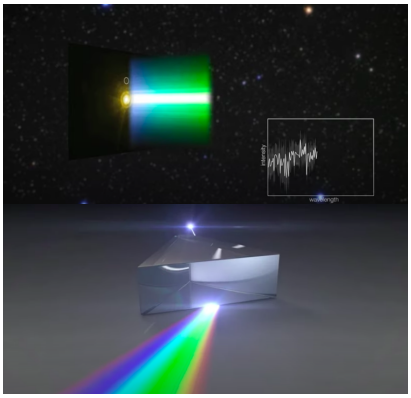
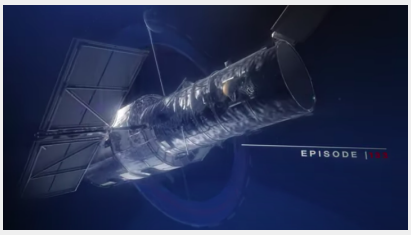
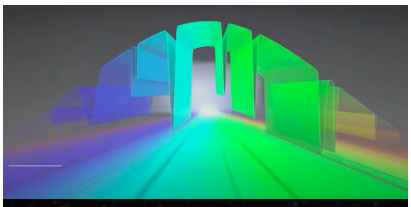
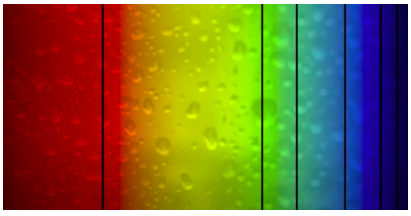
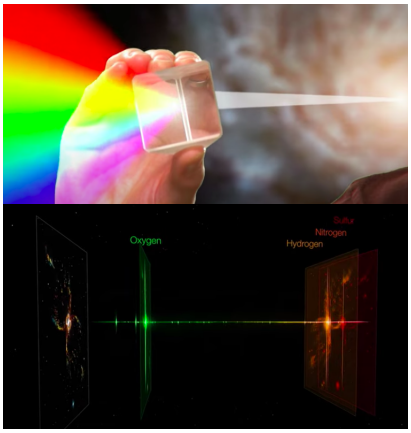
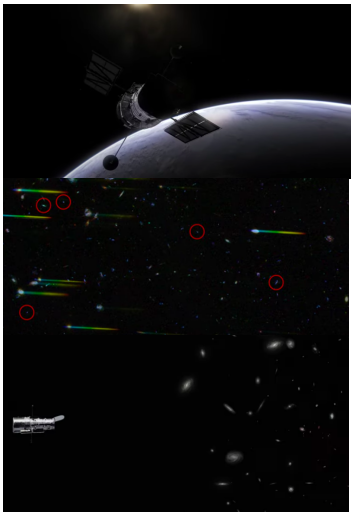
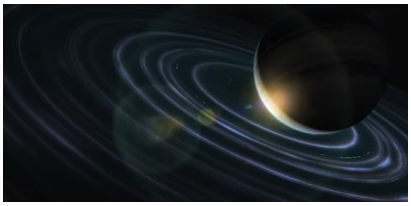
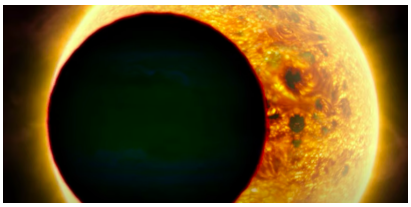
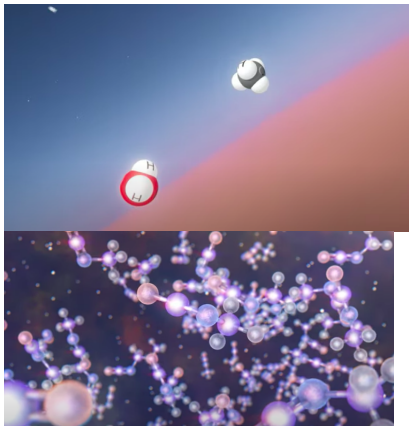
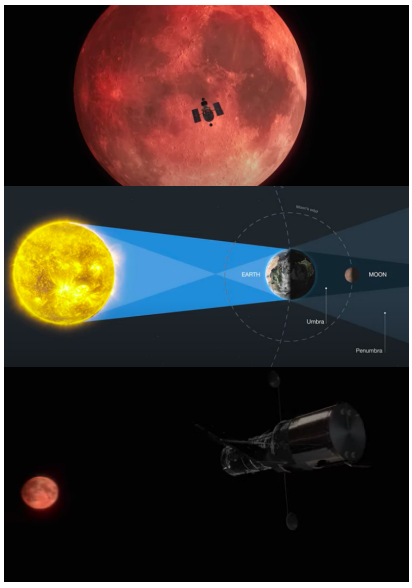
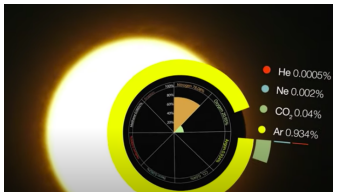
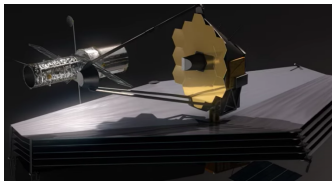
ESO, Karl-Schwarzschild-Str.2
D-85748 Garching bei München,
Germany
Telephone: +49 (0)89 3200 6855
Telefax: +49 (0)89 3200 6480
hubble@eso.org

