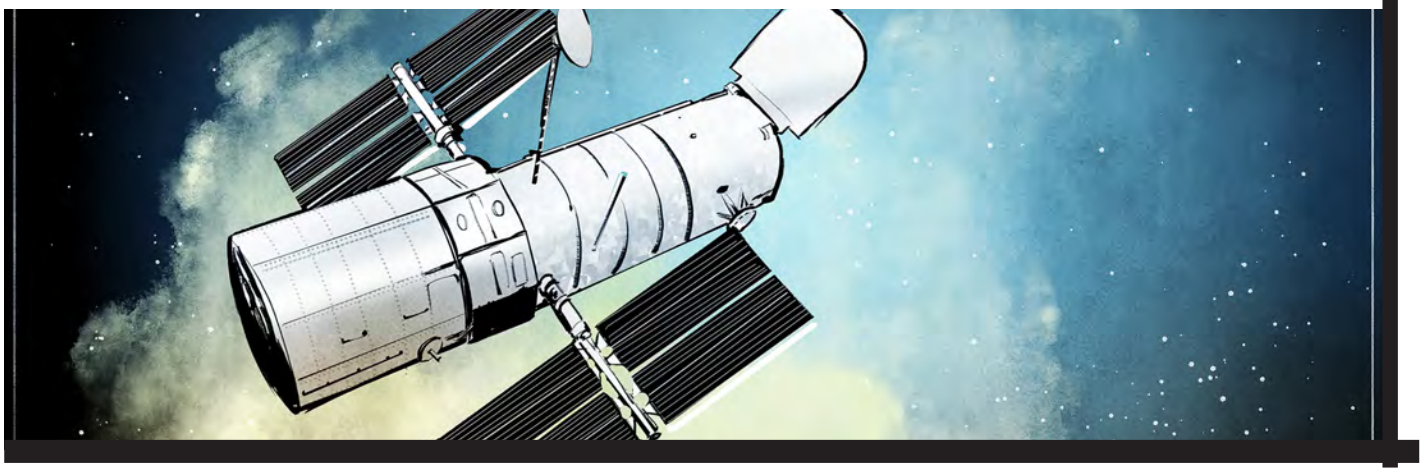
The Hubble Telescope
– Window Into a Hidden Universe



Look up, way up. On a clear night, the stars are spectacular. But with the naked eye, you can't see the details of our universe.

That's why, in 1610, Italian astronomer Galileo built a telescope. It gave stargazers a clearer view of objects in space. They learned that Saturn had rings, for example. And the Milky Way was not a cloud, but a collection of countless stars.

Over the years, telescopes became more sophisticated. So did our understanding of space. However, there's a problem with ground-based telescopes. The Earth's atmosphere blurs their view of space. The atmosphere is a fluid, **chaotic** soup of gas and dust. So it blocks certain wavelengths of light from reaching our world. (On a positive note, that shifting air makes the stars twinkle!)

The solution? Put the telescope in space, above the Earth's atmosphere.

By 1975, the European Space Agency and **NASA** were drafting plans for this space telescope. And in April 1990, the Hubble Space Telescope hitched a ride aboard the **Space Shuttle** *Discovery* to low-Earth **orbit**. The school bus-sized observatory has been circling the globe ever since, 568 kilometres above our heads. It travels at about 27,000 kilometres per hour. It completes one orbit in 97 minutes.

How Hubble works

Like any telescope, Hubble has a long tube that is open at one end to let in light. As well, it has mirrors to focus the light. Its primary mirror is 2.4 metres across. It needs to be large to collect as much light as possible to see faint objects in space.

Celestial objects emit light in a wide variety of wavelengths, from ultraviolet (UV) through visible to near infrared. Hubble can detect all these wavelengths. The incoming light bounces off the primary mirror to a secondary mirror and eventually to a focal point – Hubble's "eye." Scientific instruments turn this light into digital signals that are stored in onboard computers and transmitted to Earth. The signals are then transformed into amazing images.

