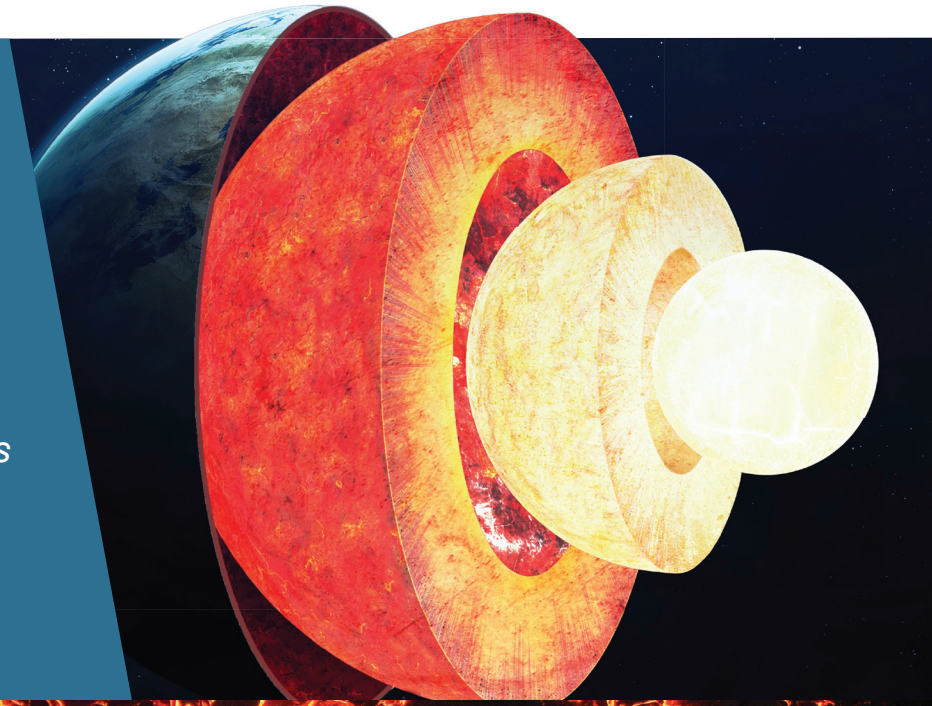
Did you know that the chemical makeup of a star could influence the composition of its planets?

CARNEGIE SCIENCE

Planetary Science

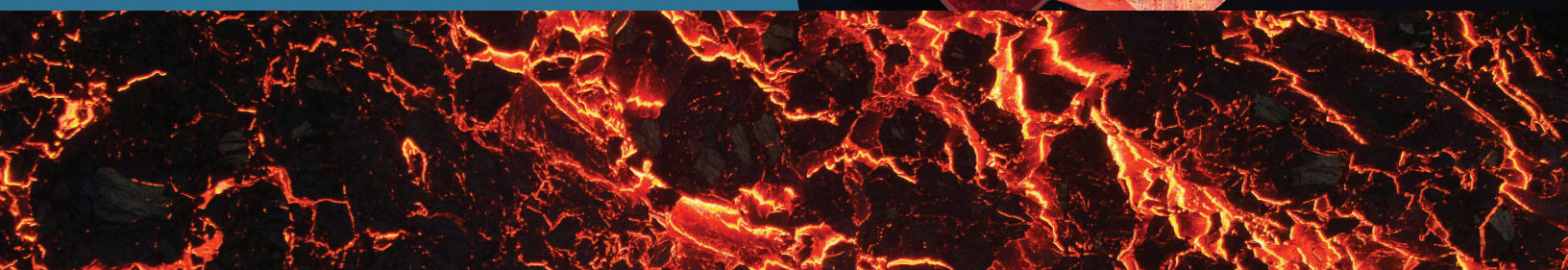
Drawing on more than 100 years of scientific excellence, Carnegie researchers cross disciplinary boundaries to discover distant worlds, illuminate Earth's inner workings, and reveal the dynamic processes that enabled **life to arise** and thrive **here**—and potentially **elsewhere in the universe**.

Our investigators combine—and often develop—a broad range of techniques to pursue fundamental questions at scales ranging from the atomic to the galactic. With a vast array of cutting-edge instruments and facilities at their fingertips, Carnegie Earth and planetary scientists advance new frontiers in sample return, planetary history, planetary interior dynamics, geochronology, and more.



