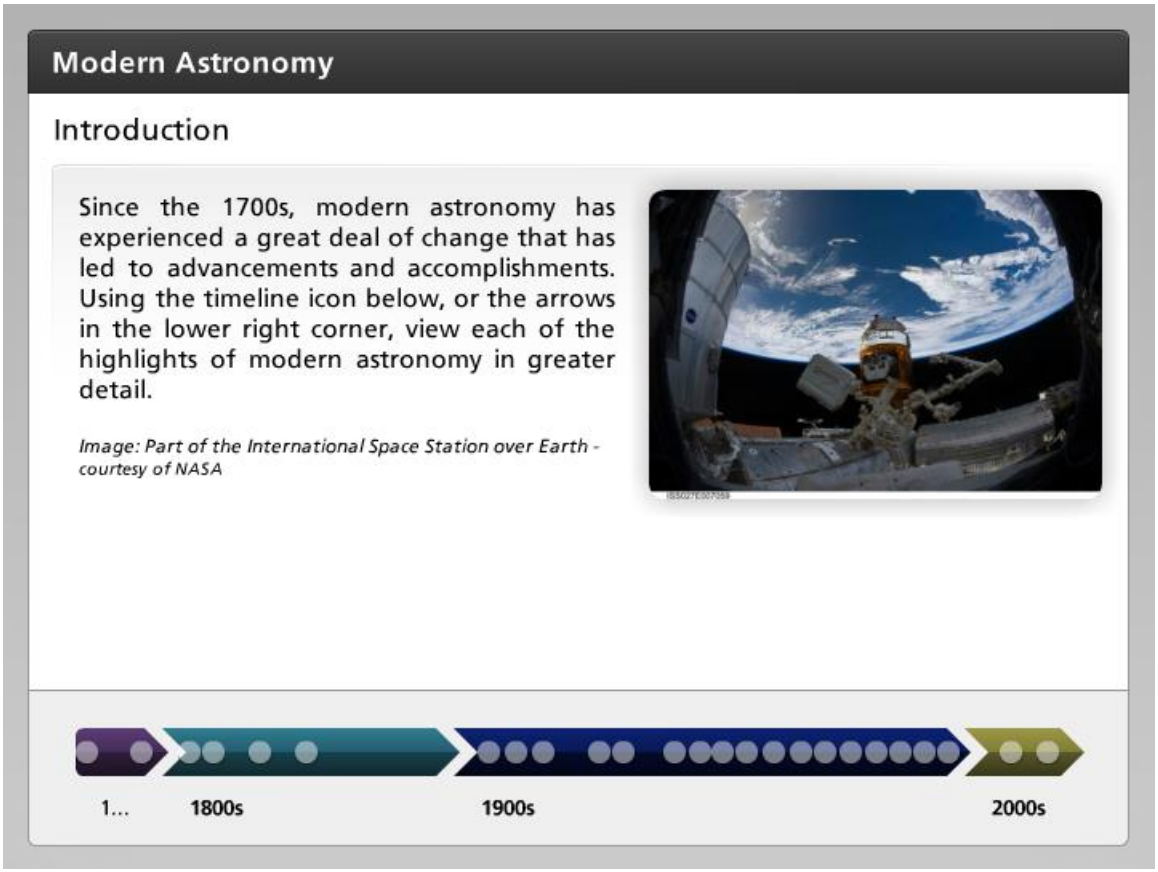
# Module 3: Astronomy – The Universe
## Topic 7 Content: Modern Astronomy Notes

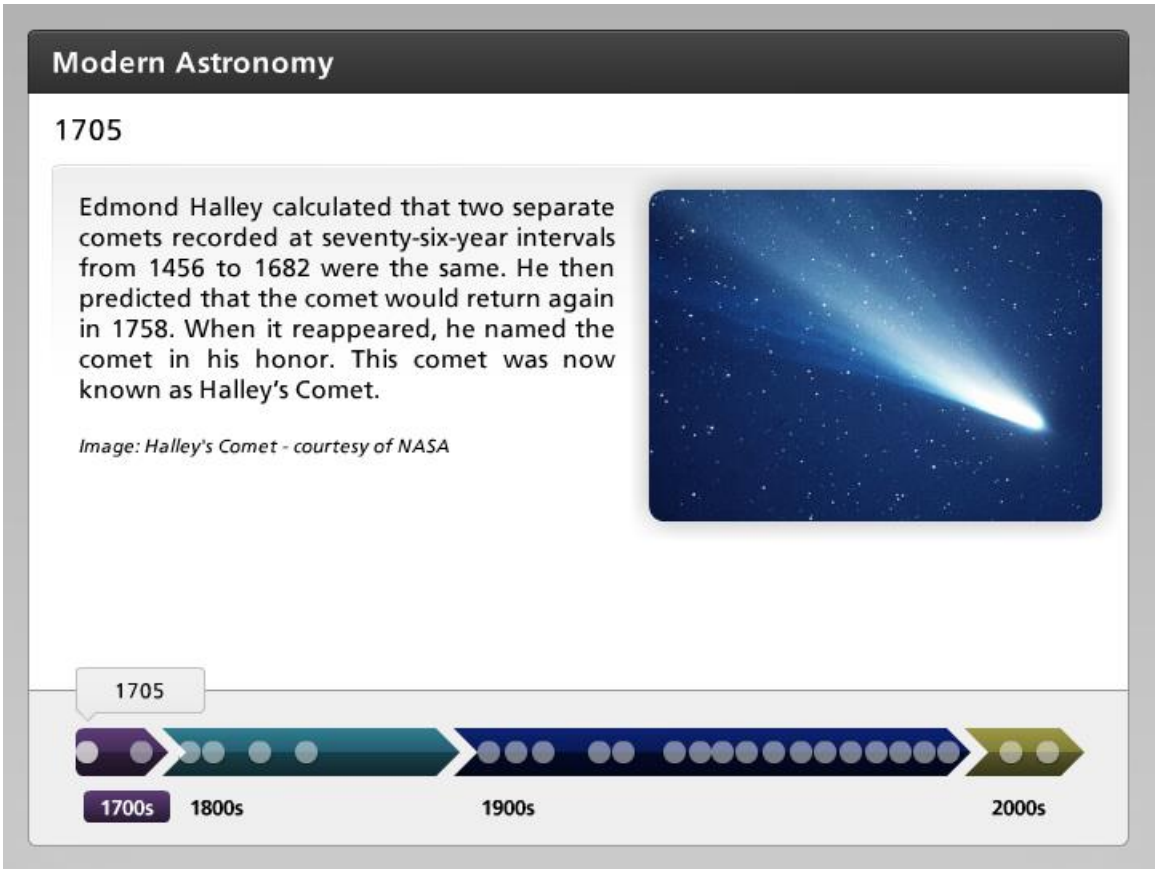
### Introduction




Since the 1700s, modern astronomy has experienced a great deal of change that has led to advancements and accomplishments. Using the timeline icon below, or the arrows in the lower right corner, view each of the highlights of modern astronomy in greater detail.

*Image: Part of the International Space Station over Earth - courtesy of NASA*

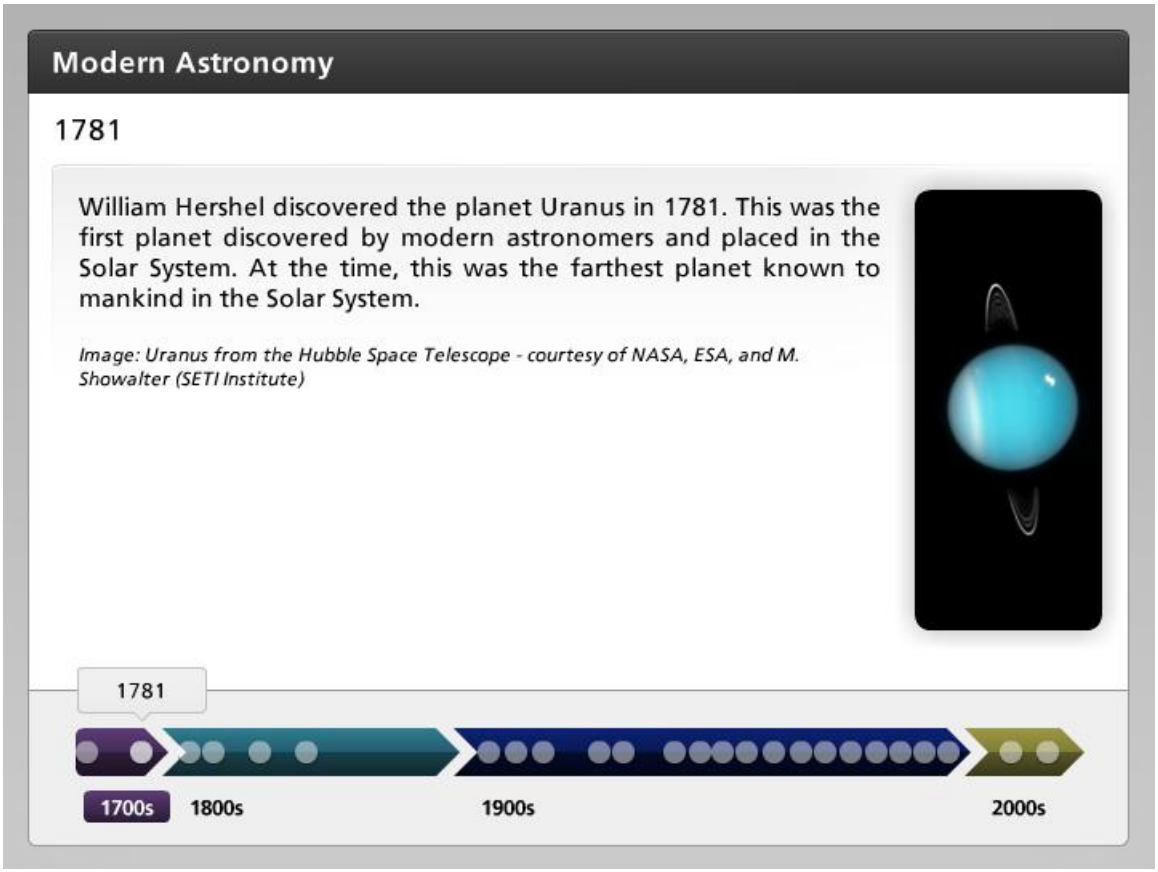
## 1705




Edmond Halley calculated that two separate comets recorded at seventy-six-year intervals from 1456 to 1682 were the same. He then predicted that the comet would return again in 1758. When it reappeared, he named the comet in his honor. This comet was now known as Halley's Comet.

