How Big is the Universe, *Really?*

When astronomers look through a telescope at distant stars and galaxies, they do what many of us might otherwise think impossible—they look backwards in time. This ultimately due to Albert Einstein's famous theory of special relativity which postulates that the speed of light is a constant. That is, no information can travel faster than this value of approximately 186,000 miles *per second.* Despite recent claims by research on particles known as neutrinos, this principle of relativity has been repeatedly tested and corroborated within the last century.

As a result, Astronomers, conveniently measure the vast distances of deep space in *light-years*—the distance a hypothetical observer would travel at luminal speed for an entire Earth-year (about 6 trillion miles!).

Scientists, including particle physicists and astrophysicists, have found from observations of a phenomenon known as the Cosmic Microwave Background (CMB) that light in our universe could not have been generated any earlier than approximately 400,000 (Earth) years after the Big Bang. The universe was so hot and so dense that light particles known as *photons* could not travel freely through space without being immediately absorbed or scattered by matter (plasma).

Given our knowledge of universe's age (13.7 billion years) from both the measurement of CMB and cosmology theory as well as our measurements of the speed of light, one can easily calculate a distance

(speed)*(time) = distance

(186,000 miles/second)*(13.7 billion years [in seconds])≈ 8 sextillion miles! (8 followed by 22 zeroes!)

Astronomers call this distance our *Particle Horizon*, and it marks the boundary of our observable universe. That is, in the age of the universe, light has not yet had enough time (not even in billions of years) to reach us from beyond this distance (in any direction).

Despite this enormous distance, the size of our *observable* universe should not be mistaken for the absolute size of this universe. Another theory from cosmology called *Inflationary Theory* predicts that the universe is still orders of magnitude larger beyond what we can see!

Sources

- A magnificent and accurate animation of the observable universe by the American Museum of Natural History
  http://www.amnh.org/news/2009/12/the-known-universe/
- An interactive flash animation for both the small and large scales of the universe
  http://www.scaleofuniverse.com/
- PBS: Space Station
  http://www.pbs.org/spacestation/station/training.htm