> *"The breadth and depth of our scientific expertise available on our campus creates a cauldron of ideas that allow our researchers to tackle big and exciting questions from a variety of perspectives."*

— MICHAEL WALTER
EARTH & PLANETS LABORATORY DIRECTOR



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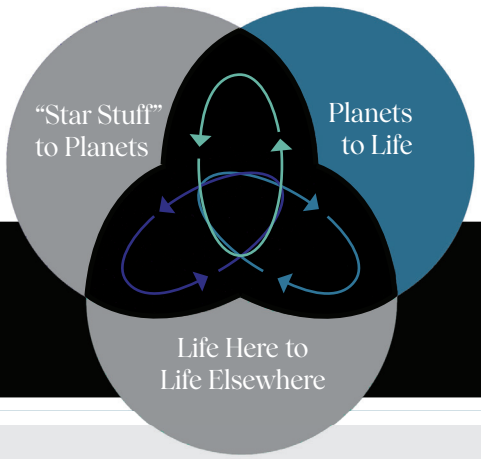
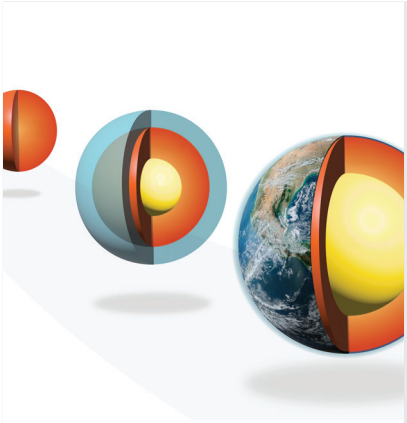


OUR RESEARCH

FORMATION OF PLANETARY SYSTEMS

During their youth, stars are surrounded by a rotating disk of gas and dust leftover from their formation. Baby planets and other celestial bodies are born from the accretion of this material over time. Revealing this process is critical for understanding planetary habitability and what makes our own Solar System so distinct from the thousands of others we've found so far. Carnegie astronomers and planetary scientists use both observing and mathematical modeling to piece together the puzzle of planet formation and early evolution.

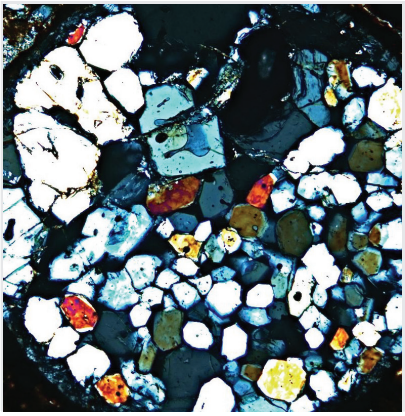
Image: *MagNIFIES will transform our understanding of young stars and the planet-forming material around them.*



PLANETARY DYNAMICS

Carnegie Scientists believe that there are three critical factors for a planet to be considered capable of hosting life: liquid water, plate tectonics, and a magnetic field. Planetary dynamics are the surface expression of these facets, which Carnegie scientists study in the field, in the lab, and at the telescope. The multi-disciplinary Sloan-funded AEThER project, is elucidating fundamental details about the nature of exoplanetary solar systems and the characteristics that could enable life to arise and thrive on rocky planets.

Image: *New Earth & Planets Laboratory instruments will let scientists recreate early planetary history in the lab.*



ORIGIN AND SUSTENANCE OF LIFE

How did life emerge on Earth and what enabled it to thrive? Answering this question requires a deep understanding of both our planet's geologic history and the raw materials from which the Solar System formed. Carnegie scientists are on the forefront of sample return missions that are enabling a brand-new understanding of organic compounds in our Solar System's history. This is critical for understanding the origin of life on Earth and how it differentiates us from other bodies within the Solar System.

Image: *Improved rock and Solar System sample analysis at Carnegie will drive new discoveries in origins research.*

DID YOU KNOW?

Carnegie Science pioneered the field of astrobiology—the interdisciplinary study of how life emerged on Earth and how to search for it elsewhere in the universe.