*Image: Halley's Comet - courtesy of NASA*

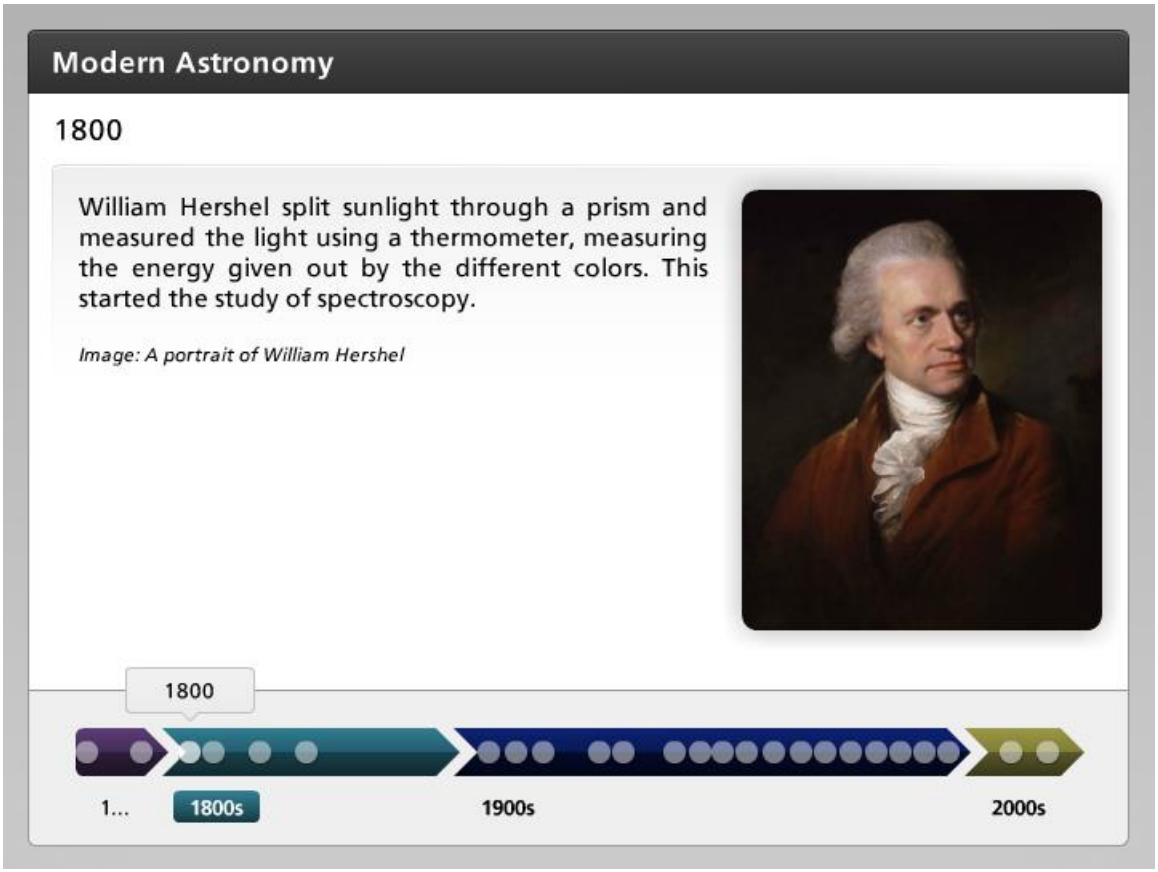
## 1781




William Hershel discovered the planet Uranus in 1781. This was the first planet discovered by modern astronomers and placed in the Solar System. At the time, this was the farthest planet known to mankind in the Solar System.

*Image: Uranus from the Hubble Space Telescope - courtesy of NASA, ESA, and M. Showalter (SETI Institute)*

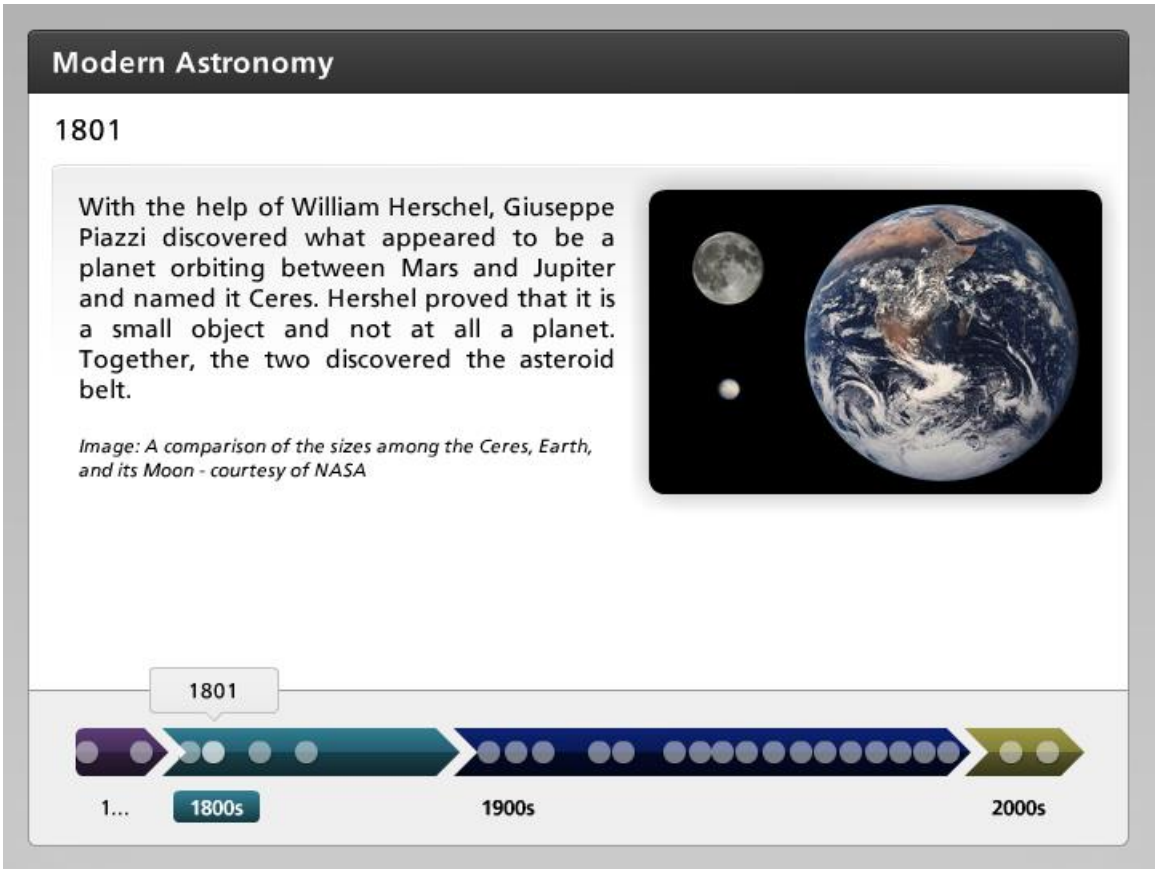
## 1800




William Hershel split sunlight through a prism and measured the light using a thermometer, measuring the energy given out by the different colors. This started the study of spectroscopy.

*Image: A portrait of William Hershel*

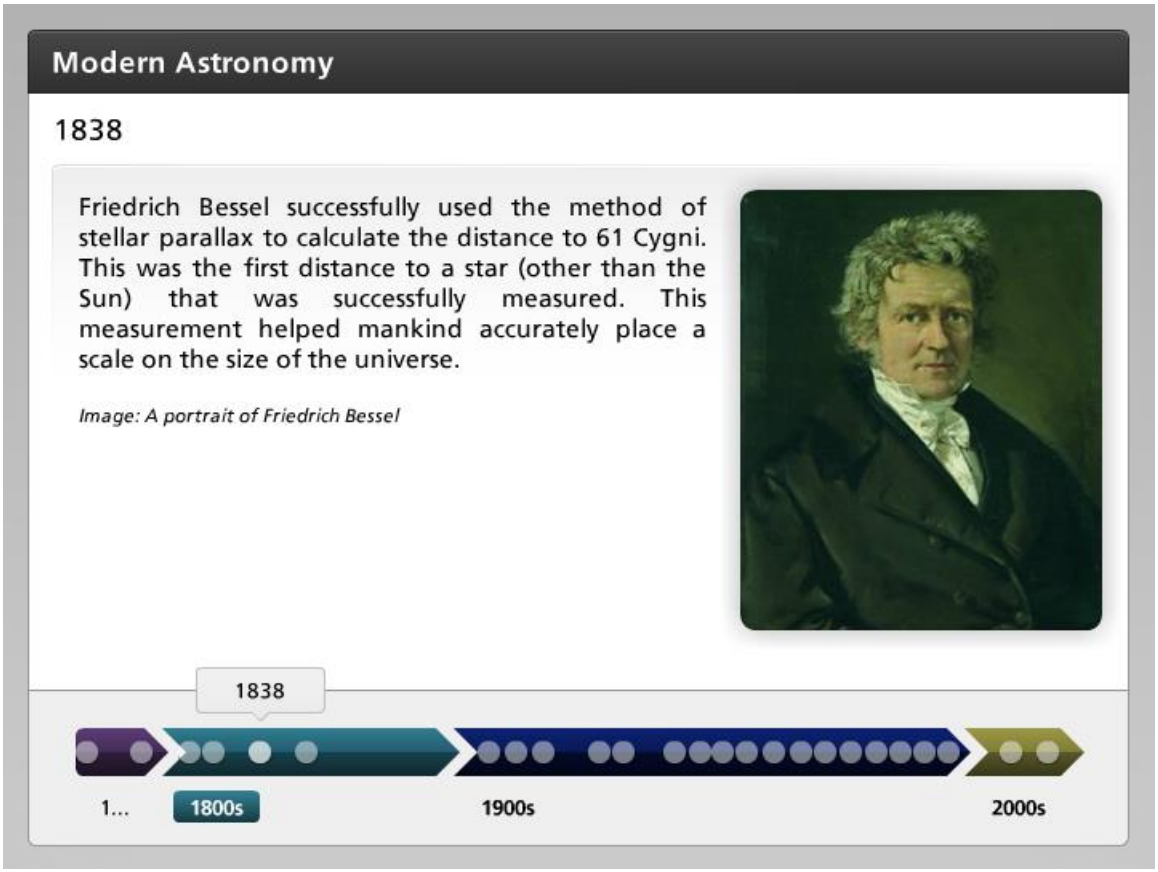
## 1801




With the help of William Herschel, Giuseppe Piazzi discovered what appeared to be a planet orbiting between Mars and Jupiter and named it Ceres. Hershel proved that it is a small object and not at all a planet. Together, the two discovered the asteroid belt.