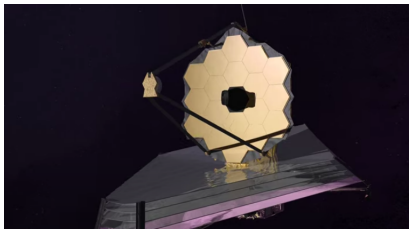
www.spacetelescope.org

| **Hubblecast 133: Spectroscopy with Hubble** | **Visual notes** |
|---|---|
| **0:00-0:32**<br>How does spectroscopy work and what can the study of light tell us about the Universe? How are astronomers using spectroscopy to study exoplanets in the search for life?<br><br>This Hubblecast will explore how spectroscopy works and how it facilitates valuable research with the NASA/ESA Hubble Space Telescope, including innovative research in the study of exoplanets. |  |
| **0:33-0:44**<br>Intro |  |

| | |
|---|---|
| **0:45-0:55**<br>While images of the Universe excite and inspire the public, spectroscopy is a fundamental tool that astronomers use to study the Universe. |  |
| **0:56-1:12**<br>Hubble's spectrographs provide scientists with the data they need to analyse the materials that make up stars, nebulae, galaxies and the atmospheres of planets. |  |
| **1:13-1:32**<br>Hubble is equipped with two spectrographs: the Space Telescope Imaging Spectrograph, which was installed on the telescope in 1997, and the Cosmic Origins Spectrograph, which was installed in 2009. |  |
| **1:33-1:47**<br>Any object that absorbs or emits light can be studied with a spectrograph to determine characteristics such as its temperature, density, chemical composition, and velocity. |  |
| **1:48-2:07**<br>Once the light enters the spectrograph it is split by a dispersive optical element into its different components (or wavelengths) in order to be studied. This element acts much like rain droplets that disperse the light to form a rainbow. |  |
| **2:08-2:15**<br>This dispersed light is then focused onto a detector and it is seen as a spectrum. |  |

| | |
|---|---|
| **2:16-2:43**<br>The spectrum's pattern can be analysed by astronomers to decipher what atoms and molecules are present in the source. This helps them to understand the various physical and chemical characteristics of the sources.<br><br>In this way, Hubble's images tell us what something looks like, while the spectrum data tell us what it is and what it's made of. |  |
| **2:44-3:08**<br>Ultraviolet spectroscopy is one of Hubble's most significant contributions to astronomy. Positioned in orbit around the Earth, Hubble is not obstructed by Earth's atmosphere, which absorbs ultraviolet light. The telescope is also equipped with detectors sensitive to ultraviolet light. |  |
| **3:09-3:35**<br>Spectroscopy has been the foundation of many key Hubble discoveries. For example, Hubble has recorded a black hole's signature, and its spectroscopic observations fingerprinted the distant Universe using the light from quasars to allow astronomers to probe the raw materials from which galaxies form. | |
| **3:36-4:15**<br>Spectroscopy has also become an essential tool for Hubble's study of exoplanets. This is significant because when Hubble was launched, planets beyond our own Solar System had not yet been discovered. Using its spectrographs, Hubble has provided the first direct detection of the atmosphere of a planet orbiting a star outside our Solar System and has detected organic molecules in the atmosphere of a planet orbiting another star. |  |
| **4:16-4:45**<br>In this way, the spectroscopy of the atmospheres of what are known as transiting exoplanets was pioneered by Hubble astronomers. The exoplanets are studied as they pass in front of their host star, as seen from Earth, when chemicals in their atmospheres leave their telltale signature in the spectra by filtering out certain wavelengths of starlight. |  |

| | |
|---|---|
| **4:46-5:27**<br>In the search for signs of life, astronomers are looking for specific spectroscopic signatures. Each chemical element in the atmosphere of an exoplanet blocks light from the star at specific wavelengths — creating absorption lines in the spectrum of the star. This is how astronomers can identify the presence of specific atoms and molecules — some of those being key prerequisites for life, such as methane, water, oxygen, ozone, and others. |  |
| **5:27-5:49**<br>For example, during the lunar eclipse of January 2019, astronomers used Hubble for a special spectroscopic experiment that tested how they will observe Earth-like planets around other stars in the search for life in the future. |  |
| **5:50-6:15**<br>Our planet's perfect alignment with the Sun and Moon during a total lunar eclipse mimics the geometry of a transiting terrestrial planet with its star. In this innovative study, Hubble used the Moon as a mirror that reflects the sunlight that has been filtered through Earth's atmosphere. | |
| **6:16-6:31**<br>Spectroscopic observations of this light were able to detect the fingerprint of ozone in Earth's atmosphere, a key prerequisite for the presence – and possible evolution – of life as we know it on an exo-Earth. | |
| **6:32-6:53**<br>To date, astronomers have used Hubble to observe the atmospheres of gas giant planets that transit their stars. But terrestrial planets are much smaller objects and their atmospheres are thinner. Therefore, analysing these signatures is much harder. |  |
| **6:54-7:14**<br>That's why researchers will need space telescopes much larger than Hubble to collect the feeble signal as the starlight passes through these small planets' atmospheres during a transit. A larger telescope collecting area will allow for effective detection of these faint signals. |  |

| | |
|---|---|
| **7:15-7:47**<br>The upcoming NASA/ESA/CSA James Webb Space Telescope will be able to penetrate deep into an exoplanet's atmosphere to detect methane and oxygen if they exist there. Not only will the new observatory support spectroscopic observations of exoplanets, but it will also pioneer new spectroscopy research in all areas of astronomy. |  |

**Ends: 7:49**