

Enrichment**LESSON 4*****Hubble, Galaxies, and Expansion***

Edwin Hubble, who lived from 1889 to 1953, has been called the greatest astronomer since the times of Galileo, Kepler, and Newton. His name is attached to many things of everyday astronomical life. Among them are Hubble's Law, the Hubble Galaxy classification, the Hubble Sequence, the Hubble Constant, the Hubble Redshift–Distance relation, and the *Hubble Space Telescope*.

Edwin Hubble was born in a small town in Missouri and attended the University of Chicago. He received an undergraduate degree in astronomy and math, a graduate degree in law, and a doctorate in astronomy. After working as an attorney in Kentucky and serving in WWI, he decided that he was bored with law and went back to his studies in astronomy.

Theory of Relativity

In 1919, when Hubble began work at the Mount Wilson Observatory in California, he was researching nebulae, which are fuzzy patches of light in the sky. At this time many astronomers still thought that the Milky Way galaxy was the entire universe, and that it was static and unchanging. Albert Einstein had already introduced his general theory of relativity

and produced a model of space based on that theory, claiming that space was curved by gravity, and therefore it must be able to expand or contract. He found this assumption so far fetched, however, that he revised his theory, stating that the universe was static and immobile.

Hubble's Work

By the 1920s, Hubble had developed a galaxy classification system and established that there were other galaxies beyond the Milky Way. In the 1930s, by observing redshifts in the light wavelengths emitted by the galaxies, he saw that galaxies were moving away from each other at a rate constant to the distance between them (Hubble's Law). The farther away they were, the faster they receded. This information led to the calculation of the point where the expansion began and provided the first evidence for the Big Bang theory, which describes the birth and evolution of the universe.

Following these discoveries by Hubble, Einstein was quoted as having said that second-guessing his original findings about the nature of the universe was the biggest blunder of his life.

Applying Critical-Thinking Skills

Directions: Respond to each statement.

1. **Explain** why the discovery that the universe is expanding can be used as evidence that the Big Bang occurred, even though no one saw it.
2. **Hypothesize** why Einstein considered his revision of his theory about the nature of the universe to be the biggest blunder of his life.