*Image: A comparison of the sizes among the Ceres, Earth, and its Moon - courtesy of NASA*

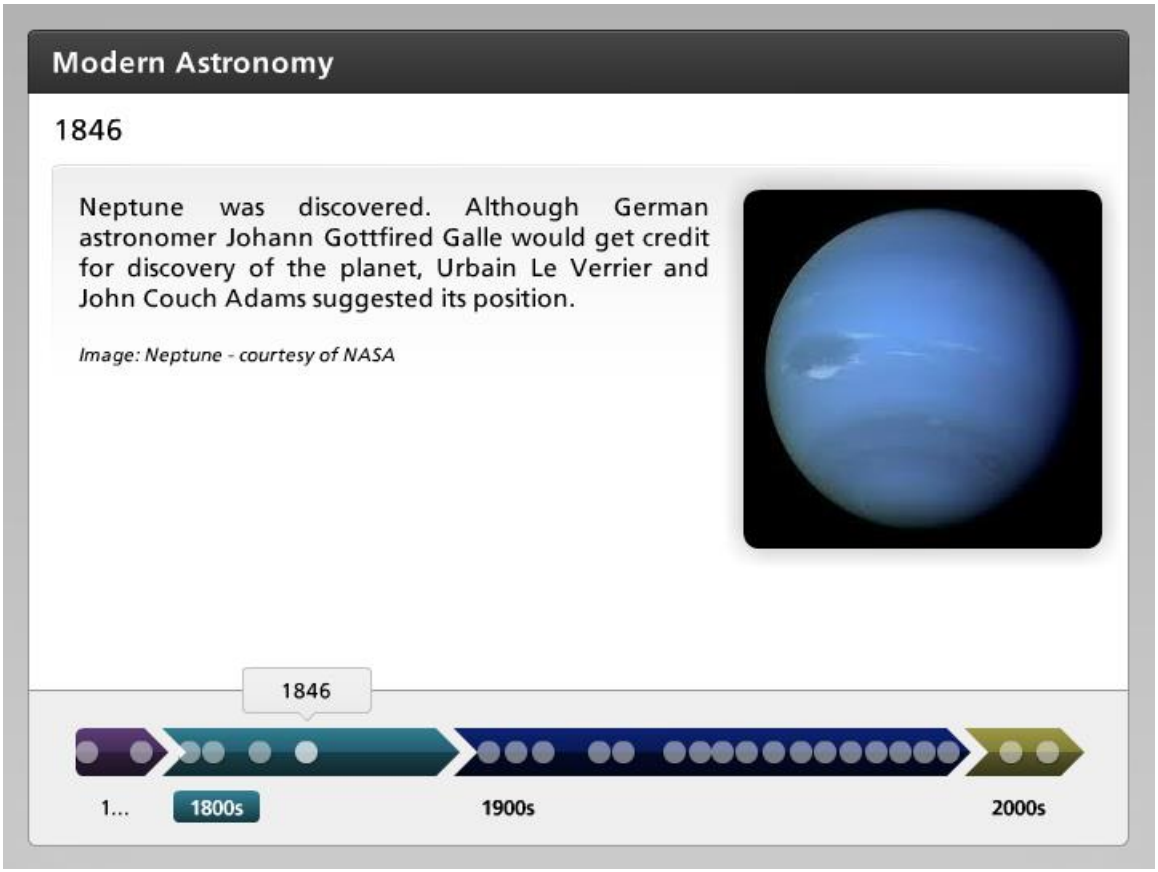
**1838**




Friedrich Bessel successfully used the method of stellar parallax to calculate the distance to 61 Cygni. This was the first distance to a star (other than the Sun) that was successfully measured. This measurement helped mankind accurately place a scale on the size of the universe.

*Image: A portrait of Friedrich Bessel*

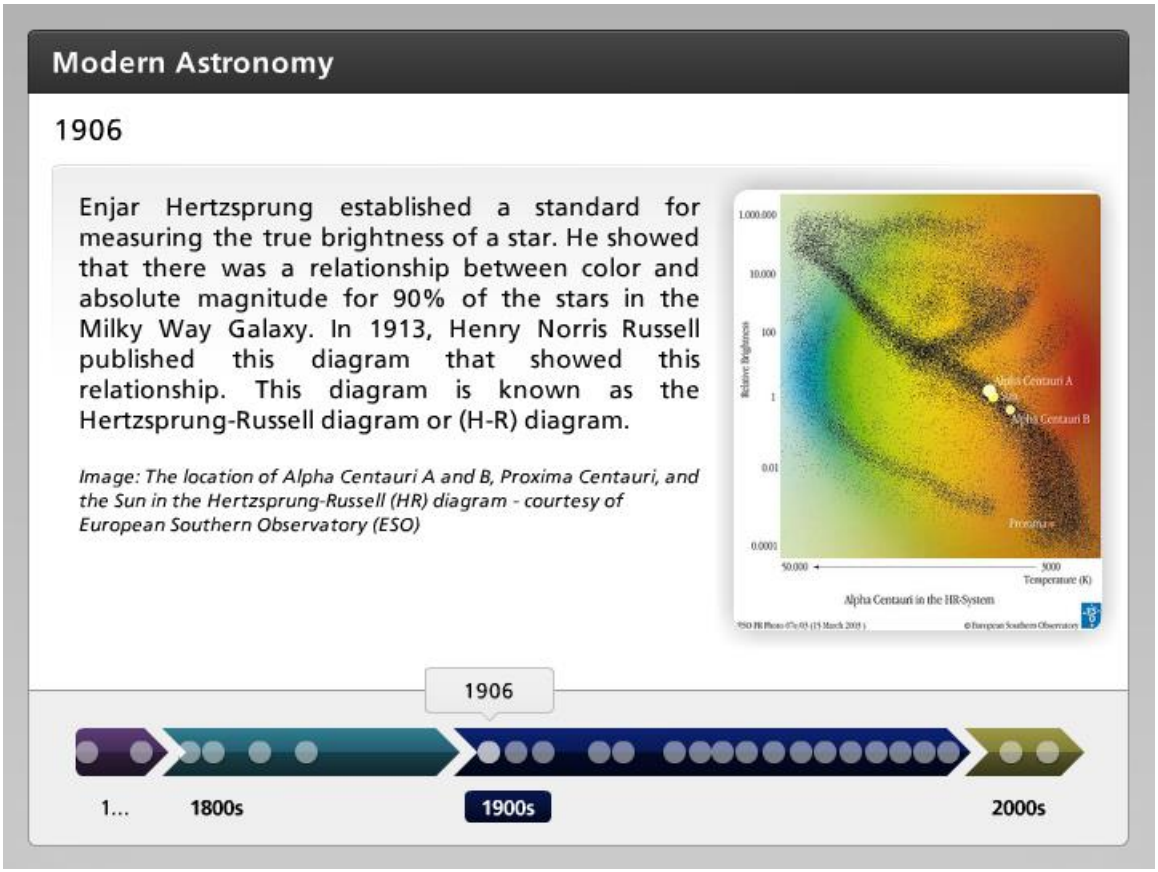
## 1846




Neptune was discovered. Although German astronomer Johann Gottfired Galle would get credit for discovery of the planet, Urbain Le Verrier and John Couch Adams suggested its position.

*Image: Neptune - courtesy of NASA*

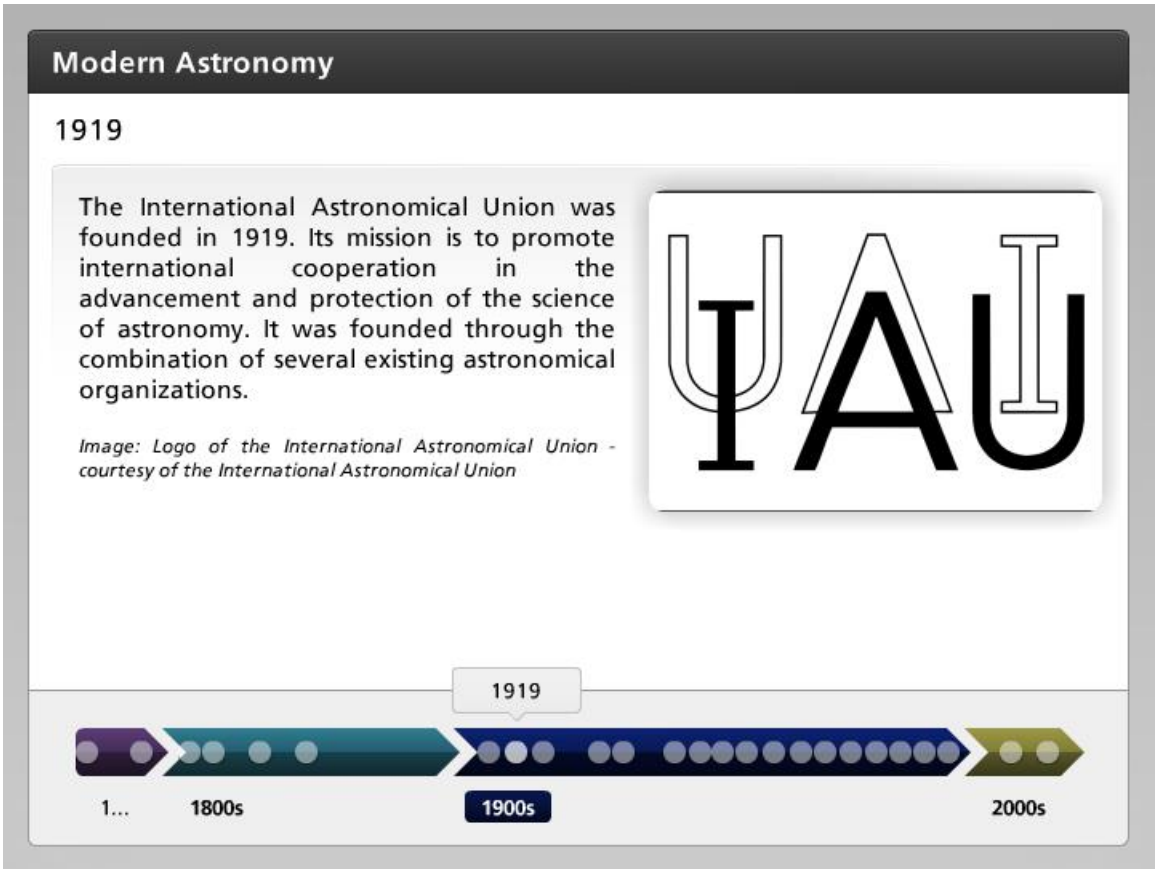
## 1906




Enjar Hertzsprung established a standard for measuring the true brightness of a star. He showed that there was a relationship between color and absolute magnitude for 90% of the stars in the Milky Way Galaxy. In 1913, Henry Norris Russell published this diagram that showed this relationship. This diagram is known as the Hertzsprung-Russell diagram or (H-R) diagram.

