The Hubble Space Telescope

- Agencies: NASA, ESA, & STScI
- Launch: April 24, 1990
- Size: 43.5 ft x 14 ft x 40 ft
- Weight: 24,500 pounds
- Ritchey-Chretien Cassegrain
- Primary Mirror: 94.5” diameter

Primary Mirror Problem
A flaw in the telescope’s primary mirror caused the light focus at different places, causing a halo to appear around objects.

COSTAR and Tiny Tim
To solve the problems with the telescope’s mirror, COSTAR was installed in December 1993. This arrangement of five mirrors bent the light rays to focus at the same place. COSTAR was removed in 2009.

How good is Hubble?
We can measure how good a telescope is by using the Rayleigh Criterion. It gives the angle needed between two light sources (or stars in this case) for the two sources to be seen as separate objects. For telescopes, this is given by:

$$\theta = \frac{1.22\lambda}{D}$$

where $\theta$ is the angle (in radians) between the two stars, $\lambda$ is the wavelength of the light, and $D$ is the diameter of the primary mirror.

For the Hubble Space Telescope (with COSTAR), this angle is 0.05 arcseconds. An Earth-bound telescope has a resolution of about 1 arcsecond under optimal conditions.

Background
There are two types of optical telescopes: refracting telescopes (uses lenses) and reflecting telescopes (uses mirrors). Refracting telescopes can be affected by chromatic aberration (where light of different wavelengths focus at different locations). This does not happen in reflecting telescopes.

Observations from Earth-based telescopes are often impeded by clouds, light pollution, and atmospheric seeing (unpredictable changes in the atmosphere that bend light going through it).

Diffraction patterns are created when a point light source (like a laser or star) illuminates a sharp edged object.

Over the past 29 years, the Hubble Space Telescope has observed known objects in higher detail and has been used to confirm theories (like the existence of black holes). It has also been used to research cosmology, dark matter, gravitational lensing, and cosmic expansion. The Hubble Space Telescope has also discovered so many space objects, especially through its deep field images.

Discoveries
- The Hubble Deep Field (spacetelescope.org)
- aXtreme Deep Field (nasa.gov)

The Hubble Space Telescope will stop functioning. The telescope slows altitude each year as well; eventually it will fall to Earth. However before that, the gyroscopes that are used to point the telescope will wear out.

However, in the future, the James Webb Space Telescope will be sent to space and the European Extra Large Telescope will use laser adaptive optics to counter astronomical seeing.

Acknowledgments
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*About the James Webb Space Telescope. *NASA, NASA (n/a/nasa.gov/about.html).
webteam@eso.org. "The European ELT." ESO, www.eso.org/sci/facilities/eelt/