

TWO TRILLION GALAXIES

According to the latest surveys the observable universe contains at least two trillion galaxies, 10 times more than previously thought

Using data from deep-space surveys taken by NASA's Hubble Space Telescope and other observatories, astronomers have performed a census of the number of galaxies in the universe. The team came to the surprising conclusion that there are at least 10 times as many galaxies in the observable universe than previously thought.

This Hubble Space Telescope view reveals thousands of galaxies stretching back into time across billions of light-years of space. The image covers a portion of a large galaxy census called the Great Observatories Origins Deep Survey (GOODS). Besides the myriad of galaxies visible in this image, only 10 percent of the total number of galaxies in the universe are observable for the current generation of telescopes, according to a new analysis of the GOODS and other Hubble deep-field surveys.



The results have clear implications for galaxy formation, and also helps shed light on an ancient astronomical paradox -- why is the sky dark at night?

In analyzing the data, scientists found that 10 times as many galaxies were packed into a given volume of space in the early universe than what is found today. Most of these galaxies were relatively small and faint, with masses similar to those of the satellite galaxies surrounding the Milky Way. As they merged to form larger galaxies the population density of galaxies in space dwindled. This means that galaxies are not evenly distributed throughout the universe's history.

These results are powerful evidence that a significant galaxy evolution has taken place throughout the universe's history, which dramatically reduced the number of galaxies visible today through mergers between them -- thus reducing their total number. **This gives us a verification of the so-called top-down formation of structure in the universe.**

One of the most fundamental questions in astronomy is that of just how many galaxies the universe contains. The landmark Hubble Deep Field, taken in the mid-1990s, gave the first real insight into the universe's galaxy population. Subsequent sensitive observations such as Hubble's Ultra Deep Field revealed a myriad of faint galaxies. **This led to an estimate that the observable universe contained about 100 billion galaxies. The new research shows that this estimate is at least 10 times too low. They painstakingly converted the images into 3-D, in order to make accurate measurements of the number of galaxies at different epochs in the universe's history.**

In addition, they used new mathematical models, which allowed them to infer the existence of galaxies that the current generation of telescopes cannot observe. This led to the surprising conclusion that in order for the numbers of galaxies we now see and their masses to add up, there must be a further 90 percent of galaxies in the observable universe that are too faint and too far away to be seen with present-day telescopes.

Who knows what interesting properties we will find when we discover these galaxies with future generations of telescopes, such as the James Webb Space Telescope.

The decreasing number of galaxies as time progresses also contributes to the solution for Olbers' paradox (first formulated in the early 1800s by physician / astronomer **Heinrich Wilhelm Olbers**): **Why is the sky dark at night if the universe is unchanging and eternal and contains an infinity of stars?** However, starlight from these far away galaxies is invisible to the human eye and most modern telescopes with reddening of light due to the expansion of space, the universe's dynamic nature, and the absorption of light by intergalactic dust and gas. All combine to keep the night sky dark to our vision.

AK, with EarthSky Notes