*Image: The location of Alpha Centauri A and B, Proxima Centauri, and the Sun in the Hertzsprung-Russell (HR) diagram - courtesy of European Southern Observatory (ESO)*

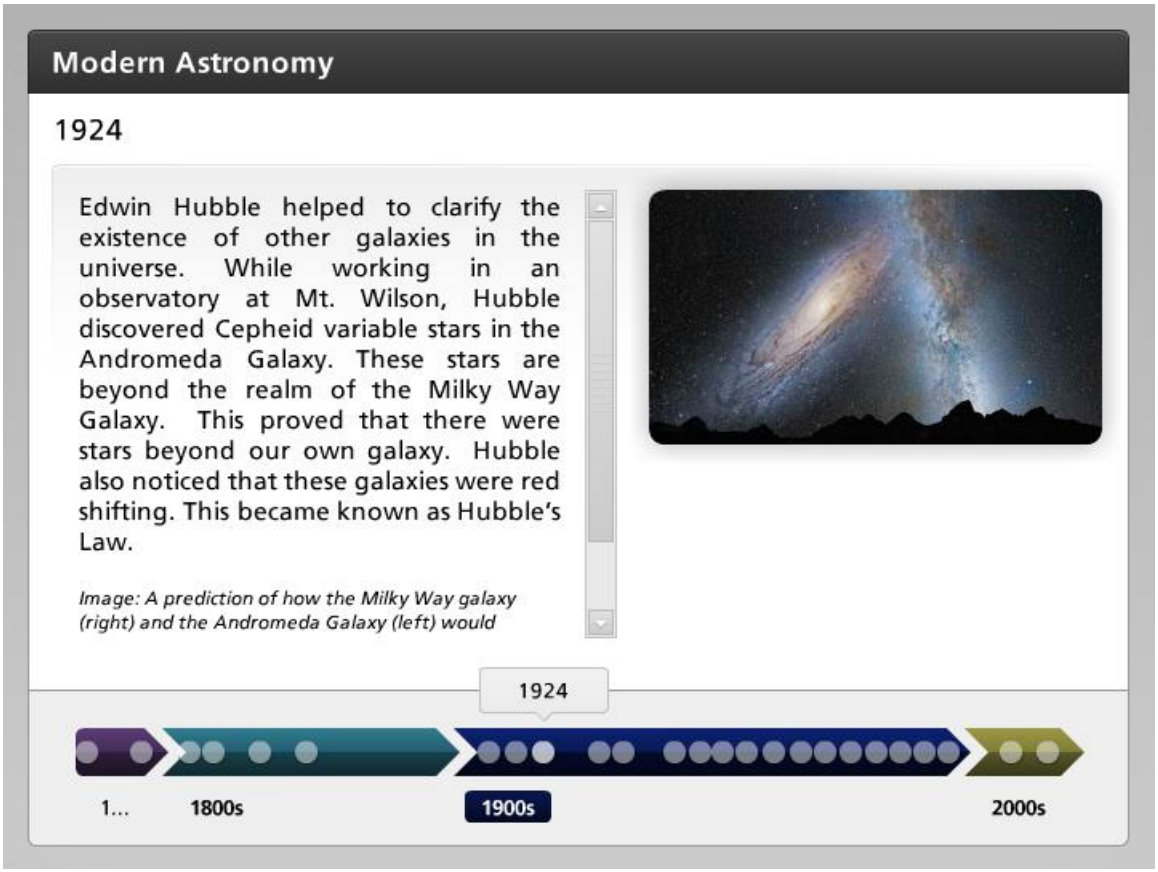
**1919**




The International Astronomical Union was founded in 1919. Its mission is to promote international cooperation in the advancement and protection of the science of astronomy. It was founded through the combination of several existing astronomical organizations.

*Image: Logo of the International Astronomical Union - courtesy of the International Astronomical Union*

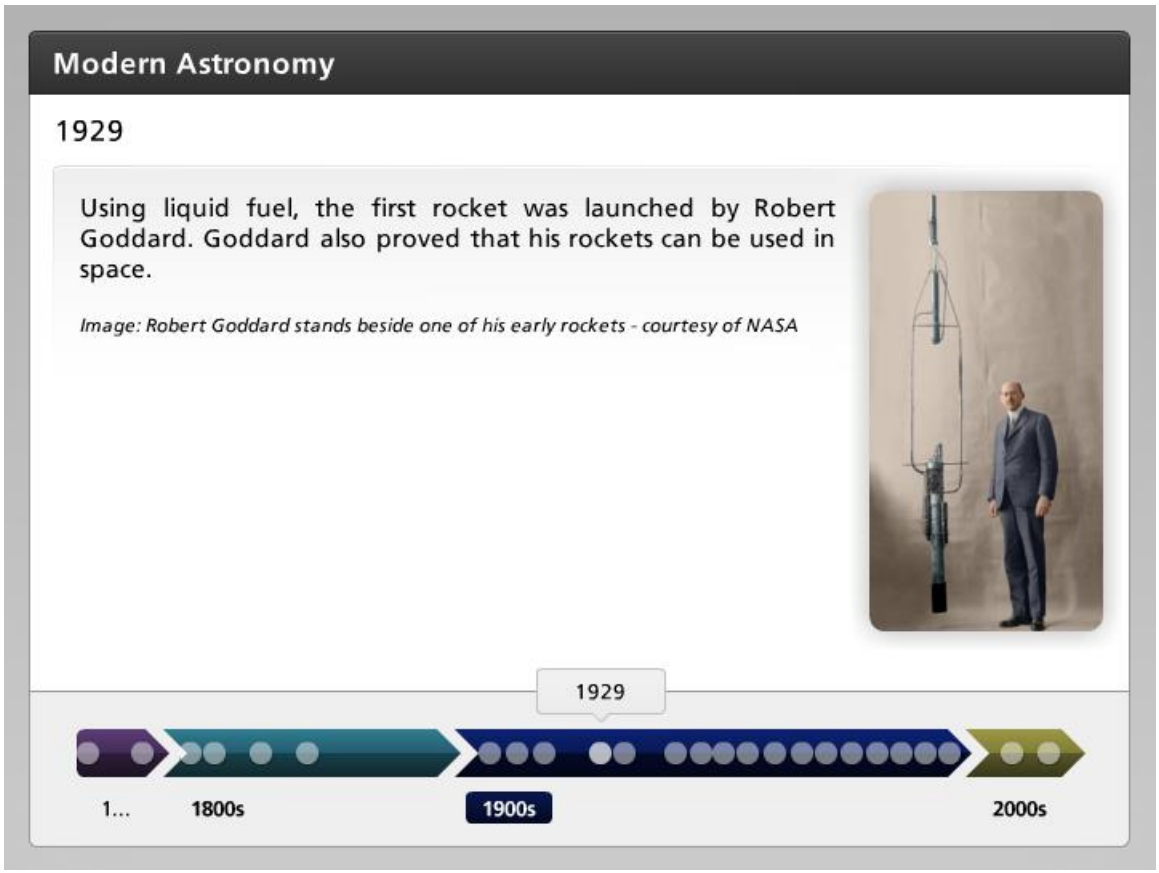
**1924**




Edwin Hubble helped to clarify the existence of other galaxies in the universe. While working in an observatory at Mt. Wilson, Hubble discovered Cepheid variable stars in the Andromeda Galaxy. These stars are beyond the realm of the Milky Way Galaxy. This proved that there were stars beyond our own galaxy. Hubble also noticed that these galaxies were red shifting. This became known as Hubble's Law.

*Image: A prediction of how the Milky Way galaxy (right) and the Andromeda Galaxy (left) would eventual merge in 3.75 billion years due to the red shifting of the two galaxies - courtesy of NASA; ESA; Z. Levay and R. van der Marel, STScI; T. Hallas; and A. Mellinger*

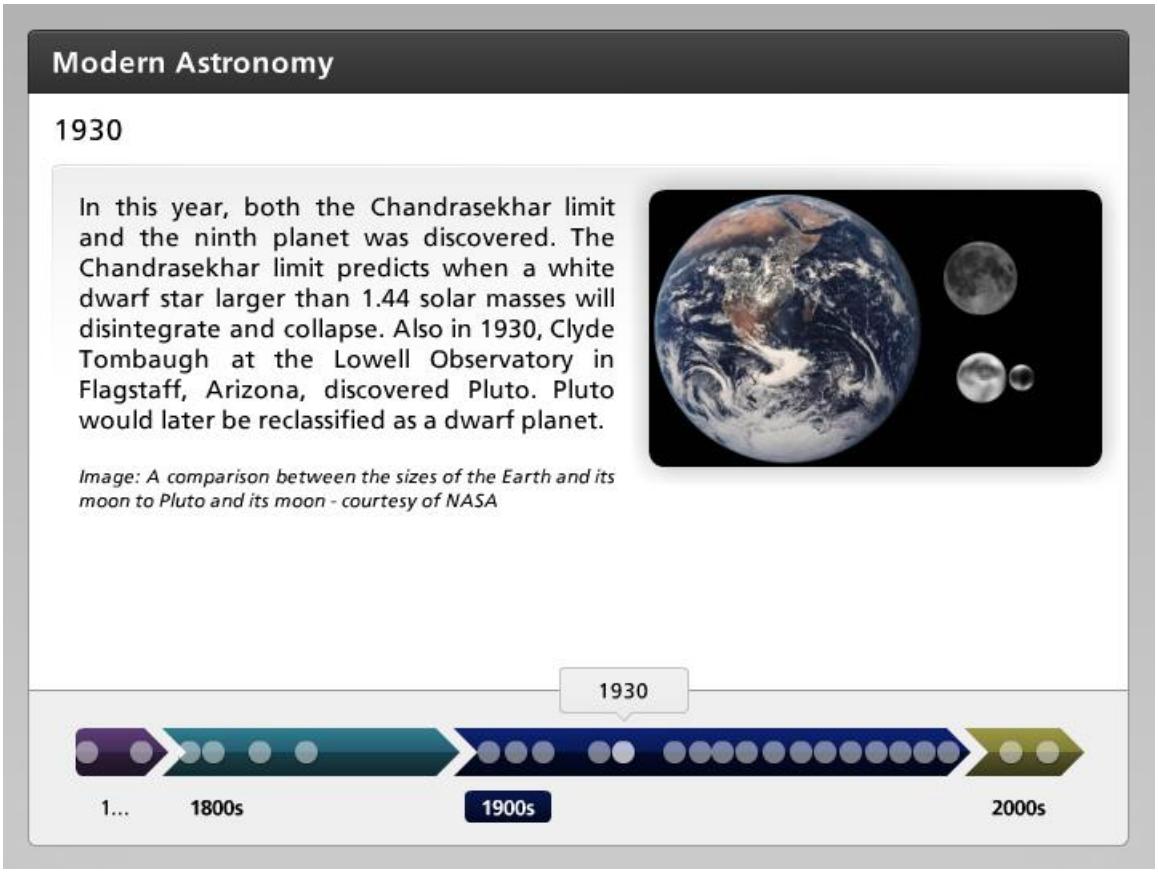
## 1929




Using liquid fuel, the first rocket was launched by Robert Goddard. Goddard also proved that his rockets can be used in space.

