

Chapter 30. Universal Expansion and the Cosmic Background

Note. The expansion of the universe is the first bit of evidence for the Big Bang Theory.

Note. In 1929, Edwin Hubble (1889–1953) discovered that the speed with which a galaxy moves away from the Earth is directly proportional to its distance, implying that the universe is expanding. Mathematically, $v = Hd$ where v is velocity, d is distance, and H is Hubble's constant. The present value of H is between 50-100 km/sec/Mpc. Hubble's constant can be used to determine the age of the universe:

H (km/sec/Mpc)	age (billion years)
540	1.8
100	10
75	13
50	20

There is uncertainty in the value of H . One of the main reasons for the development of the Space Telescope is to determine H more accurately.

Note. Notice that, with a value of H , the distance to a galaxy can be determined simply by measuring the redshift.

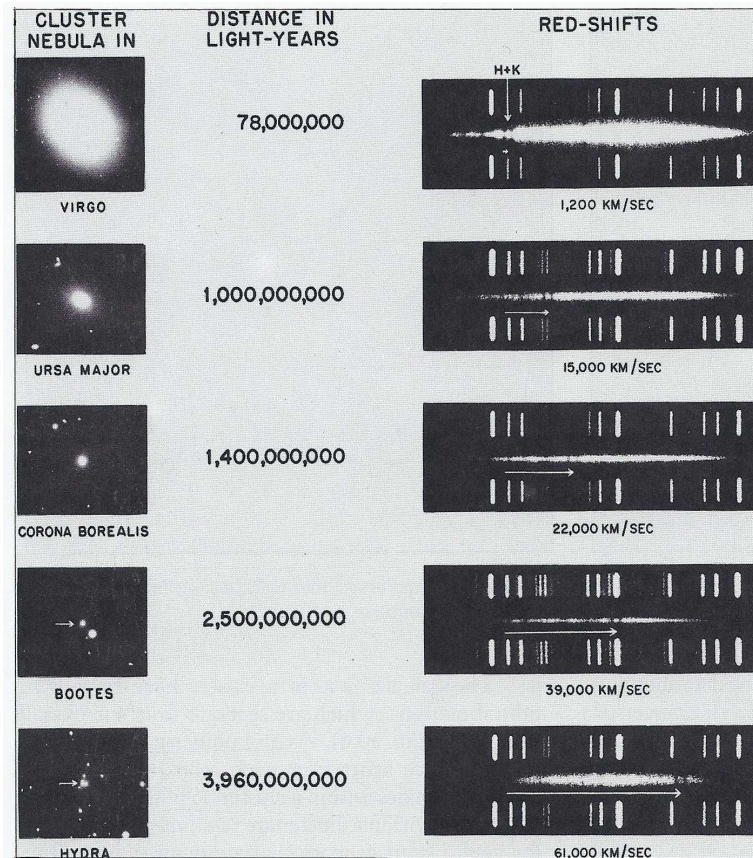


Figure 30.1 Page 581. Spectra of Galaxies.

Note. In the 1940s George Gamow (1904–1968) predicted that if there was a *big bang* then there should be remnant radiation. The radiation was emitted as γ -ray radiation. As the universe cooled, this radiation was shifted to longer and longer wavelengths, corresponding to a cooler temperature.

Note. In 1965 Arno Penzias (1933–) and Robert Wilson (1936–), using a radio antenna, discovered a *microwave background* at 1.1 mm corresponding to 2.7° K. They received the Nobel Prize in Physics for this discovery in 1978. This radiation is very uniform in distribution (it is *isotropic*). The redshift of the background radiation indicates that the Local Group is moving toward the Virgo Cluster at 780 km/sec.

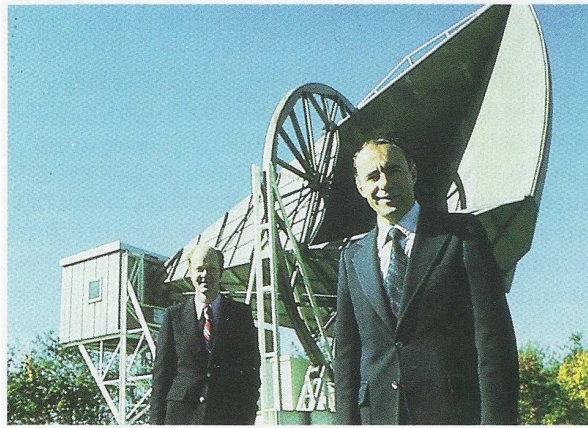


Figure 30.10 Page 588. Wilson and Penzias.

Note. All clusters seem to be rushing towards one point, as if there were some “great attractor.”

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