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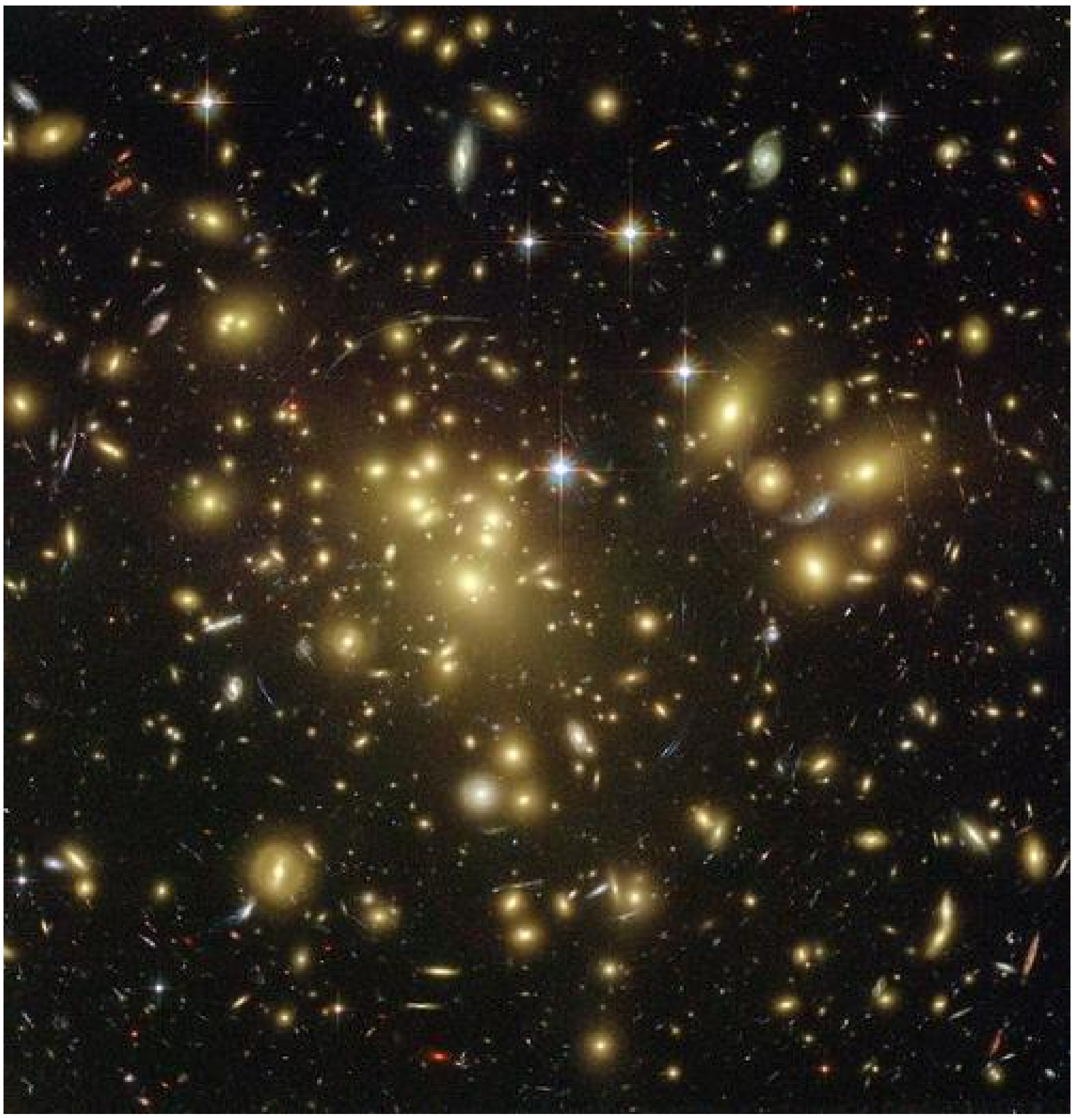
# How do we know dark matter exists?