*Image: Robert Goddard stands beside one of his early rockets - courtesy of NASA*

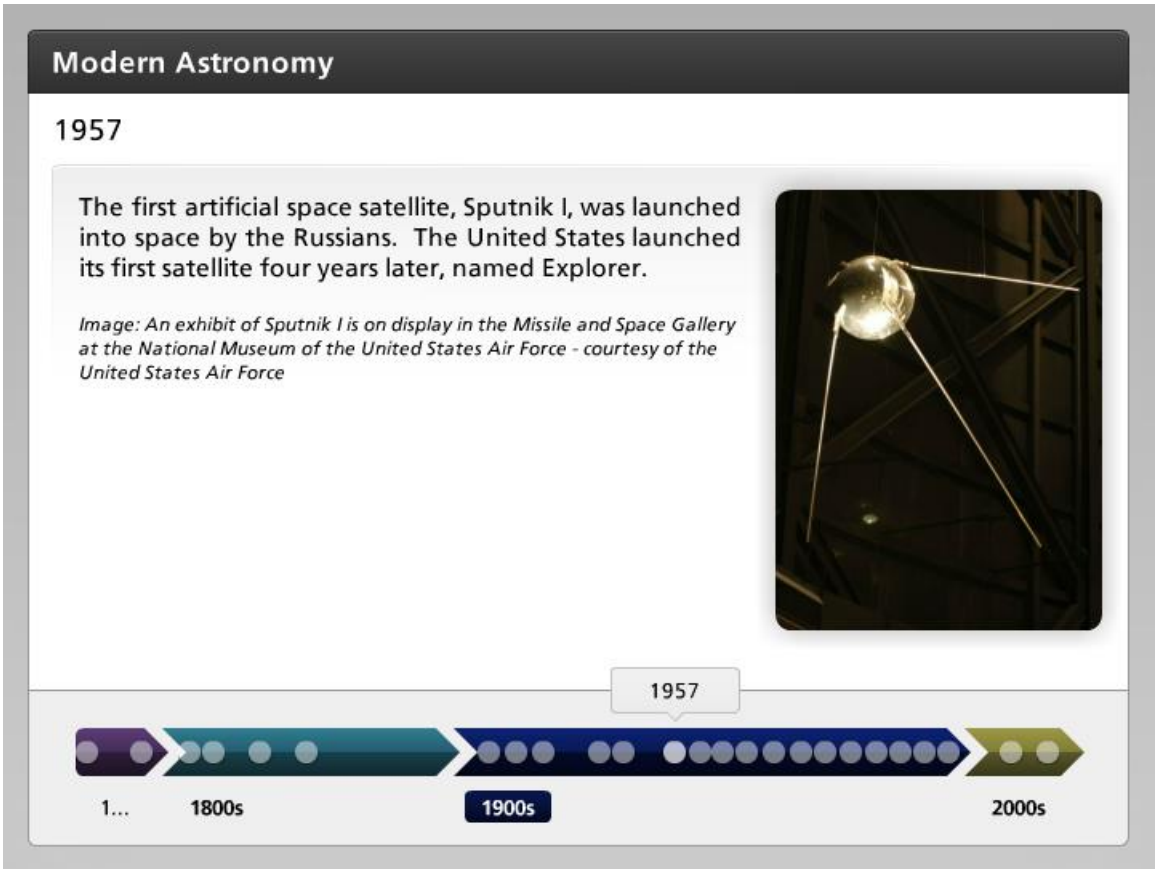
## 1930




In this year, both the Chandrasekhar limit and the ninth planet were discovered. The Chandrasekhar limit predicts when a white dwarf star larger than 1.44 solar masses will disintegrate and collapse. Also in 1930, Clyde Tombaugh at the Lowell Observatory in Flagstaff, Arizona, discovered Pluto. Pluto would later be reclassified as a dwarf planet.

*Image: A comparison between the sizes of the Earth and its moon to Pluto and its moon - courtesy of NASA*

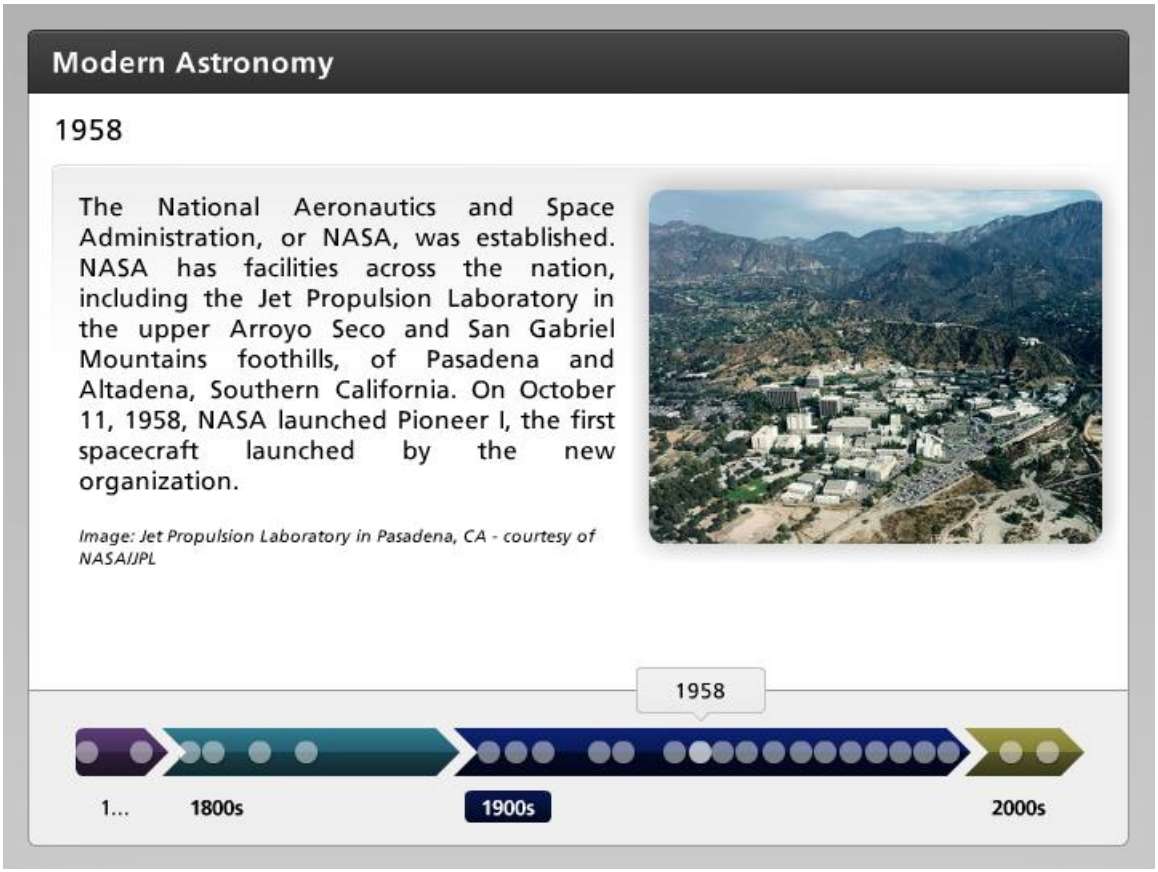
## 1957




The first artificial space satellite, Sputnik I, was launched into space by the Russians. The United States launched its first satellite four years later, named Explorer.

*Image: An exhibit of Sputnik I is on display in the Missile and Space Gallery at the National Museum of the United States Air Force - courtesy of the United States Air Force*

## 1958




The National Aeronautics and Space Administration, or NASA, was established. NASA has facilities across the nation, including the Jet Propulsion Laboratory in the upper Arroyo Seco and San Gabriel Mountains foothills, of Pasadena and Altadena, Southern California. On October 11, 1958, NASA launched Pioneer I, the first spacecraft launched by the new organization.

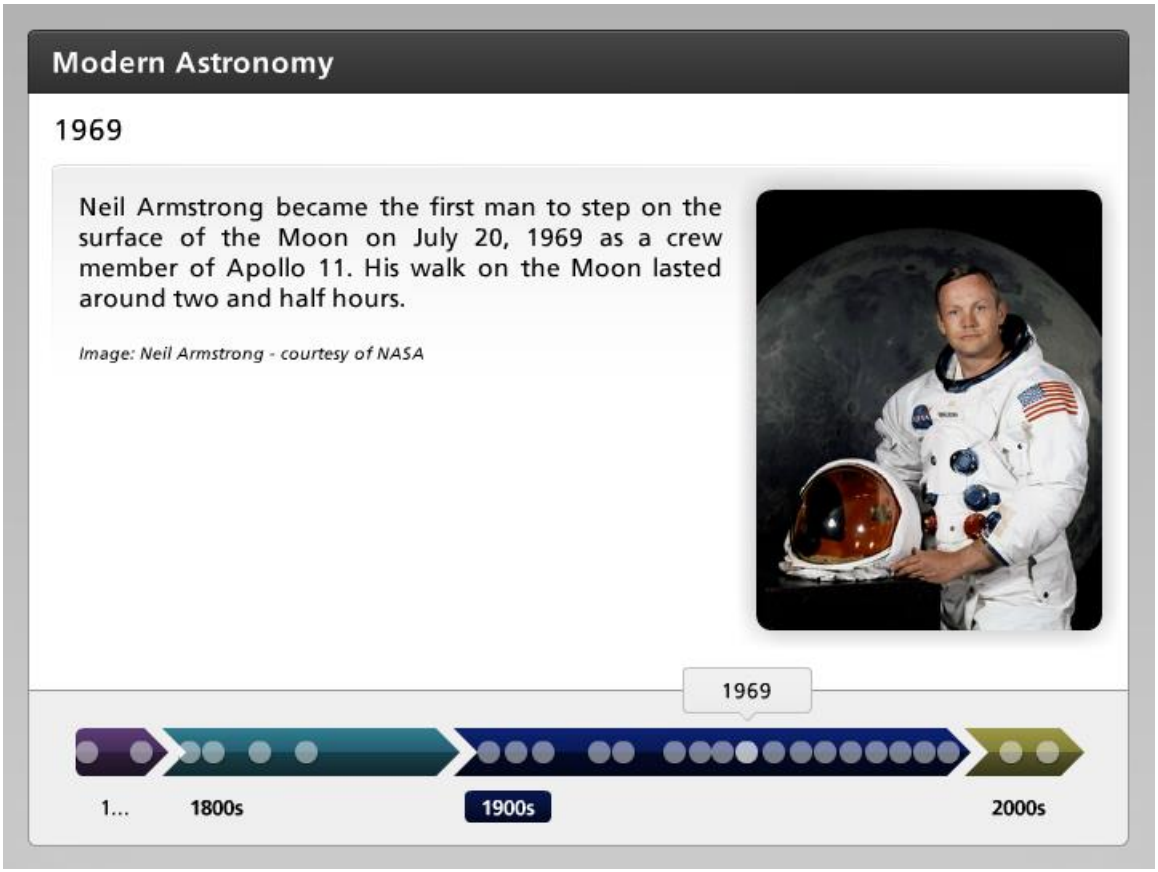
*Image: Jet Propulsion Laboratory in Pasadena, CA - courtesy of NASA/JPL*

## 1961


Russian Yuri Gagarin became the first person to orbit Earth. Astronaut Alan Shepard became the first American into space. The United States launched Explorer I, its first space satellite.

