Challenge to Dark Matter

by

Geoff Hudson

Galaxies seem to rotate as one complete fixed disc. This is quite different from our solar system where Mercury goes around the sun in 88 days, Earth takes 365, while Neptune takes sixty thousand of our days to get around. By extreme contrast, all the suns and solar systems in our galaxy take 240 million years to do one rotation about the centre of the galaxy. The speed around the centre of the stars at the edge of the galaxy, 50,000 light years out, is ten times the speed of those only 5,000 light years away from the centre. What stops them flying away? To solve this problem, astronomers invented "Dark Matter" to generate a gravitational attraction. This dark matter has to be distributed in a special way to create the forces needed. Even when it is distributed as specified by the models of the hypothesis, these models predict arrangements which disagree with observation in many cases. As far as I can tell, it does not explain anything else about our galaxies, such as the reason for the spiral appearance or the very large black hole in the middle. To me it is just a fudge factor and a very poor fudge factor because not only is there no indication of the origin of this dark matter, no explanation of how it gets distributed in the manner which is needed, and no excuse for the cases where the models get it wrong.

Before I go any further, I should make sure we are all on the same page with respect to the word Matter. For lawyers, a matter is an issue usually involving a client, someone from the firm, and some other party. But for physicists, matter is physical. There is ordinary matter which practically everything is made of, there is antimatter which is pretty well known and has a very short life, and Dark Matter which we know almost nothing about. The contrast between Dark Matter and antimatter is profound. We know a lot about antimatter. We know that for every particle which has mass, there is an antiparticle with the same mass and opposite electrical charge. We know that when an antiparticle collides with an ordinary particle of the same kind they annihilate each other and produce high energy X rays we call gamma rays. We use antimatter for Positron Emission Tomography, the PET scans used for medical imaging. Some mildly radioactive elements emit anti-electrons, called positrons, when they decay. When the antielectron meets an electron, the two annihilate each other and produce gamma rays in opposite directions. These rays are detected by apparatus in the hospital and used to locate the tissue consuming the radioactive element. The doctors can then locate the tumor or other abnormality. We know the properties of antimatter, we can create it in laboratories, and we use it in everyday life. In contrast, Dark Matter has no known properties except its presumed gravitational pull. We don't know if it is granular or gaseous, or if it can be detected by any force other than gravity. We have no idea where it came from or how it got distributed in the fancy way needed to explain the movements of stars. Two different acronyms have been conceived for Dark Matter. One is *Weakly Interacting Massive Particles* or WIMPs and the other is *Massive Astrophysical Compact Halo Objects* or MACHOs. These acronyms suggest a serious undercurrent of skepticism, to which I subscribe.

One is reminded of the "ether" which physicists a hundred years ago assumed existed everywhere to allow the propagation of light. Light is a wave, and therefore it needed a medium like air or the surface of water to move in. We look back and scoff at the foolishness of that assumption.
It is easy to cast doubt on a hypothesis. The least you should do is offer an alternative, even if the

mathematics necessary to check it out are beyond you. My idea came from the description of the detection of gravitational waves on 14th September 2015. The signal received indicated that two black holes had been rotating around each other for some time, radiating energy by generation of weaker gravitational waves and spiraling towards each other as a consequence. In the last 5th of a second, the rotational speed increased from 2 thousand revolutions per minute, to 15 thousand revolutions per minute. Well those speeds aren't faster than some car engines, but when you realize the black holes were more than 350 kilometres apart and each weighed around 30 times the mass of our sun, you can see that the angular momentum was enormous. The speed of the black holes reached 200,000 kilometres per second before they joined, about 60 percent of the speed of light1. And you thought the blades in jet engines were fast. That speed and mass made for a huge angular momentum. Astronomical is a very appropriate word.

So where did the angular momentum go?

