Edwin Powell Hubble

Edwin Powell Hubble, the American astronomer, is considered the father of observational cosmology in recognition of his significant contributions that revolutionized our understanding of galaxies, and the Universe at large. Edwin Hubble was born on November 20, 1889, in Marshfield, Missouri, USA. His family soon moved to Chicago where he attended high school. In addition to being a good student, he was also a good athlete, noted for his skills in basketball and boxing. Hubble studied mathematics, astronomy, and philosophy at the University of Chicago from where he obtained his BS degree. He spent the next three years at Oxford University with a Rhodes scholarship, where he studied law. In 1913, Hubble returned from England and set up a small law practice in Louisville, Kentucky. He also taught Spanish at a school in Indiana. However, his real passion was astronomy and he joined the Yerkes Observatory to pursue a career in astronomy. Hubble obtained his doctorate in 1917 from the University of Chicago, for his dissertation titled ‘Photographic investigations of faint nebulae’. He then went on civic duty to serve his country during World War I and was promoted to the rank of Major. On his return, he accepted the offer made by George Ellery Hale, who was the director and founder of the Mt. Wilson Observatory, near Pasadena, in California.

During 1922–1923, Hubble used the 100-inch Hooker telescope at Mt. Wilson Observatory to study the Cepheid variables in the Andromeda nebula and other nearby spiral nebulae. From the distances obtained using the period – luminosity relationship for Cepheids, he proved that these nebulae were far away, and had to be galaxies that lie beyond the Milky Way. His findings were revolutionary and changed the existing view of the Universe, when it was thought that all the fuzzy nebulae were part of the Milky Way. Hubble also devised a classification system for the various galaxies, sorting them by their appearance on photographic plates, resulting in the Hubble sequence of galaxy morphologies. Another breakthrough came from the collaboration of Hubble and Milton Humason, who worked as his night assistant at the Mt. Wilson Observatory. They noticed that the emission lines from galaxies were redshifted indicating that they were moving away from each
other at velocities proportional to the distance between them. This redshift–distance relation, which was published in 1929, later came to be known simply as ‘Hubble’s Law’. Using the velocity and distance measurements for 46 galaxies, they found a value of 500 km/s/Mpc for the proportionality constant (Hubble’s constant). This value has been refined in recent years, by measurements using the Hubble Space Telescope, and WMAP measurements of the Cosmic Microwave Background. The currently accepted value is $72 \pm 8$ km/s/Mpc, which is much smaller than Hubble’s original estimate.

In 1917, Albert Einstein introduced the general theory of relativity and claimed that space was curved by gravity, and hence the Universe must expand or contract depending on the available matter. But since the idea appeared so far-fetched, Einstein modified his equations so that the Universe remains static. Edwin Hubble’s observations revolutionized astronomy, presenting the first evidence that the Universe is expanding. If galaxy redshifts were interpreted as a measure of recession, then Hubble’s law was consistent with Einstein’s equations in its original form for an expanding Universe. It is often quoted that, after hearing about Hubble’s discoveries, Einstein remarked that modifying his equations to assert a static Universe was the biggest blunder of his life. On January 29, 1931, during Albert Einstein’s visit to California, Hubble took him up to Mt. Wilson, to see the 100-inch telescope which he had used for his observations.

Hubble’s discovery had important implications. It strengthened the view that in the past there must have been something that caused the expansion to begin with, as proposed by the Big Bang theory. Hubble calculated this epoch to be around 2 billion years ago, although recent estimates have revised it to about 13 billion years ago. Hubble also used the distribution of galaxies based on number counts above a certain magnitude limit, to measure the curvature of space, or the departure from Euclidean geometry. He concluded that the Universe is flat and homogenous with departure from flatness at very large distances. Although he did not include the luminosity evolution of galaxies in his study, the methodology was a very novel one that deserves credit.
Hubble left Mt. Wilson in 1942 to help fight Nazis in World War II, but returned to work at the Mt. Wilson Observatory after the war. He was successful in convincing his employers about the need for a larger telescope, and was instrumental in setting up the Hale telescope at Mt. Palomar Observatory. He was also the first to use the 200-inch Hale telescope, when it was completed shortly before his death. Edwin Hubble continued to work both at Mt. Wilson and Mt. Palomar Observatories, until he died on September 28, 1953, from cerebral thrombosis.

Hubble described his work in two books, *The realm of the nebulae*, and *Observational approach to cosmology*, published during 1936–1937. Hubble was a recipient of many awards and honors, including the Bruce medal in 1938, the Gold medal of the Royal Astronomical Society in 1940, and the medal of merit for his contribution to ballistics research during the war. It is often said that if astronomy was considered an area of physics, rather than a field in its own, Edwin Hubble would have been a strong contender for the Nobel Prize in Physics. The Hubble Space Telescope (HST), which was launched in 1990, and named after Edwin Hubble, is one of the most powerful optical telescopes. One of the key projects of the Hubble Space Telescope was to measure the Hubble constant as accurately as possible. The deep surveys carried out with the HST have provided the deepest images of the Universe allowing astronomers to study the birth of galaxies and their evolution. Hubble’s legacy of peering deeper into the observable Universe to unveil the secrets of galaxies, lives on with the most valuable images produced by the telescope named after him.

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