*Image: Alan Shepard - courtesy of NASA*

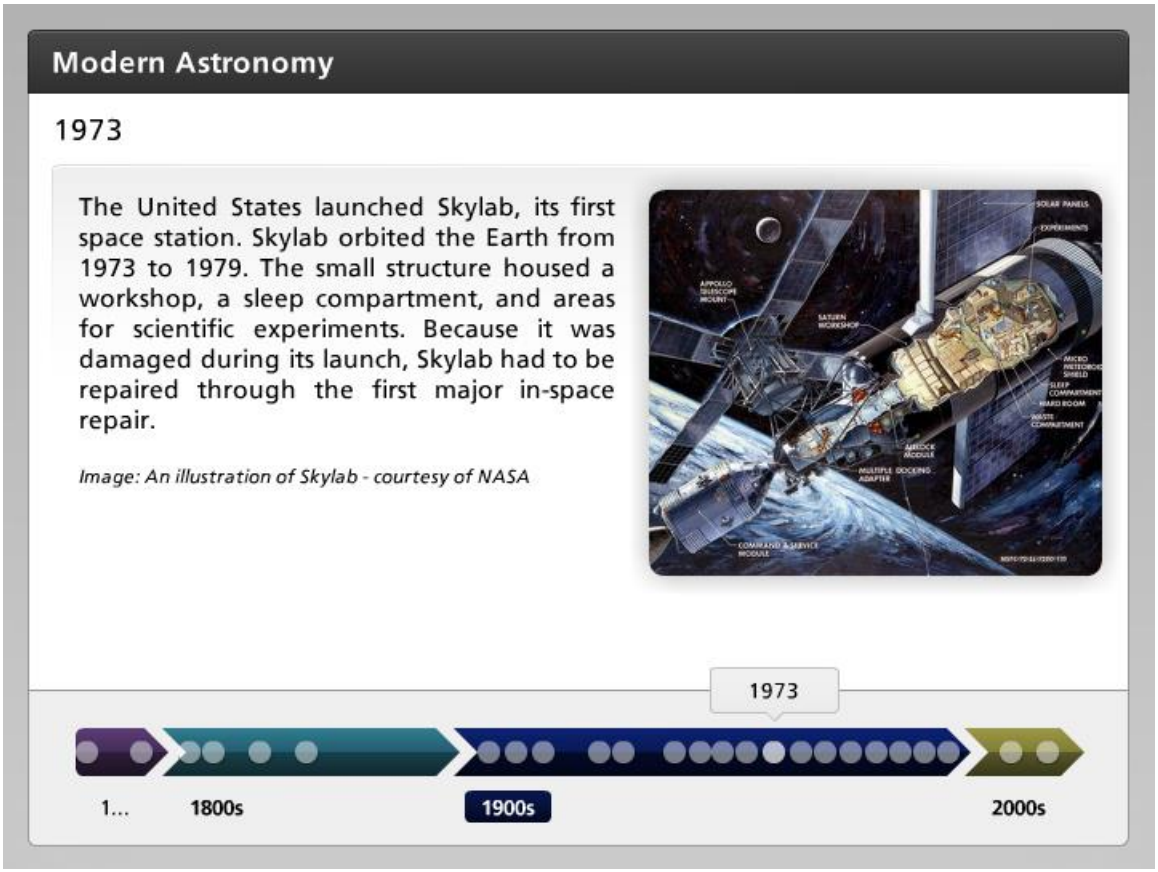
## 1969




Neil Armstrong became the first man to step on the surface of the Moon on July 20, 1969 as a crew member of Apollo 11. His walk on the Moon lasted around two and half hours.

*Image: Neil Armstrong - courtesy of NASA*

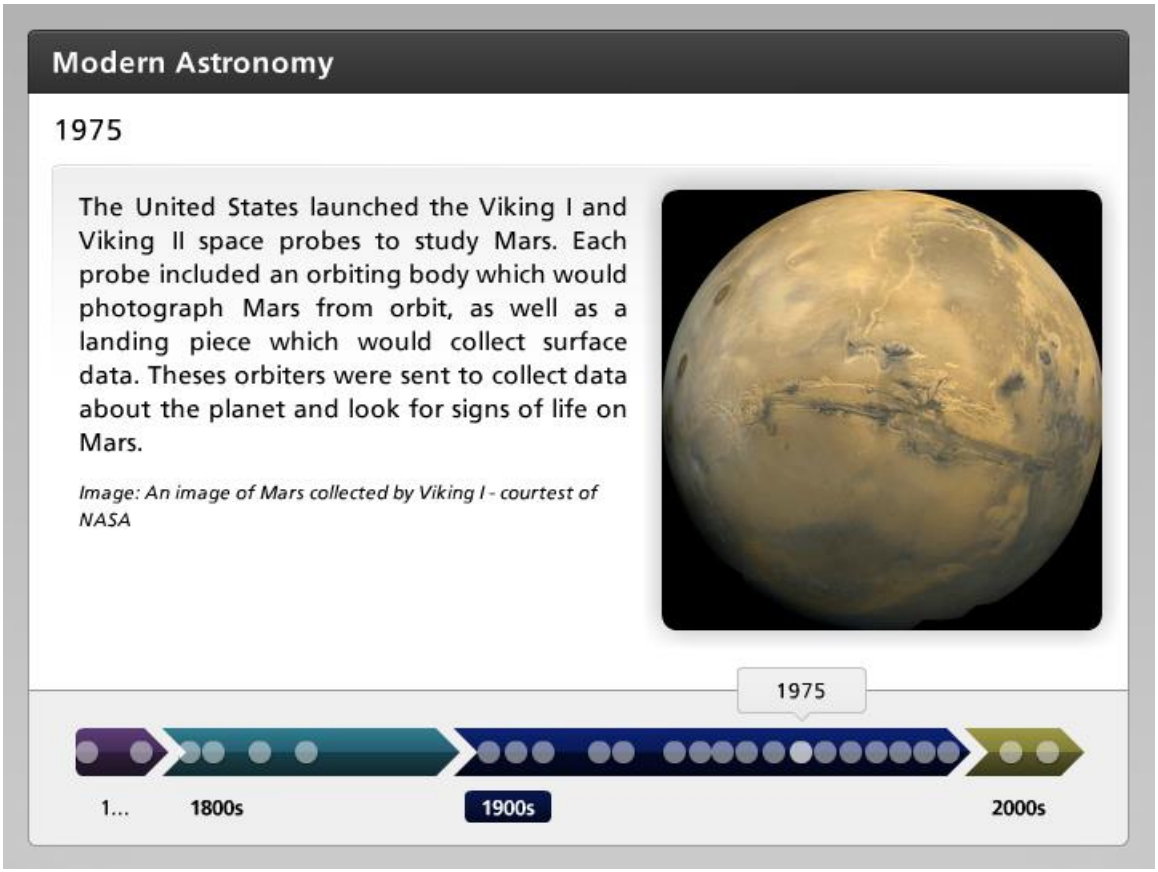
## 1973




The United States launched Skylab, its first space station. Skylab orbited the Earth from 1973 to 1979. The small structure housed a workshop, a sleep compartment, and areas for scientific experiments. Because it was damaged during its launch, Skylab had to be repaired through the first major in-space repair.

