Dark Matter, what is it?

Tapping, Ken

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/23000792
Skygazing: Astronomy through the seasons, 2016-09-27

DARK MATTER, WHAT IS IT?

Ken Tapping, 27th September, 2016

The Earth, other planets, and all the stars and galaxies we can see add up to about 16% of the material making up the universe. The other 84% is invisible. However, it's there, or something is, because we see its gravitational influence almost everywhere. If we measure the orbit of the Moon, we can calculate its mass. When we measure the orbits of stars around their galaxies, and do the same calculation, we end up with several times more mass than we can see. Someone started referring to this invisible stuff as "Dark Matter", and the name stuck. However, nobody is happy with the idea of a mystery ingredient that makes our calculations work but is otherwise undetectable, so the quest is on to find out what Dark Matter is. One possibility is that our ideas about gravity are not correct, but could they be incorrect to the extent of 84% of the mass of the universe?

So far our knowledge about gravity has worked very well. Even though we still don't know exactly what it is, we can use it to navigate our spacecraft around the Solar System and model the collapse of clouds to form stars and planetary systems. We have also used it in searching for new planets, by measuring their gravitational tugging at known bodies. We are fairly reluctant to accept – yet – that something is grossly wrong with our gravitational calculations. What else is there?

One possibility is an unknown particle, that is heavy enough to create strong gravitational effects, but otherwise does not react much with anything else. These have become known as WIMPS (weakly interacting massive particles). This might sound like the fudge factor we started with – an undetectable something that makes our calculations work. However, according to our understanding of how elementary particles work, WIMPS, if they exist, should be detectable.

If 84% of the universe is made up of WIMPS, there are lots of them around. Even if they only interact with our kind of matter occasionally, there should still be enough interactions for us to detect some. That is the objective of the LUX experiment. Lux is Latin for light, and is also the acronym for the Large Underground Xenon experiment.

Deep in a mine in South Dakota there is a large tank containing 350 kg of liquid xenon. The tank is lightproof, and inside the tank are many sensitive light detectors. The device is deep in a mine to use the Earth to screen out any cosmic rays and "strongly interacting particles" from space. WIMPS would easily penetrate down to the detector, and possibly collide with one of the xenon atoms, producing a flash of light, which will be detected. Xenon atoms are particularly big targets. The project has been running now for about three years and as yet has detected no WIMPS. These particles are either even more wimpy than predicted, or they don't exist at all.

However, the idea that Dark Matter is made up of some sort of particle is still the most popular among scientists, so there are plans to make an even bigger detector, containing 7 tonnes of xenon. Experience so far suggests that patience will be an important component in this search. How long will it take to produce a credible negative result? Since the idea that Dark Matter is made up of particles is largely in agreement with our current understanding of particle physics, this is the most widely accepted idea. If these detectors don't find any WIMPS or other Dark Matter particles, how long will it take to establish a solid negative result? If no WIMPS turn up, our ideas about the nature of space and the dynamics of the universe could be in for another upset. Is there something wrong with our understanding of gravity? Stay tuned!

Venus lies very low in the after-sunset glow, but might be visible as a bright, starlike object. Mars and Saturn lie very low in the southwest after dark. Mars is on the left and Saturn on the right. The Moon will be New on the 30th.

Ken Tapping is an astronomer with the National Research Council's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.

Tel (250) 497-2300, Fax (250) 497-2355

E-mail: ken.tapping@nrc-cnrc.gc.ca