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A MATTER OF MATTER

Ken Tapping, 26th July, 2016

Everything we see around us in the universe today, including our world and all the living things in it, are the consequence of what happened right at the beginning, almost 14 billion years ago. The young universe was small, unbelievably hot and extremely dense. Initially it was too hot for atoms to exist. Anything that came together was immediately broken up again. However eventually the temperature fell to the point where hydrogen, the element with the most hardy atoms, could form. So almost all the primordial energy and particles turned into hydrogen. Consequently as the temperature fell further, to the point where atoms of other elements could form, there was little material left over to make them. So the young universe was mostly made up of hydrogen, with some helium and only traces of anything else.

Over billions of years, stars formed from the hydrogen, and made energy by turning it into other elements. When those stars died, they distributed those waste products into space, where they slowly reacted to build the mix of chemicals that are the basis of life as we know it. This chain of events is interesting, but then we need to add two more ingredients: dark matter and dark energy.

The trouble is that at the moment, these mysterious concepts are a bit of a fudge. Studies of galaxies suggested the existence of a lot of material we can't see; we called it Dark Matter. Similarly, the expansion of the universe is accelerating; to account for this an outward force called Dark Energy was introduced. These concepts nicely account for our observations, but there is no direct proof that either of them exist. Moreover, when we budget up how much dark energy and dark matter we need to explain those observations, they account for more than 95% of the material in the universe. The less than 5% remaining makes up everything we CAN see. Knowing next to nothing about more than 95% of the universe is guaranteed to trigger a lot of curiosity, so there is a strong effort to get solid evidence that dark matter and dark matter really exist, and to find what they are. This means we have to better understand what was going on at the beginning. Unfortunately until 380,000 years after the Big Bang, the universe was completely opaque to light, radio waves and the other electromagnetic waves we can observe. Fortunately we are not completely blind; observing gravitational waves can take us further back, and we can look at neutrinos (strange particles that can pass through almost anything, which however makes them hard to detect), In Canada the Sudbury Neutrino Observatory, in Ontario, is a powerful tool for this. Using our current understanding of physics does not help much because the calculations break down or - as far as we can guess – give unrealistic results when applied to the bizarre conditions existing at the beginning of the universe. There is one more research approach we can use – laboratory experiments. This means duplicating those extreme conditions in the laboratory. This is very difficult, because even the temperatures and densities in the core of the Sun are negligible compared with what are needed to emulate things that happened at the beginning of the universe.

This research was one of the objectives that led to the construction of the Large Hadron Collider, a massive international research facility located near Geneva, Switzerland. This instrument can, for tiny lengths of time, on an extremely small scale, duplicate the conditions existing during the Big Bang. It's early days yet, but there are already some cracks appearing in long-held theories. However, finding out what is wrong with our ideas is a key step towards finding out what is right.

Jupiter is lost in the sunset glow. Mars and Saturn lie low in the southern sky. Mars is the brighter one; Saturn lies to Mars' left. The Moon will reach Last Quarter on the 26th and be New on the 2nd.

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