*Image: An illustration of Skylab - courtesy of NASA*

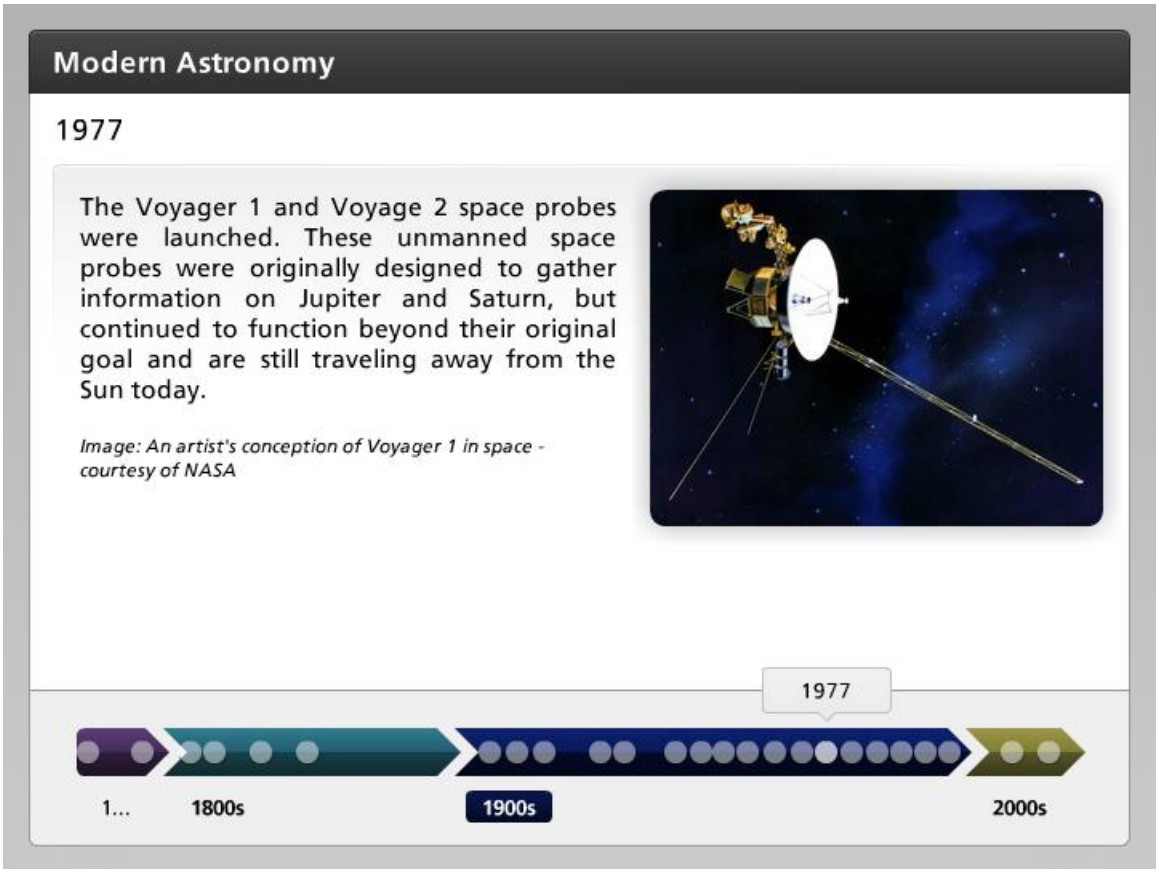
## 1975




The United States launched the Viking I and Viking II space probes to study Mars. Each probe included an orbiting body which would photograph Mars from orbit, as well as a landing piece which would collect surface data. Theses orbiters were sent to collect data about the planet and look for signs of life on Mars.

*Image: An image of Mars collected by Viking I - courtest of NASA*

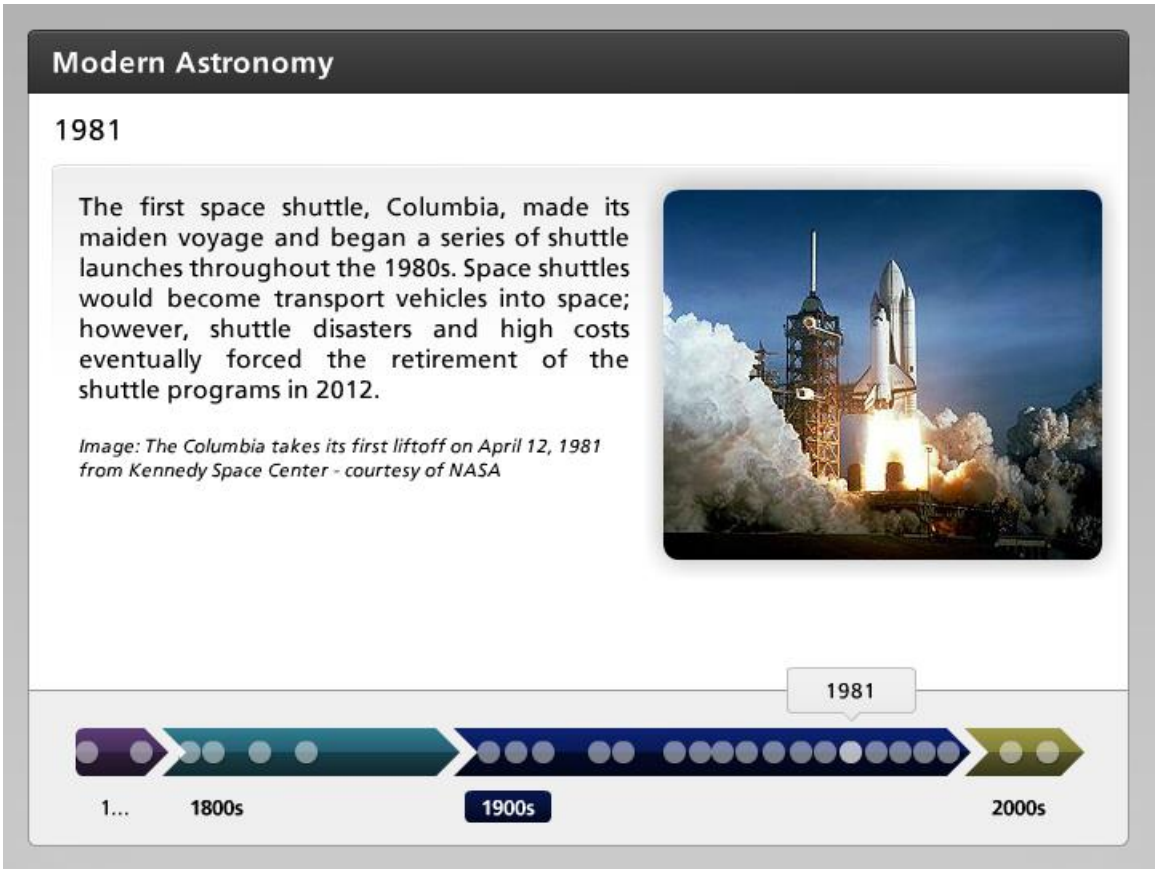
## 1977




The Voyager 1 and Voyage 2 space probes were launched. These unmanned space probes were originally designed to gather information on Jupiter and Saturn, but continued to function beyond their original goal and are still traveling away from the Sun today.

*Image: An artist's conception of Voyager 1 in space - courtesy of NASA*

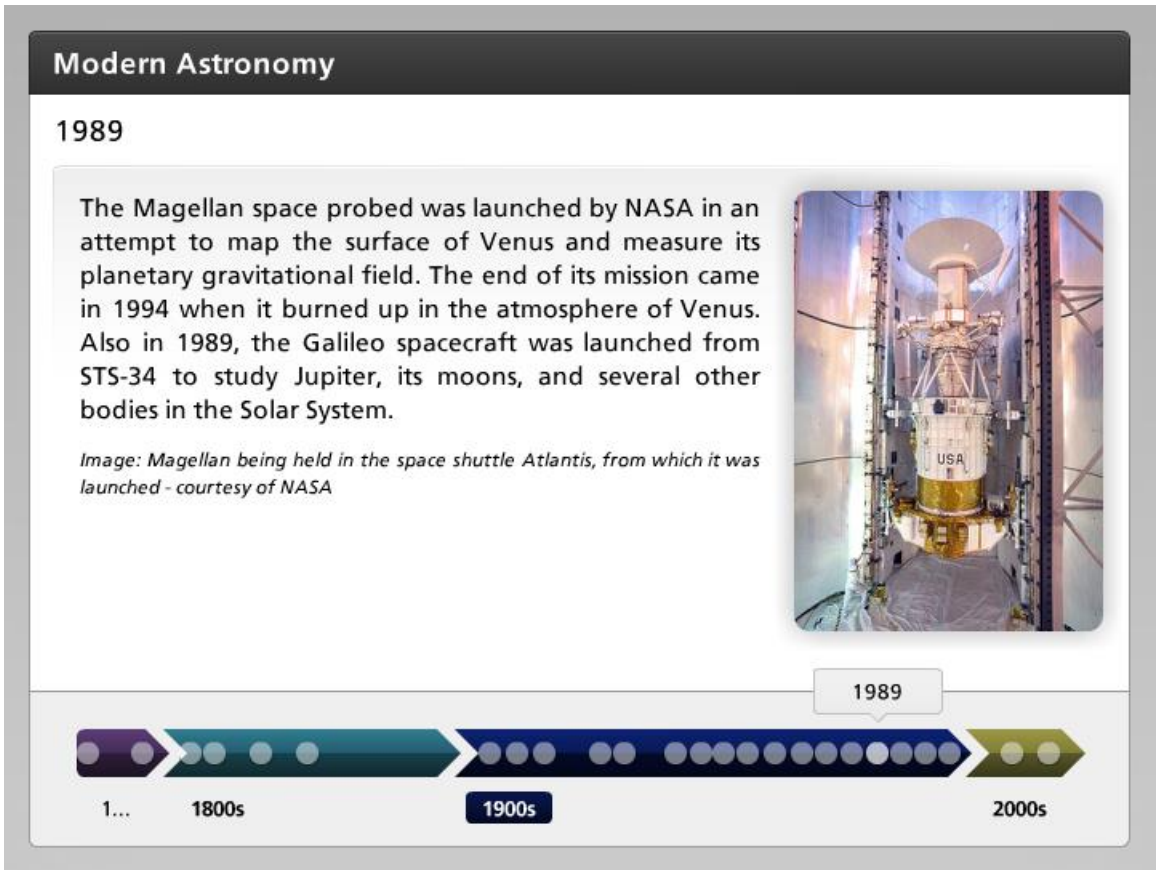
## 1981




The first space shuttle, Columbia, made its maiden voyage and began a series of shuttle launches throughout the 1980s. Space shuttles would become transport vehicles into space; however, shuttle disasters and high costs eventually forced the retirement of the shuttle programs in 2012.

*Image: The Columbia takes its first liftoff on April 12, 1981 from Kennedy Space Center - courtesy of NASA*

