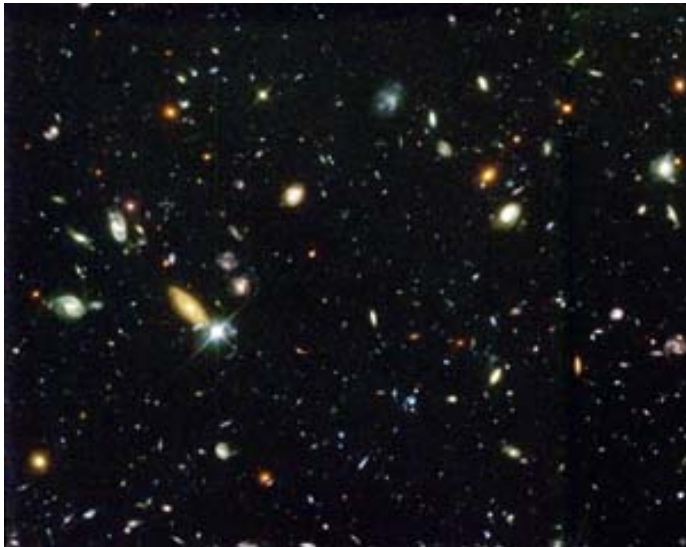


## The Universe

It is estimated that our Universe contains around two hundred billion galaxies, each containing an average of four hundred billion stars.



The Hubble Deep Field - North  
R. Williams (STScI), the Hubble Deep Field Team and NASA

In December 1995, the Hubble Space Telescope was used to create a spectacular image of the Universe called the Hubble Deep Field. This image shows a small section of the sky (about the size of a grain of sand held at arms length) that appears empty in Earth-based telescope images. The Hubble Telescope was aimed at this region of sky for 10 consecutive days. It was able to capture the faint light from distant galaxies and shows that even a small area of space contains many galaxies of different sizes, shapes, ages and colours.

Great advances in our understanding of the Universe were made in the early part of last century. Brilliant minds like Albert Einstein and innovative astronomers like Edwin Hubble showed that the Universe is expanding. Run the expansion backwards, as if time were reversed, and we end up with the entire Universe contained in a tiny point. The Big Bang theory remains our best scientific explanation for how it all started and has withstood many tests.

What Hubble uncovered as he observed distant galaxies was not that galaxies are flying away from each other but

that the space between the galaxies is stretching. The Big Bang was the explosion of space and time, and it raises three possibilities for how the Universe may end. The expansion may continue forever, slow almost to a halt or collapse back on itself in what has been termed the Big Crunch.

Just recently astronomers studying exploding stars, called supernovae, in distant galaxies have discovered that not only is the Universe expanding but that the expansion is accelerating. This discovery was named Science Magazine's Breakthrough of the Year in 1998. It was a puzzling discovery because there is currently no known force that can account for the expansion of the Universe.

So what does it mean to say that the Universe is expanding and accelerating? Think of the Universe as a giant balloon that expands as it is inflated. That the Universe is accelerating means that the air flowing into the balloon is not constant but is speeding up over time, so that the balloon expands faster and faster.

The question astronomers are asking today is what's causing the acceleration? Does there exist a force opposite to gravity that repels matter rather than attracts? Einstein, in his original theory of general relativity, included an extra term, the Cosmological Constant, to his equations. The Cosmological Constant was a counter to gravity. A repulsive force to balance the attractive force of gravity so that the equations would describe a non-expanding Universe. When the Universe was found to be expanding he called it his greatest blunder, but perhaps it wasn't.

So what is the fate of our Universe? It starts action packed with the death of the Sun and our Galaxy's collision with the neighbouring Andromeda Galaxy. But then it turns bleak. The Universe will grow to a size where light from distant objects won't be able to make it across the vast expanse of space. All parts of the Universe will become cut-off from each other. Eventually all matter will be locked away in stellar corpses—black dwarfs, neutron stars and black holes. Even these will decay sooner or later leaving just radiation and the odd everlasting particle or two. And so it ends, not with a bang but a whimper.

## Internet Resources

[High-Redshift Supernova Search \(http://cfa-www.harvard.edu/supernova//highz.html\)](http://cfa-www.harvard.edu/supernova//highz.html)