

+ *Researchers*

*More women researchers who have contributed to our understanding of galaxies and cosmology:*



**Sandra Faber**  
(United States, 1944)

An Astronomer at the Observatories of the University of California (USA), she discovered the relation between the brightness of an elliptic galaxy and the width of the absorption lines in its spectrum: the brightest galaxies have narrower lines. This relationship is known as the Faber-Jackson relation and is used to compute the distances to galaxies.



**Neta Bahcall**  
Professor of Astrophysics at Princeton University (USA) she developed a pioneering method for analysing the distribution of galaxy clusters, concluding that the Universe contains less material than was previously thought. This research was crucial to our understanding of how the Universe will evolve.



**Henrietta Leavitt**  
(United States, 1868-1921)

Began working at the Harvard Observatory in 1893. She discovered the relationship between the period and the luminosity of a particular type of variable star: the Cepheids. This relationship allowed scientists to compute the distance to other galaxies - objects much farther away than had been studied previously. She demonstrated that this relationship was universal regardless of the type of galaxy. She was the first historical cosmologist.



**Wendy Freedman**  
(Canada, 1957)

Her work at the prestigious Carnegie Institution Washington was focused on the study of Cepheid stars. She led the key Hubble space telescope project on the scale of extragalactic distances, in which Cepheid stars were used to measure the speed of the expansion of the universe. This work merited her being awarded the Gruber Cosmology prize in 2009.



# The age of the Univers

The astronomer Edwin Hubble discovered in 1929 that the Universe is expanding, so that the galaxies in it are moving away from one another at a speed proportional to the distance between them. The constant of proportionality is called the '**Hubble Constant**'. The exact value of this constant is dependent upon the age and size of the Universe.

During the 1990s the astronomer **Wendy Freedman** was able to determine the value of the Hubble constant after ten years work, and so could calculate the age of the Universe. Her conclusion, that the Universe is 13,700 million years old, is still regarded as accurate today.

## ASTRONOMICAL MILESTONES IN THE STUDY OF COSMOLOGY

**1915**  
Formulation of the **General Theory of Relativity** which was to be used to create mathematical models of the Universe.

**1920**  
Discovery that **spiral nebulae** are outside our galaxy.

**1927**  
A **mathematical model of the Universe** is put forward which will later come to be known as the Big Bang model. In this model, distant objects exhibit what is known as "redshift", indicating that they are moving away from the observer.

**1928**  
The relationship between redshift and the distance to spiral nebulae is determined.

**1948**  
The theory of the creation of chemical elements in the Universe is elaborated (**Big Bang**).

**1965**  
Discovery that the Universe is full of an electromagnetic radiation called **Cosmic Microwave Background Radiation**. Together with the expansion of the Universe and its chemical composition, this constitutes the third proof of Big Bang.

**1989**  
Readings from the **COBE satellite** corroborate some of the characteristics forecast for the Microwave Background Radiation.

**1998**  
Observations suggest that the **expansion of the Universe is accelerating**. This implies the existence of some force that is opposing gravity, of an unknown nature: it is given the name dark matter.

**2000**  
**Images** of the early Universe from the **Boomerang Telescope** support the Big Bang theory and also suggest that the collapse foreseen in the so-called Big Crunch theory will not occur.