March 13 2015, by Fraser Cain



A massive cluster of yellowish galaxies, seemingly caught in a red and blue spider web of eerily distorted background galaxies, makes for a spellbinding picture from the new Advanced Camera for Surveys aboard NASA's Hubble Space Telescope. To make this unprecedented image of the cosmos, Hubble peered straight through the center of one of the most massive galaxy clusters known, called Abell 1689. The gravity of the cluster's trillion stars — plus dark matter — acts as a 2-million-light-year-wide lens in space. This gravitational lens bends and magnifies the light of the galaxies located far behind it. Some of the faintest objects in the picture are probably over 13 billion light-years away (redshift value 6). Strong gravitational lensing as observed by the Hubble Space Telescope in Abell 1689 indicates the presence of dark matter. Credit: NASA, N. Benitez (JHU), T. Broadhurst (Racah Institute of Physics/The Hebrew University), H. Ford (JHU), M. Clampin (STScI),G. Hartig (STScI), G. Illingworth (UCO/Lick Observatory), the ACS Science Team and ESA

Dark matter can't be seen or detected by any of our instruments, so how do we know it really exists?

Imagine the Universe was a pie, and you were going to slice it up into tasty portions corresponding to what proportions are what. The largest portion of the pie, 68% would go to dark energy, that mysterious force accelerating the expansion of the Universe. 27% would go to dark matter , the mysterious matter that surrounds galaxies and only interacts through gravity. A mere 5% of this pie would go to regular normal matter, the stuff that stars, planets, gas, dust, and humans are made out of.

Dark matter has been given this name because it doesn't seem to interact with regular matter in any way. It doesn't collide with it, or absorb energy from it. We can't see it or detect it with any of our instruments. We only know it's there because we can see the effect of its gravity.

Now, you might be saying, if we don't know what this thing is, and we can't detect it. How do we know it's actually there? Isn't it probably not there, like dragons? How do we know dark matter actually exists, when we have no idea what it actually is?

Oh, it's there. In fact, pretty much all we know is that it does exist. Dark matter was first theorized back in the 1930s by Fritz Zwicky to account for the movement of galaxy clusters, but the modern calculations were made by Vera Rubin in the 1960s and 70s. She calculated that galaxies were spinning more quickly than they should. So quickly that they should tear themselves apart like a merry-go-round ejecting children.

Rubin imagined that every galaxy was stuck inside a vast halo of dark matter that supplied the gravity to hold the galaxy together. But there was no way to actually detect this stuff, so astronomers proposed other models. Maybe gravity doesn't work the way we think it does at vast distances.

But in the last few years, astronomers have gotten better and better at detecting dark matter, purely though the effect of its gravity on the path that light takes as it crosses the Universe. As light travels through a region of dark matter, its path gets distorted by gravity. Instead of taking a straight line, the light is bent back and forth depending on how much dark matter is passes through.

And here's the amazing part. Astronomers can then map out regions of dark matter in the sky just by looking at the distortions in the light, and then working backwards to figure out how much intervening dark matter would need to be there to cause it.

These techniques have become so sophisticated that astronomers have discovered unusual situations where galaxies and their dark matter have gotten stripped away from each other. Or dark matter galaxies which don't have enough gas to form stars. They're just giant blobs of dark matter. Astronomers even use dark matter as gravitational lenses to study more distant objects. They have no idea what dark matter is, but they can still use it as a telescope.

They've never captured a dark matter particle, and haven't studied them in the lab. One of the Large Hadron Collider's next tasks will be to try and generate particles that match the characteristics of dark matter as we understand it. Even if the LHC doesn't actually create dark matter, it will help narrow down the current theories, hopefully helping physicists focus in on the true nature of this mystery.

This is how science works. Someone notices something unusual, and then people propose theories to explain it. The theory that best matches reality is considered correct. We live in a modern world, where so many scientific theories have already been proven for hundreds of years: germs, gravity, evolution, etc. But with dark matter, you're alive at a time when this is a mystery. And if we're lucky, we'll see it solved within our lifetime. Or maybe there's no dark matter after all, and we're about to learn something totally new about our Universe. Science, it's all up to you.

Source: Universe Today

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