

Roman Space Telescope begins journey to L2 after Falcon Heavy launch

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NASA's Nancy Grace Roman Space Telescope began its journey into deep space on Aug 30 after being launched aboard a SpaceX Falcon Heavy rocket, opening a new chapter in efforts to investigate dark energy, dark matter, and planets outside the solar system.

The rocket lifted off from Launch Complex 39A at NASA's Kennedy Space Center in Florida at 7:26 am, Eastern Daylight Time, on Aug 30. After separation, Falcon Heavy's two side boosters returned to landing zones at Cape Canaveral, while the telescope continued toward the Sun-Earth system's second Lagrange point, or L2 (Figure 1).

Roman is expected to spend about one month traveling to its destination, roughly 1.5 million kilometers from Earth. Rather than remaining stationary at L2, it will enter a larger orbit around the region, where the gravitational influences of the Sun and Earth allow a spacecraft to maintain a relatively stable position with limited fuel consumption.

The new telescope is named after Nancy Grace Roman, NASA's first chief astronomer, who is widely known as the "Mother of Hubble" for her role in making the Hubble Space Telescope possible. The James Webb Space Telescope, launched in 2021, has already been operating in the same broad region, yet the two observatories have quite different strengths.¹

With its 6.5-meter primary mirror and exceptional infrared sensitivity, Webb is designed to examine selected objects in extraordinary detail, including some of the earliest galaxies and the atmospheres of distant planets. Roman, equipped with a 2.4-meter mirror and a much wider field of view, is designed to survey vast areas of the sky rapidly.

In simple terms, Roman will identify populations, patterns and promising targets across the cosmos, while Webb can subject selected objects to much closer examination.