CARNEGIE SCIENCE

Biology

Carnegie biologists have played a foundational role in advancing our knowledge of the natural world across scales, spanning from the molecular to the global and beyond. Our scientists investigate community interactions across an array of habitats, from native California grasslands to marine ecosystems and even inhospitable hot springs that may mimic the conditions in which **life first evolved on Earth.**

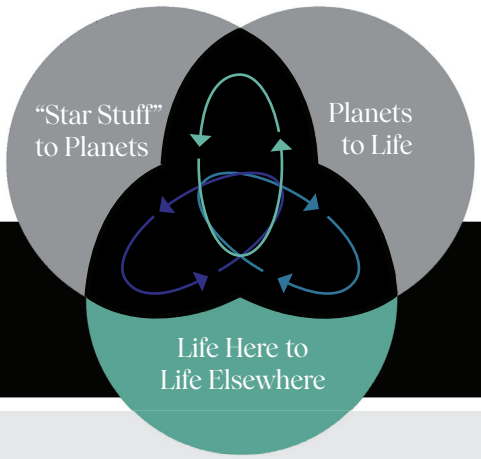
Recent technological breakthroughs have enabled Carnegie biologists to reveal connections between the synthesis of molecules that comprise individual physiological functions and the complex community interactions that shape ecosystem resilience. These advances build on Carnegie's well-recognized history of developing model organisms to gain a deep understanding of biological principles and mechanisms. For decades, Carnegie biologists have used these tools to gain a deep understanding of the mechanisms that govern life as we know it.

"

Strong collaborations across our areas of expertise promise to provide new dimensions to our understanding of not only life on Earth, but also life's position in the universe."

— YIXIAN ZHENG
INTERIM BIOSPHERE SCIENCES & ENGINEERING DIRECTOR

CARNEGIE SCIENCE



OUR RESEARCH

CO-EVOLUTION OF PLANETARY ATMOSPHERE, CLIMATE & BIOSPHERE

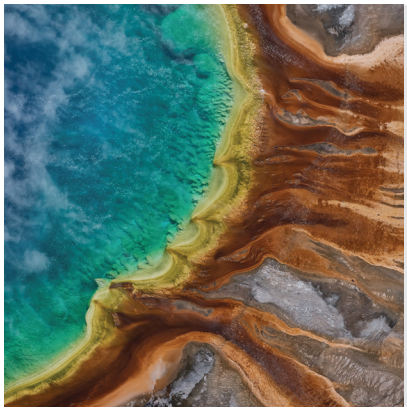
Life on Earth was born of its unique geology. In turn, organisms have transformed our planet. For instance, the ancient biological innovation of photosynthesis allowed the vast diversity of life to flourish. Today, microbes, plants, and human societies continue to have a profound impact on life on our planet. Carnegie scientists who work at the interface of biology, community ecology, and Earth System science are uniquely poised to answer some of the most pressing questions about sustaining life on Earth and the possibility of life elsewhere.

Image: *Unseen interactions between microorganisms and plants regulate atmospheric oxygen and carbon dioxide levels on planet Earth.*

PATTERNS & MECHANISMS FROM MOLECULES TO ECOSYSTEMS

It's been said that the 21st century is the age of biology. Genome-enabled research, coupled with other new technologies, allow us to probe in unprecedented detail the unending diversity of living organisms and their dynamic interactions with each other and their environments. Carnegie biologists study a variety of microbes, plants, and animals. They are uniquely placed to integrate studies that span from molecules and cells to organisms, populations, and ecosystems using diverse approaches, including field biology, molecular analyses, and mathematical modeling.

Image: *Carnegie biologists are revealing how the evolution of diverse microbial functions, including photosynthesis, impacts a variety of ecosystems, including coral reefs.*



LIFE ACROSS DIVERSE & CHANGING ENVIRONMENTS

Carnegie scientists study how living organisms survive, compete, and cooperate in a broad range of terrestrial and aquatic environments, including extreme conditions found in the hot springs of Yellowstone National Park and volcanic vents on the ocean floor. Their work uncovers how organisms and communities adjust to fast-changing conditions, including how species can be resilient in a warming world. Their efforts could inform the search for life on ocean moons like Enceladus and Europa.

Image: *Lateral transfer of genes between microbial members of an extremophile community reveals details about how these species thrive in challenging conditions, such as hot springs.*

DID YOU KNOW?

Biological processes, like photosynthesis, and geological processes, like volcanism, produce chemical fingerprints that can be seen from space. Carnegie scientists are working to differentiate between the two types of signals, and elucidating how to look for distinct signs of life on other worlds.