US astronomer who studied extragalactic nebulae and demonstrated them to be galaxies like our own. He found the first evidence for the expansion of the universe, in accordance with the cosmological theories of Georges Lemaître and Willem de Sitter, and his work led to an enormous expansion of our perception of the size of the universe.

Hubble was born in Marshfield, Missouri, on 20 November 1889. He went to high school in Chicago and then attended the University of Chicago where his interest in mathematics and astronomy was influenced by George Hale and Robert Millikan. After receiving his bachelor's degree in 1910, he became a Rhodes scholar at Queen's College, Oxford, where he took a degree in jurisprudence in 1912. When he returned to the USA in 1913, he was admitted to the Kentucky Bar, and he practised law for a brief period before returning to Chicago to take a research post at the Yerkes Observatory 1914-17.

In 1917 Hubble volunteered to serve in the US infantry and was sent to France at the end of World War I. He remained on active service in Germany until 1919, when he was able to return to the USA and take up the earlier offer made to him by Hale of a post as astronomer at the Mount Wilson Observatory near Pasadena, where the 2.5-m/100-in reflecting telescope had only recently been made operational. Hubble worked at Mount Wilson for the rest of his career, and it was there that he carried out his most important work. His research was interrupted by the outbreak of World War II, when he served as a ballistics expert for the US War Department. He was awarded the Gold Medal of the Royal Astronomical Society in 1940, and received the Presidential Medal for Merit in 1946. He was active in research until his last days, despite a heart condition, and died in San Marino, California, on 28 September 1953.

While Hubble was working at the Yerkes Observatory, he made a careful study of nebulae, and attempted to classify them into intra- and extragalactic varieties. At that time there was great interest in discovering what other structures, if any, lay beyond our Galaxy. The mysterious gas clouds, known as the smaller and larger Magellanic Clouds, which had first been systematically catalogued by Charles Messier and called 'nebulae', were good extragalactic candidates and were of great interest to Hubble. He had been particularly inspired by Henrietta Leavitt's work on the Cepheid variable stars in the Magellanic Clouds; and later work by Harlow Shapley, Henry Russell, and Ejnar Hertzsprung on the distances of these stars from the Earth had demonstrated that the universe did not begin and end within the confines of our Galaxy. Hubble's doctoral thesis was based on his studies of nebulae, but he found it frustrating because he knew that more definite information depended upon the availability of telescopes of greater light-gathering power and with better resolution.

After World War I, with the 2.5-m/100-in reflector at Mount Wilson at his disposal, Hubble was able to make significant advances in his studies of nebulae. He found that the source of the light radiating from nebulae was either stars embedded in the nebular gas or stars that were closely associated with the system. In 1923 he discovered a Cepheid variable star in the Andromeda nebula. Within a year he had...
detected no fewer than 36 stars within that nebula alone, and found that 12 of these were Cepheids. These 12 stars could be used, following the method applied to the Cepheids that Leavitt had observed in the Magellanic Clouds, to determine the distance of the Andromeda nebula. It was approximately 900,000 light years away, much more distant than the outer boundary of our own Galaxy - then known to be about 100,000 light years in diameter.

Hubble discovered many gaseous nebulae and many other nebulae with stars. He found that they contained globular clusters, novae, and other stellar configurations that could also be found within our own Galaxy. In 1924 he finally proposed that these nebulae were in fact other galaxies like our own, a theory that became known as the ‘island universe’. From 1925 onwards he studied the structures of the galaxies and classified them according to their morphology into regular and irregular forms. The regular nebulae comprised 97% of them and appeared either as ellipses or as spirals, and the spirals were further divided into normal and barred types. All the various shapes made up a continuous series, which Hubble saw as an integrated ‘family’. The irregular forms comprised only 3% of the nebulae he studied. By the end of 1935, Hubble’s work had extended the horizons of the universe to 500 million light years.

Having classified the various kinds of galaxies that he observed, Hubble began to assess their distances from us and the speeds at which they were receding. The radial velocity of galaxies had been studied by several other astronomers, in particular by Vesto Slipher. Hubble analysed his data, and added some new observations. In 1929 he found, on the basis of information for 46 galaxies, that the speed at which the galaxies were receding (as determined from their spectroscopic red shifts) was directly correlated with their distance from us. He found that the more distant a galaxy was, the greater was its speed of recession - now known as Hubble's law. This astonishing relationship inevitably led to the conclusion that the universe is expanding, as Lemaître had also deduced from Albert Einstein's general theory of relativity.

This data was used to determine the portion of the universe that we can ever come to know, the radius of which is called the Hubble radius. Beyond this limit, any matter will be travelling at the speed of light, and so communication with it will never be possible. The data on galactic recession was also used to determine the age and the diameter of the universe, although at the time both of these calculations were marred by erroneous assumptions, which were later corrected by Walter Baade. The ratio of the velocity of galactic recession to distance has been named the Hubble constant, and the modern value for the speed of galactic recession is 530 km/330 mi per sec - very close to Hubble's original value of 500 km/310 mi per sec.

During the 1930s, Hubble studied the distribution of galaxies and his results supported the idea that their distribution was isotropic. They also clarified the reason for the ‘zone of avoidance’ in the galactic plane. This effect was caused by the quantities of dust and diffuse interstellar matter in that plane.

Among his later studies was a report made in 1941 that the spiral arms of the galaxies probably did ‘trail’ as a result of galactic rotation, rather than open out. After World War II Hubble became very much an elder statesman of US astronomy. He was involved in the completion of the 5-m/200-in Hale Telescope at Mount Palomar, which was opened in 1948. One of the original intentions for this telescope was the study of faint stellar objects, and Hubble used it for this purpose during his few remaining years.

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