

The Orion Nebula and NASA's Astronomical Search for Origins

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Telescopes take us on a journey from our home planet Earth to the beginning of the universe, on a quest for answers to age-old questions. NASA's Astronomical Search for Origins program explores the universe in search of one piece of the puzzle – the answers to the enduring questions: Where did we come from? Are we alone? Today, you will see an amazing new image of the Orion Nebula taken by the Hubble Space Telescope – an image that provides spectacular views of the birthing grounds of stars and planets.

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Let's start by finding the Orion Nebula in the sky. Due to its prominence in the winter skies, the constellation Orion has captured our attention and inspired our imaginations for ages. The Orion Constellation has long garnered the attention of scientists and amateur astronomers for another reason as well – it is home to the closest example of a nursery of stars – the Orion Nebula.

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Images of the Orion Nebula taken with telescopes on the ground show a region resembling a giant bubble adorned with intricate filaments and interacting sheets of gas. This is a region of star birth, where we can see stars of all sizes, including a few very bright and massive stars, as well as smaller stars like the sun. (Photo by David Malin from plates taken with the UK Schmidt Telescope)

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By placing telescopes above the blurring effects of the Earth's atmosphere, we can see the Orion Nebula with unprecedented clarity. This just-released image taken by the Hubble Space Telescope represents the sharpest view ever taken of the Orion Nebula. More than 3,000 stars of various sizes appear in this image. Some of the stars have never been seen in visible light. Astronomers have also identified disks of dust encircling stars – the raw material for planet formation.

(Image Credit: NASA,ESA, M. Robberto (Space Telescope Science Institute/ESA) and the Hubble Space Telescope Orion Treasury Project Team)

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This section of the new Hubble image shows the Trapezium stars, the four most massive stars in the Orion Nebula, illuminating the area. Ultraviolet light unleashed by these stars is carving a cavity into the nebula and heating the gas to a temperature of 18,000 degrees Fahrenheit. Astronomers have used another

one of NASA's observatories – the Far Ultraviolet Spectroscopic Explorer – to investigate how the ultraviolet light from hot stars interacts with the nearby gas and dust. Notice the bowed shape of the gas blowing past the star in the lower-right corner.

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The image also shows “protoplanetary disks,” disks of gas and dust out of which solar systems form. The one on the right is so dense that light from the nebula behind it cannot get through, and so it appears dark. Scientists have also discovered planets around two stars in the constellation of Orion. Over 150 planets have been identified around stars so far. These planets are giants, like Jupiter or Saturn, and are unlikely to support life as we know it. Future NASA missions, including the Kepler mission and SIM PlanetQuest, will search for Earth-size planets.

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This portion of the Hubble image shows dark, dense pillars of dust and gas (near the top of this image section) are resisting erosion from intense ultraviolet light released by Orion's biggest stars. We can use infrared observations to peer through these dense clouds of gas in search of the stars within.

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This glowing region in the Hubble image reveals arcs and bubbles formed by stellar winds – streams of charged particles ejected by stars. The stellar winds compress the surrounding gas, causing it to contract and form new stars and new solar systems.

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The faint red stars in this close-up image are the myriad brown dwarfs that Hubble spied for the first time in visible light in Orion. Sometimes called “failed stars,” brown dwarfs are cool objects that are too small to be ordinary stars because they cannot sustain nuclear fusion in their cores the way our Sun does. Brown dwarfs are objects that are intermediate in mass between stars and planets, and they help us to understand the formation process of stars and planets. Brown dwarfs emit most of their energy at infrared wavelengths. NASA's future Wide-Field Infrared Survey Explorer and James Webb Space Telescope will use infrared light to study these objects.

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An image of Orion in visible light, such as this, tells only a small part of the story. To understand more of what's going on in Orion, we need to look at it in other

wavelengths of light – wavelengths of light that we cannot see with our eyes. For example, in infrared light, we see...

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...a vast complex of clouds of gas that show the Orion Nebula to be just one part of a much more extensive region of star formation. These images dramatically illustrate how features that cannot be seen in visible light show up very brightly in the infrared. The infrared image shows several regions of hot, dense clumps of gas and dust. These are the stellar nurseries where new stars are being born. Embedded in these molecular clouds, the young stars are difficult to see in visible light – but heat reveals their presence in the infrared.

At long infrared wavelengths, astronomers are able to study the distribution of dust that characterizes these cocoons where star formations occur. At short infrared wavelengths, scientists can pierce through the obscuring dust and gas to reveal the young stars in the process of being born. Scientists will continue to investigate the Orion Nebula and other star forming regions using NASA's infrared observatories, such as the Spitzer Space Telescope and the Stratospheric Observatory for Infrared Astronomy.

(Image courtesy of Howard McCollon, Infrared: NASA/IRAS)

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We get additional information by looking at different wavelengths of light. This image of the Orion Nebula, taken by the Chandra X-ray Observatory, reveals about 1,400 young stars. Some of these are young, sun-like stars that are producing powerful bursts (or flares) of x-rays. Flaring, young Sun-like stars can affect the formation of planets around them by producing strong turbulence in the surrounding planet-forming disk. Such turbulence might affect the position of rocky, Earth-like planets as they form and influence whether the planets end up in a region where they could support life. The survival chances of the Earth may have been enhanced by large flares from the young Sun.

(Image Credit: NASA/CXC/Penn State/E.Feigelson & K.Getman et al.)

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Where stars form in the Orion Nebula, entire solar systems can form as well. This artist's concept illustrates a solar system that is a much younger version of our own. Dusty disks, like the one shown here circling the star, are the breeding grounds of planets, including rocky ones like Earth.

Astronomers using NASA's Spitzer Space Telescope spotted some of the raw ingredients for DNA and protein in one such disk. Thus NASA's space

observatories can be used to learn not only about stars, but also about their environments where habitable planets might form.

(Image Credit: NASA/JPL-Caltech/T. Pyle (SSC))

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In the future, new NASA missions such as the Terrestrial Planet Finder will not only detect habitable planets, but will also investigate those planets for signs of life. The scientists of NASA's Astrobiology Institute are among those seeking to understand the possibilities of finding life elsewhere in the universe.

(Illustration Credit: NASA and G. Bacon (STScI))

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Stars and planets form as a natural consequence of the stellar "life cycle." The Orion Nebula is the closest stellar birthplace. Where stars form, planets form, too. Toward the end of their lives, massive stars explode, expelling gas containing various chemical elements. Solar systems can later form out of that gas. The chemical elements in that gas can be used in the creation of Earth-like planets and, eventually, life on those planets.

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We now return to the most detailed image of the Orion Nebula acquired to date. This dramatic Hubble image offers a peek inside a cavern of turbulent dust and gas where thousands of stars are forming. Since NASA's space-based observatories are located above the Earth's atmosphere, images from space can be more detailed than ground-based images and can be used to observe wavelengths of light that cannot be observed from the ground. Visit NASA's websites to learn more about our explorations of the universe!

Note: To download a 45-second animated "fly-through" of the Orion Nebula, visit:

<http://hubblesite.org/newscenter/newsdesk/archive/releases/2001/13/video/a>

To download a 2.5-minute version of the fly-through with narration, visit:

<http://vis.sdsc.edu/research/orion.html>