

UNIVERSE IN A JAR

What is the universe made of?

Everything we can see and interact with, on the Earth and in the sky, is made of atoms: protons, neutrons, and electrons. However, with careful observations of the cosmos, astronomers and physicists have been able to determine that the normal matter we're familiar with is actually a very small fraction of the matter and energy in the universe. So what is everything else?

Dark Matter

By measuring how fast galaxies rotate and how fast the galaxies in galaxy clusters move, we can figure out the mass of the galaxies or clusters: the total amount of matter they contain. If we compare this total amount to the total mass of the stars and gas in the galaxies or clusters of galaxies, we find that the normal matter we can see accounts for only a few percent of the total mass. The rest of the mass is what we call dark matter: we can detect it because of its gravitational effects on the stars we can see, but it's completely invisible. What is it? We don't know! Our best guess is some kind of very small particle, but the nature of dark matter is one of the big unsolved questions in astrophysics.



This image from the Hubble Space Telescope shows the galaxy cluster MACSJ0717.5+3745, one of the most massive galaxy clusters known.

Dark Energy

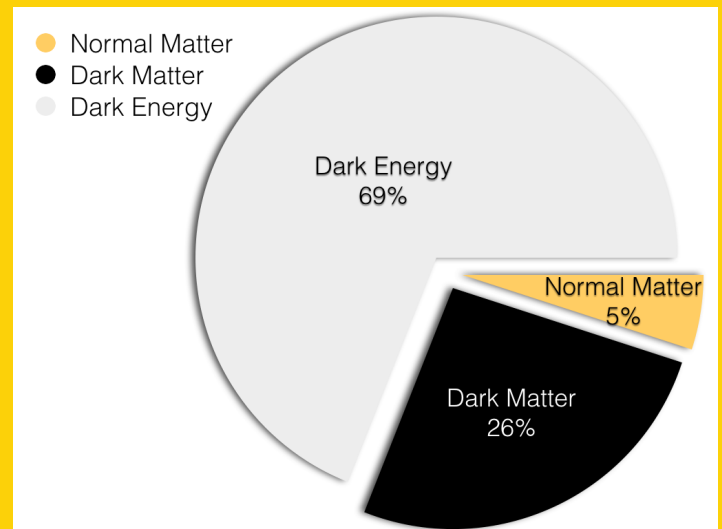
The universe began in a Big Bang 13.7 billion years ago, and has been expanding ever since: galaxies are moving away from each other. In the last 20 years, careful observations of exploding stars have revealed that not only

is the universe expanding, this expansion is speeding up. Imagine that you threw a ball into the air, and instead of falling down again, it kept moving away faster and faster. This can't happen unless something is pushing on the ball, and the expansion of the universe can't speed up unless there's some force making it happen. We call this force dark energy, but we have no idea what it is! The nature of dark energy is an even bigger mystery than the nature of dark matter.

How Much of Each?

By carefully counting the largest galaxy clusters in the universe, using exploding stars to measure dark energy, and studying the radiation left over from the Big Bang, we can figure out the total amount of mass and energy in the universe, and figure out how much there is of each. The result is that the normal matter we know about makes up only 5% of the universe! The rest is dark matter and dark energy.

The marbles in this jar show the proportions of the stuff in the universe: 5% normal matter, 26% dark matter, and 69% dark energy.



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