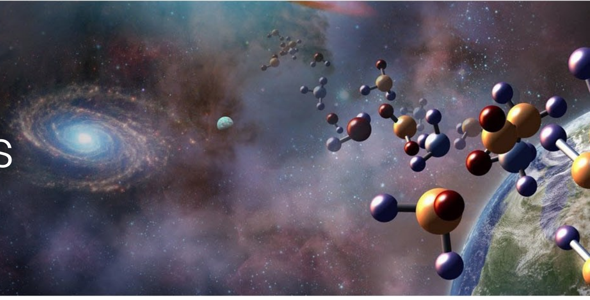
# ORIGINS Space Telescope

From first stars to life



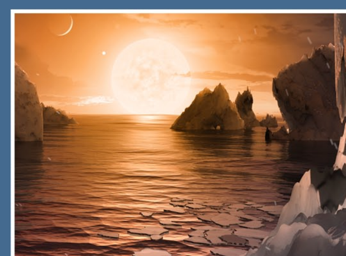
## HOW DOES THE UNIVERSE WORK?

**How do galaxies form stars, buildup metals, and grow their central supermassive black holes from reionization to today?**

Through deep and wide spectroscopic surveys, Origins will reveal the complete history of star formation, metal enrichment and supermassive black hole growth in galaxies across cosmic time.

## HOW DID WE GET HERE?

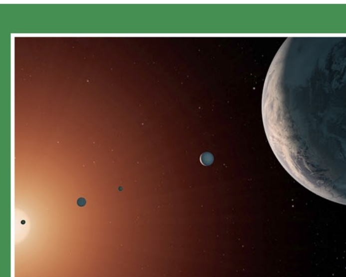
**How do the conditions for habitability develop during the process of planet formation?**



With sensitive and high-resolution far-infrared spectroscopy, Origins will illuminate the trail of water in our Galaxy from star forming disks to habitable planets.

## ARE WE ALONE?

**How common are life bearing planets around M dwarf stars?**



By obtaining precise mid-infrared transmission and emission spectra, Origins will assess the habitability of nearby exoplanets and search for signs of life.

SCIENCE DRIVERS FOR MISSION DESIGN

## DISCOVERY SPACE OF ORIGINS

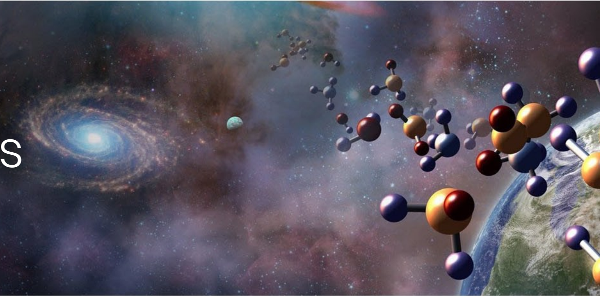
**Origins is not only capable of addressing known questions but has a vast discovery space that will enable astronomers in the 2030s to find new phenomena and address unknown questions. All science programs on Origins will be selected by the community via peer review.**

The Origins Space Telescope is a community-led mission concept study sponsored by NASA in preparation for the 2020 Astronomy and Astrophysics Decadal Survey.

**origins.ipac.caltech.edu**

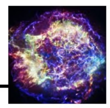
# ORIGINS Space Telescope

From first stars to life

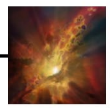


## How do galaxies form stars, buildup metals, and grow their central supermassive black holes from reionization to today?

Conduct the first unbiased survey of the co-evolution of stars and supermassive black holes by measuring redshifts, black hole accretion rates, and star formation rates in ≥$10^6$ galaxies since reionization to 1 $M_\odot$/yr at cosmic noon (z=2), and 10 $M_\odot$/yr at cosmic dawn (z=6).

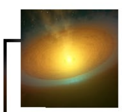


Measure the metal and dust content of ≥ $10^5$ galaxies out to z=6 as a function of cosmic time, morphology and environment, tracing the rise of heavy elements, dust and organic molecules.



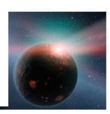
Establish an accurate model of galaxy growth and evolution, measure galactic outflows in ≥ $10^3$ galaxies as a function of luminosity over the past 10 Gyr to determine the relative role of supernovae and AGN feedback.

## How do the conditions for habitability develop during the process of planet formation?



Measure the water content across all evolutionary stages of planetary system formation, tracing water vapor and ice at temperatures between 10 and 1000 K down to fundamental chemical limits.

Determine how planetary systems form by measuring the gas mass of planet-forming disks down to one Neptune mass (5σ) at a distance of 125 pc, across all evolutionary stages and across the range of stellar mass.

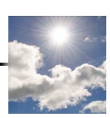


Determine the cometary contribution to Earth's water content to a 99.9% confidence level through measurements of the D/H ratio in cometary water.

## How common are life bearing planets around M dwarf stars?

Distinguish between clear and cloudy atmospheres for ≥12 terrestrial planets in the habitable-zone using $CO_2$ and $H_2O$ spectral features.

Establish whether the apparent surface temperatures of at least six habitable zone exoplanets with the clearest atmospheres are consistent with liquid water at >95% confidence.



Detect biosignatures at ≥99.97% confidence (≥3.6 σ, assuming an Earth-like atmosphere) on at least four exoplanets, highest-ranked from Objectives #1 and #2.

The Origins Space Telescope is a community-led mission concept study sponsored by NASA in preparation for the 2020 Astronomy and Astrophysics Decadal Survey.

**origins.ipac.caltech.edu**