Physics says that angular momentum is always conserved and every good ice skater knows how you can show that by starting a spin with your arms wide and speeding up by closing them. When two black holes collide and combine, they produce one black hole where all the mass is at a point in the centre. A cosmic version of closing the arms. In the Physics of the first 40 years of Einstein's General Relativity, that final black hole must have zero angular momentum because the distance by which the masses are separated is zero. The angular momentum of each part of a spinning object is the mass of that part multiplied by the distance of that part from the centre of the rotation multiplied by the speed around the centre. All the parts of the black hole are in the same spot, so the distance multiplier is zero, so the angular momentum is zero even if the mass is colossal. 1963 was the year when Roy Kerr devised a solution to the equations of general relativity which allowed black holes to have angular momentum. The relevant equations are beyond me, but they are only equations. No-one has measured the angular momentum of a black hole.

To explore this further we have to rely on the wisdom of Albert Einstein. His general theory included gravity in space and time and was stimulated by the question "What would happen to the earth's orbit around the sun if the sun suddenly disappeared?" He knew that nothing can travel faster than the speed of light, so earth would have to continue in its circular orbit for 8 minutes until the disappearance signal arrived. To explain that, he deduced that the mass of the sun was distorting space and time. The grid lines we think of as straight were being curved and the earth was responding to that curvature. The usual way to picture this is to imagine space as a stretchy cloth a bit like a finely woven nylon fishing net. This is spread flat and pulled tight so all the fibers align to give a nice square pattern. You then drop a large heavy ball in the middle. That is the sun. The cloth stretches to allow the bottom of the sun ball to be lower than the edges of the cloth. Then you throw a marble, the earth, onto the cloth and it will go around the sun because the cloth is sloping towards it. Take the sun ball away and the cloth will lift up so the earth marble will then go straight, but only when the cloth restoration ripple reaches it.

The related issue which especially interests me, is, can the heavy object twist the cloth around if it is spinning? Well it turns out that it can. There is a name for it: "Gravitomagnetism", the extent to which a rotating object drags space time around with it. The gravitomagnetic effect of the spin of our earth was measured by NASA's Gravity Probe B in 2004 to be between 30 and 44 milliarcseconds per year, comparing nicely with the prediction from Einstein's general relativity of 39 millarcseconds per year.

Going back to the black holes, I ask if the enormous amount of angular momentum could not cause the space time of an entire galaxy to be spun around. The power emitted in that last burst has been estimated as 50 times the power emitted by all stars in the known universe, so we know we are dealing with a remarkable event. It made ripples in the space time continuum which were detected

more than a billion years later in 2015. Now if it could do that, why couldn't it rotate the entire space time continuum around the resulting black hole. The rotation would propagate out at the speed of light and reach the edge the galaxy around the black hole in a few hundred thousand years. And then when we looked at that galaxy we would see all the stars rotating together in the spinning space time wrenched around by the angular momentum of those black holes. Could that be why the stars in galaxies appear to have the same period to orbit the centre, regardless of their distance from it?

Remember this rotation period is long, hundreds of millions of years, so galaxies would only have rotated a few dozen times since time began. Perhaps this rotation affects the brightness of stars within the galaxies or the red shift of their light. If it did then it might be able explain dark energy, but that might be a bridge too far.

It may be that much smarter minds than mine have thoroughly explored this possibility and concluded that it is less likely than the magical appearance of some previously unknown heavy material distributed in some cute way to suit the observations so far. I wonder if they would mind double checking their algebra. Did they include the fact that the black holes were travelling at speeds approaching the speed of light? Can we be sure that there are no other solutions for equations which dictate the properties of black holes?

I for one would be very happy to forget about dark matter.

Geoff Hudson has a Ph.D. in Physics (Experimental, Nuclear) and an M.B.A. from The University of Melbourne. He has worked in computing for most of his life, but found time to invent binary microfiche (2 MB on one 3¢ fiche) and a bedside clock which wakes you naturally with the light and sound of sunrise. He has contributed to the ABC Science unit program Ockham's Razor, having had 11 contributions broadcast.