In some cases Hubble captures a 'snapshot.' In others, it captures light coming from thousands of **galaxies**. This 'deep field' view lets scientists probe the distant

Definitions

celestial: of or relating to the sky
chaotic: happening in a confused way and without order
galaxy: a collection of star systems
NASA: National Aeronautics and Space Administration – an independent agency of the U.S. government responsible for aviation and spaceflight
orbit: the path taken by an object moving around a larger object in space
space shuttle: a partially reusable low Earth orbital spacecraft system that NASA operated from 1981 to 2011

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universe's mysteries. Hubble's deepest, widest view of the universe took over 250 days of telescope time. It was stitched together from nearly 7500 individual exposures.

Amazing discoveries

Hubble casts its gaze both near and far. It has revealed new details about the solar system around our Sun. But it can also detect faint light from galaxies trillions of kilometres away.

Distances in space are vast. So it takes the light a long time to reach Hubble. When it snaps a picture of a galaxy 100 million light years away, it shows the galaxy as it looked 100 million years ago. Hubble is not only seeing through vast distances, it is seeing far back in time.

This gives excited astronomers a ringside seat to the evolution of galaxies and stars. We see stars coming to life in the glowing gas of a **nebula**. We see galaxies collide with other galaxies.

Dying stars collapse inward, leaving behind dense **neutron stars** or **black holes**. Or they expand, shedding outer layers. Some explode in **supernovas**.

Thanks to Hubble, scientists have pinned down the age of the universe. It is about 13.8 billion years old. They've learned it has at least 100 billion galaxies.

Another revelation? There are thousands of **exoplanets** orbiting stars in space. Hubble has even analyzed a few and found water vapour on them. The data could help in our search for extraterrestrial life.

The dark side

Hubble taught us that black holes exist. Black holes are fascinating. They suck in everything around them, including light. We've learned that supermassive black holes are common in the dense core of galaxies.

Then there's dark matter. This odd material radiates no light. Yet its gravity holds galaxies and galaxy clusters together.

Perhaps the biggest surprise is dark energy. Scientists once thought that the universe started slowing down after the **Big Bang**. But Hubble has shown us distant supernovas. From their light, we've learned that distant galaxies are flying away from ours at ever higher speeds.

That can only mean that a mysterious force works against gravity and contributes to this expansion. Scientists call this anti-gravity force "dark energy."

Dark energy makes up about 68 percent of everything in the universe. The objects that we can see, such as galaxies? Just five percent. Dark matter accounts for the remaining 27 percent.

Did you know?

NASA is working on two new telescopes, the James Webb Space Telescope and the Wide Field Infrared Survey Telescope.

The view is fine!

Hubble is a window into the **enigmas** of deep space. It has helped redefine our universe. It has answered questions that plagued astronomers for decades. It is revealing strange new mysteries. It's a handy tool!

In 30 years, it has captured more than 1.4 million pictures. It has been upgraded five times and is still going strong. But no more upgrades are planned. Hubble will eventually crash to Earth.

Until then, enjoy the light show. ★

Definitions

BIG BANG: the cosmic explosion that is hypothesized to have marked the origin of the universe
BLACK HOLE a region of space resulting from the collapse of a star; extremely high gravitational field
ENIGMA: something mysterious and difficult to understand
EXOPLANET: a planet that orbits a star outside the solar system
NEBULA: a very large cloud of dust and gas in outer space
NEUTRON STAR: a dense celestial object that consists mainly of closely packed neutrons and that results from the collapse of a much larger star
SUPERNOVA: an exploding star that produces an extremely bright light

THE HUBBLE TELESCOPE

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ON THE LINES

Answer the following in complete sentences:

1. What are telescopes used for?

2. Who built the first space telescope?

3. What problem do ground-based telescopes have when observing space?

4. When and how was the first space-based telescope launched into space?

5. Explain how this telescope captures light emitted by distant objects.

6. Explain why some images from the Hubble telescope are reflections of the distant past.

7. What has Hubble revealed about the expansion of the universe?

8. List at least two other important discoveries that Hubble has helped astronomers find.