OUR UNIVERSE

Introduction

This series of articles was published in my local parish newsletter on subsequent months. It came about in answer to questions posed by the Rector in his leading editorial, as a result of him watching a series of astronomy programs on television by Brian Cox. So it was read by the general public over a period of several months, which is why some is slightly repetitive and it jumps topics to avoid concentration on just one topic for a whole article. It does have a cohesive whole.

Part 1

I first discuss the formation of stars and the synthesis of the elements.

The Sun came from gravitational attraction of tenuous hydrogen and helium clouds in the galaxy, eventually compacting down to form clusters of stars. The solar system formed from the remaining gas and dust heated up by the new Sun and collapsing down and cooling into a rotating disc; then condensing and crystallising into solid material, that gravitationally grouped into the planets.

The energy of the Sun comes from within its core at 15 million degrees Celsius. Here, hydrogen atoms in the form of protons occasionally fuse in quadruplets to form helium atoms (each of two protons of positive charge and two neutrons (which were protons stripped of their repelling electric charge, ejected as anti-electrons (positrons)). Helium atoms have a few percent lower total mass (mass energy) than the sum of their parts (the protons and neutrons). That is because it is more stable than its separated parts (lower energy) and has given off the difference in the form of electromagnetic energy, as gamma-ray photons. These are scattered by all the electrostatic charged atoms on their Million year journey to the solar surface, emerging As heat and light. The Sun is 4.7 billion years old, halfway through its life cycle.

When the supply of hydrogen runs out in the core of the Sun, its core will shrink, due to the huge pressure of gas above and lack of sustainable temperature pressure to balance it. The protons and neutrons in the core, get as close as they can to each other, each one at a different energy level, like steps of the latter, with no energy levels empty. This is called degeneracy. The outer layers of the Sun will expand and cool and envelop the inner planets, before finally shrinking. That could be the fate of the Earth. But it might just escape that, as some of the solar gas will blow off, making the Sun less massive, causing the planet orbits to move further out.

In a much bigger star, the temperature of the core will reach over 100 million degrees C at core collapse, and then a small fraction of the helium can fleetingly fuse to form stable carbon (triplets of helium). In very massive stars a series of further reactions involving carbon and its products produce all the basic elements up to iron. But in forming iron, energy is absorbed rather than released under core collapse, suddenly to be completely degenerate, a state in which all the protons, which normally repel each other due to their electric charge, convert to neutrons to be even more compact. The rest of the star bounces off the core and shatters as a supernova. In that fleeting moment the temperature is so high that, with a flood of neutrons, elements beyond the mass iron form and become stable. These elements include gold and platinum. All the elements so far formed are blown out into space. These mix with the hydrogen and helium in space and eventually form new stars such as the Sun.

So this is where all the elements on Earth have been formed, including carbon and everything else that we are made of: not in the Sun, but in huge, massive stars long since gone before the Sun ever existed.

You may ask where the hydrogen and much of the helium in the Sun came from if it was not formed in stars as such. It was formed in a series of nuclear reactions about one minute after the creation of the Universe. Due to the expansion and consequent rapid cooling of the early Universe, no production of heavier elements occurred.

So we just have hydrogen and helium from the formation of the Universe. All other elements came from very massive stars long before our Sun.

The material for life, basic amino acids together with other carbon-based molecules and water ice , were also formed in dark very cold hydrogen clouds in the vacuum of space between the stars, before arriving on earth through comet impacts, that eventually formed the oceans.

Now briefly I discuss energy, order and disorder. The second law of thermodynamics states that as time passes, order decreases towards chaos (entropy increases). At a fundamental level this means that matter particles split to their individual lowest energy building blocks. This is controlled by the first law, which is usually stated as the overall conservation of energy, i.e. that the total energy in any isolated system remains the same (conserved) but can be transmuted between one form and another. One cannot create or destroy energy, just transmute it to different forms.

Synthesis of elements and heavy elements in massive stars as they finally explode, are examples of increased order, but the surrounding space of what is left over is actually less ordered. This is true of any ordering process, even building a house from its materials!

In the next part I will explain the basic positive energy building blocks of atoms (fundamental particles) and their basic rules of behaviour, in theory analogous to rules of combinations of children's coloured bricks. I will also cover the negative energy binding forces, including gravity, which, for the Universe, is balanced by its positive energy of expansion, in my view, thus making the overall energy of the Universe zero (always has been and always will be). I will also explain how all the fundamental particles of the Universe were created from the vacuum of space, which itself can never be absolutely zero energy at any location. Nor do they occupy any specific location at any one time, which makes them wavelike. They were moulded in a copy of the vacuum of virtual particles! in a production line process at the very start of the universe at a an incredibly brief time of super rapid inflation. This creation process continues to go on fleetingly around us all the time, but no longer leads to sustainable particles.

In the final part I will explain that, in accordance with the Anthropic Principle, we, as observers, define the state of particles and thus the actual course of events from all the possibilities, and so it can be argued that we have control of all that has happened and ever will. But, ambiguously, perhaps we have no determinacy whatsoever. Nature refuses to decide; only we can.

CHRIS BADDILEY