Roman's primary mirror has the same diameter as Hubble's. It was

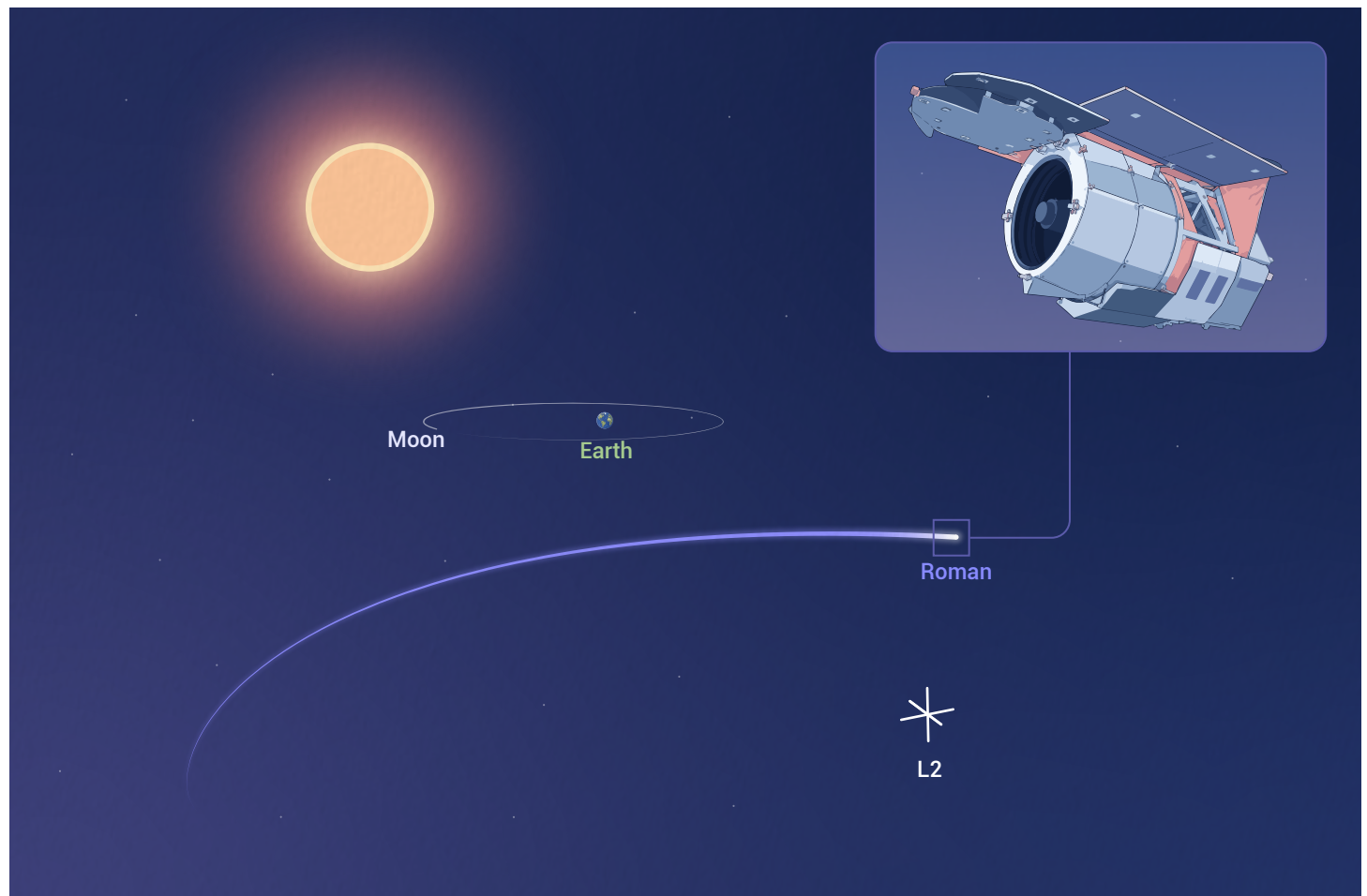


Figure 1. Nancy Grace Roman Space Telescope bound for Sun-Earth L2 point

originally manufactured as part of a reconnaissance satellite programme before the US National Reconnaissance Office donated it to NASA. The telescope's Wide Field Instrument uses a 300-megapixel camera to produce images with Hubble-like sharpness while covering an area of sky about 100 times larger in a single exposure.

Its wide field, highly sensitive detectors and rapid survey capabilities will

allow Roman to map the sky up to 1,000 times faster than Hubble for some observing programmes.²

The scale of the expected data flow illustrates the difference. Hubble returned about 172 terabytes of data during its first three decades in orbit. Roman is expected to transmit as much as 2,500 terabytes during its five-year primary mission. One of its major objectives will be to investigate

two of modern cosmology's greatest mysteries, namely dark matter and dark energy.

Dark matter, which is thought to account for about 85 percent of all matter in the universe, has never been directly detected as a particle. Its presence has instead been inferred from its gravitational effects on galaxies, galaxy clusters and light travelling through the universe.

Dark energy is the name given to the still-unexplained phenomenon believed to be driving the accelerating expansion of the universe. By measuring the distribution of galaxies, mapping gravitational lensing and observing large numbers of distant supernovae, Roman will allow scientists to test competing explanations for cosmic acceleration.

If the measurements cannot be reconciled with the prevailing cosmological model, they could force scientists to reconsider fundamental assumptions about the nature and history of the universe.

Alongside its Wide Field Instrument, Roman carries a technologically advanced Coronagraph Instrument. Using masks and deformable mirrors, the instrument will suppress the overwhelming glare of a star, allowing scientists to detect the extremely faint light reflected by planets orbiting it.

The coronagraph is expected to study Jupiter-sized planets orbiting nearby Sun-like stars, as its systems are designed to detect objects around 100 million times fainter than their host stars, which sensitivity could enable scientists to observe a "Jupiter twin" in visible light reflected from its cloud tops. By analysing that light, researchers may be able to identify chemical components in the planet's atmosphere.

Astronomers have so far confirmed more than 6,000 exoplanets, many discovered with the help of NASA's Kepler Space Telescope and subsequent missions. Roman is expected to expand that catalogue substantially through several complementary methods.

Its Galactic bulge survey could discover around 1,400 planets through gravitational microlensing, including worlds far from their stars and potentially free-floating planets that orbit no star at all. Scientists have also estimated that the mission's observations could potentially reveal tens of thousands transiting planets, although many would require follow-up observations for confirmation.

During its five-year primary mission, Roman will conduct three major community-designed surveys.

The High-Latitude Wide-Area Survey will observe a large region beyond the

Milky Way's dusty plane. Covering about 12 percent of the sky, it is expected to catalogue the positions and properties of more than 1 billion galaxies. The resulting map will help researchers trace the development of cosmic structure and measure how dark matter has shaped the universe.

The High-Latitude Time-Domain Survey will conduct about 180 days of observations over two years. Roman will repeatedly photograph the same regions, covering a total area equivalent to about 90 full moons. By assembling the images into a kind of cosmic movie, scientists will be able to identify short-lived or changing phenomena, from exploding supernovae to flashes produced when stars are torn apart by black holes.

The Galactic Bulge Time-Domain Survey will focus on the densely populated central region of the Milky Way. The bulge contains enormous numbers of stars, together with gas and dust, while the galaxy's supermassive black hole influences the movement of stars in its immediate neighbourhood.

Repeated observations of the region will support Roman's search for exoplanets through microlensing and provide a detailed picture of stellar populations near the Galactic centre.

Beyond the three core surveys, Roman is also expected to examine the Milky Way's disk across an area equivalent to about 3,455 full moons. The programme could map approximately 20 billion stars, producing one of the most comprehensive views yet of the galaxy's structure.

Space telescopes often remain operational far beyond their original design lifetimes. Hubble, designed for a mission of about 15 years, has now spent more than 36 years in orbit and continues to observe the universe. Roman was launched 36 years after Hubble began its journey, but how long the new observatory will ultimately serve remains unknown—as do the breakthroughs in humanity's exploration of deep space that it may live to witness.

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DECLARATION OF INTERESTS

The authors declare no competing interests.