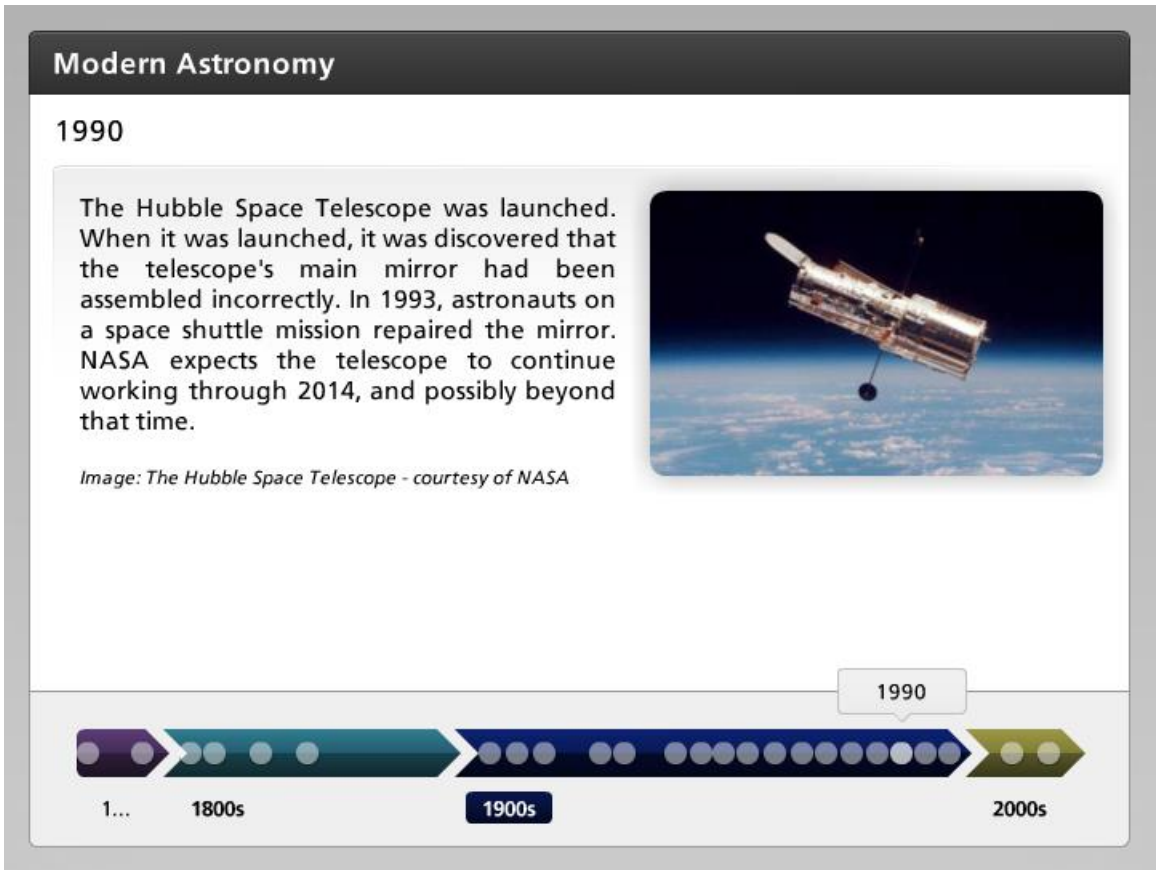
## 1989




The Magellan space probed was launched by NASA in an attempt to map the surface of Venus and measure its planetary gravitational field. The end of its mission came in 1994 when it burned up in the atmosphere of Venus. Also in 1989, the Galileo spacecraft was launched from STS-34 to study Jupiter, its moons, and several other bodies in the Solar System.

*Image: Magellan being held in the space shuttle Atlantis, from which it was launched - courtesy of NASA*

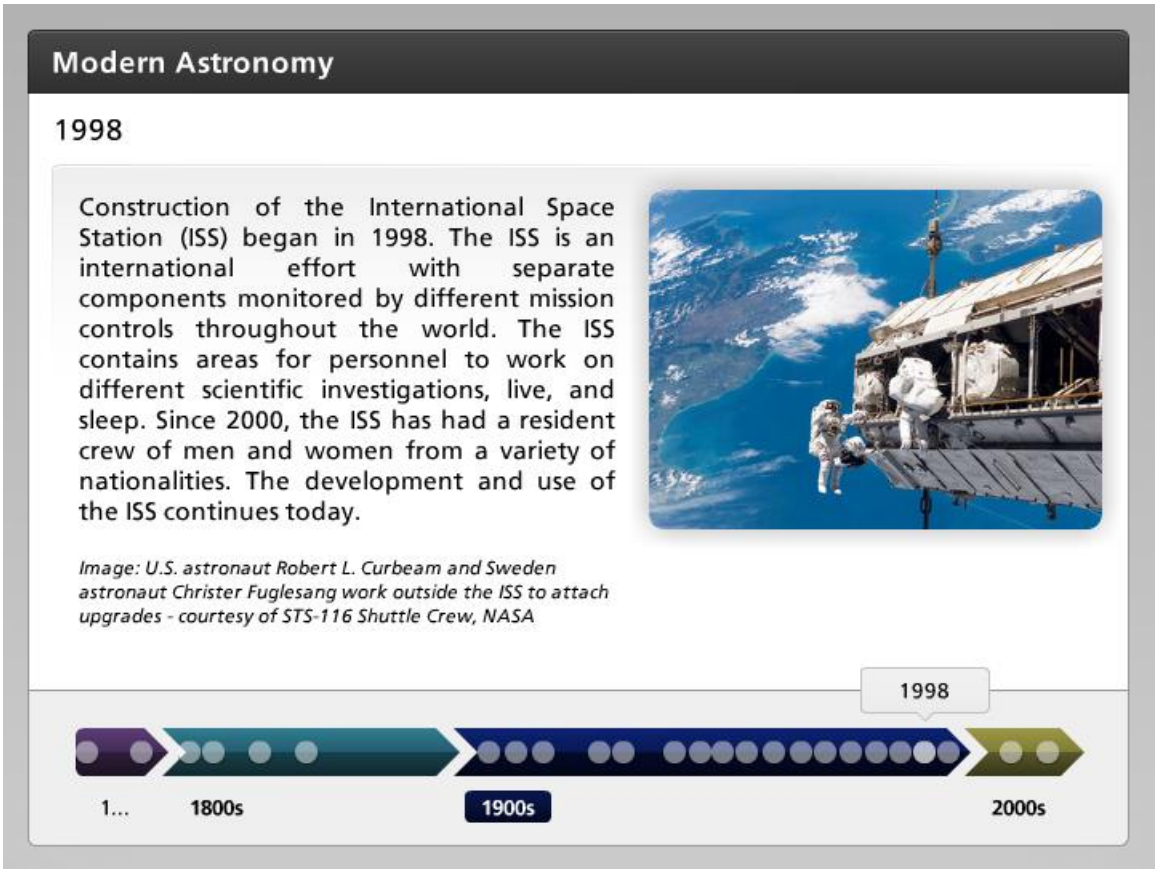
**1990**




The Hubble Space Telescope was launched. When it was launched, it was discovered that the telescope's main mirror had been assembled incorrectly. In 1993, astronauts on a space shuttle mission repaired the mirror. NASA expects the telescope to continue working through 2014, and possibly beyond that time.

*Image: The Hubble Space Telescope - courtesy of NASA*

**1998**




Construction of the International Space Station (ISS) began in 1998. The ISS is an international effort with separate components monitored by different mission controls throughout the world. The ISS contains areas for personnel to work on different scientific investigations, live, and sleep. Since 2000, the ISS has had a resident crew of men and women from a variety of nationalities. The development and use of the ISS continues today.

*Image: U.S. astronaut Robert L. Curbeam and Sweden astronaut Christer Fuglesang work outside the ISS to attach upgrades - courtesy of STS-116 Shuttle Crew, NASA*

**1999**


Terra, the flagship of NASA's Earth Observing System, was launched from Vandenberg Air Force Base in California. It is part of an international program to monitor climate and environmental change on Earth over the next 15 years.

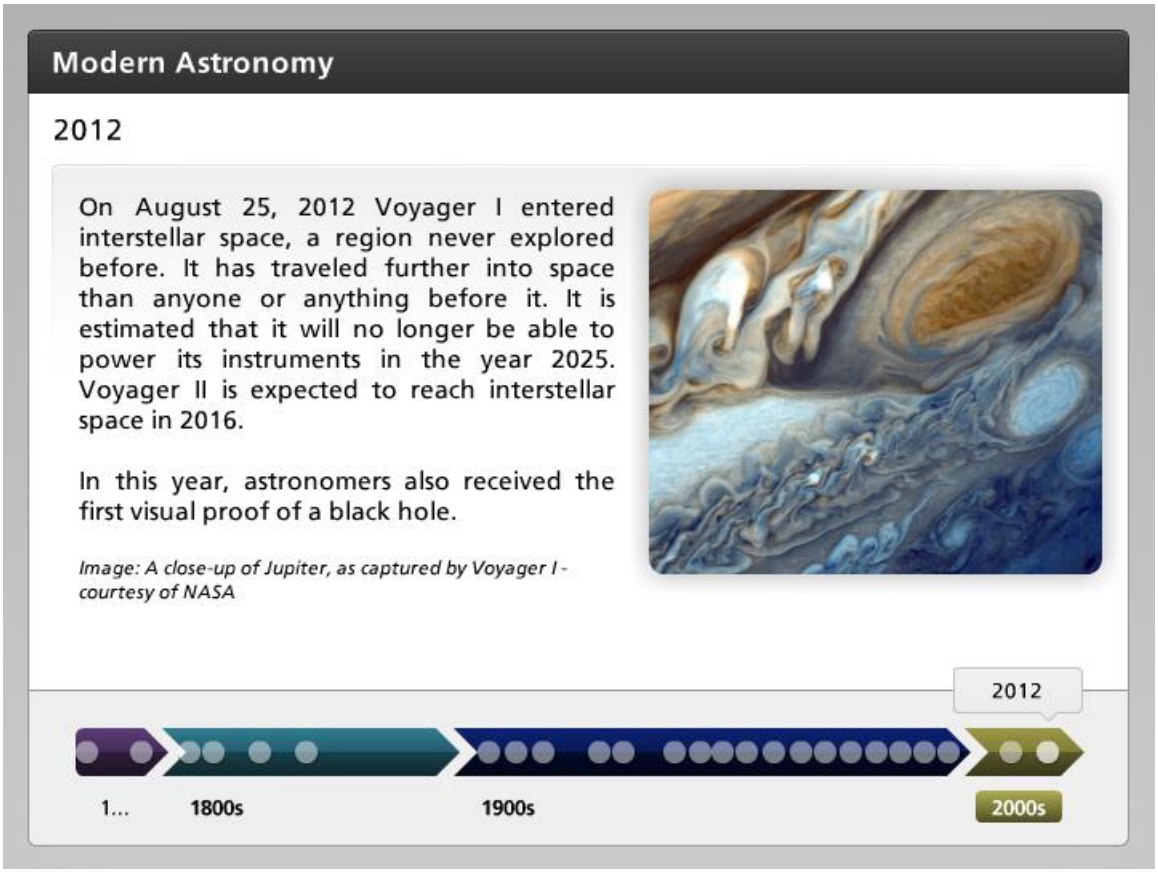
*Image: An artist's depiction of Terra - courtesy of NASA*

## 2003, 2004, 2011


During these three years, NASA launched and landed three separate automated motor vehicles on the planet Mars. These vehicles are named Opportunity, Spirit, and Curiosity. They were sent on a mission to Mars to study the planet's surface characteristics.

*Image: The Curiosity on the surface of Mars - courtesy of NASA/JPL-Caltech/MSSS*

## 2012




On August 25, 2012 Voyager I entered interstellar space, a region never explored before. It has traveled further into space than anyone or anything before it. It is estimated that it will no longer be able to power its instruments in the year 2025. Voyager II is expected to reach interstellar space in 2016.

In this year, astronomers also received the first visual proof of a black hole.

*Image: A close-up of Jupiter, as captured by Voyager I - courtesy of NASA*