

Hubble Expansion of the Universe Explanation

The data are the results of a 10-year programme to use the Hubble Space telescope to accurately measure the distance of galaxies from the Milky Way. These final results were published by the project leader, astronomer Wendy Freedman, in May 2000. (The Astrophysical Journal, volume 553, pages 47-72)

The distances were found by measuring the brightness of individual stars in those galaxies, and knowing how objects get fainter with distance, astronomers used the intrinsic (true) brightnesses to calculate how far away they are.

The largest distance measured by the Hubble Space Telescope was a little under 70 million light-years. Hubble can see galaxies much further away than this, but cannot make out individual stars. Note that this means when the light left the distant galaxies observed, dinosaurs still lived on Earth.

Column descriptions:

Galaxy Names: These are just catalogue numbers - very few galaxies have proper names, two being our own (the Milky Way) and the Andromeda Galaxy.

Distances: Two columns with distances in different units are given. The first column gives the distance in millions of parsecs (megaparsecs). A parsec is the standard unit used by astronomers to measure distances between stars or galaxies, and is equivalent to 3.1×10^{13} kilometers.

The second column gives the distance to the galaxy in millions of light years, as students may be more familiar with that unit. For reference, 1 parsec = 3.26 lightyears, so a megaparsec is 3.26 megalightyears.

Velocity: This is apparent velocity of the galaxy given in kilometers per second. These were measured using telescopes on Earth via the redshift in the wavelengths of light emitted by the galaxy. Note that galaxies generally lie in groups or clusters, and the force of gravity between them can make them move in a different direction to that of the Hubble expansion. These velocities have been mostly corrected for this effect, but it is impossible to do this exactly.

Measuring the expansion rate of the Universe:

By plotting velocity v against distance d , the rate of expansion (called H_0) can be measured from the gradient of the resulting slope, because $v = H_0 d$. The units of H_0 are velocity/distance.

If Megaparsecs are used as distances, the students should get an answer of around 81 km/sec/Megaparsec. If Megalightyears are used, they should get an answer of about 25 km/sec/Megalightyear.

The real result is 72 km/sec/Megaparsec or 22 km/sec/Megalightyear. You will get a slightly different answer because no measurement uncertainties have been included in this data.