OUR UNIVERSE

Part 2

Here I will concentrate on the very small and briefly summarise the Standard model of particles.

An atom is typically 1/10,000 of a micrometre across, and is mostly empty space; electrons exist in this space as structured shells of waves of negative electrical charge, around a core of protons and neutrons that have a scale some 1/10,000 smaller but over 1000 times more massive. The more protons in the nucleus , the more electrical charge it has and this is balanced by more negative shells of electrons.

Bonding into molecules is by outer electron swapping between adjacent atoms . And it is this that gives elements their physical and chemical properties in nature (The periodic table of the elements). In the nucleus, some 1/100,000 smaller than the atom, are protons of positive charge, and neutrons. An electron has less than 1/1000 of the mass of a proton, but has equal and opposite electric charge.

Electrons have no component parts, i.e. are fundamental and are infinitely stable. There are more massive versions, but they are very short lived and so only are found briefly in high energy processes.

Protons and neutrons are not fundamental because they have component parts on a much smaller scale. A neutron can be thought of consisting of a positive proton and a negative electron in combination . There are heavier versions and even heavier ones, but those are extremely shortly lived. The components are called ‘quarks’ and bind to each other in triplets by continually swapping each other's properties. By analogy, they behave a bit like red green and blue coloured lights seen from a distance, where one can't distinguish them, and they look as one as overall white. Quarks can appear in doublets in particles called Mesons that are less massive than protons or neutrons. It is a Meson gas that maybe the ultimate fate of the Universe when the triplet pairings finally break down in the protons of all matter.

The more massive the particle, the shorter its life, as it decays into more stable and less massive combinations. The more massive families only last 1/100,000,000 of a second and can only produced at extremely high energies, as in the large Hadron Collider, or at the very beginning of the Universe when it was only that old. Neutrons on their own soon decay to protons by emitting electrons. But in the presence of other protons stabilise the nucleus.

We know of four forces of nature. The strong force and the weak force only apply within the nucleus, holding it together. They are very short range but extremely strong, and behave like messenger particles themselves carrying the properties between quarks for the strong force and between protons and neutrons for the weak force. Then we have a electromagnetism, that is electrostatic and magnetic attraction and repulsion. This is between electric charges in the first case and spinning or moving charges in the second. Here, the force messenger is the infinite range photon, which can also be thought of in terms of an oscillating wave of energy, in the form of heat or light or radio waves etc. that we are so familiar with. These average out over any significant distance as electrical opposite charges balance out. By far the weakest force is gravity and only acts on total mass of an object. It takes the mass of the Earth and a mass of 1 kg to produce an attractive force of

1 kg weight, and falls off with distance like the others, but never becomes zero . It is miniscule compared with all the others, but it adds up to be the most strongly influential force in the Universe.

A simple analogy of force messenger particles, is two warships firing shells at each other. The recoil from the guns causes the ships to move apart, as also does the impact of the shells on the opposing ships, one against the other. So effectively this acts like a repelling force. An attracting force would be if they fired their guns away from each other!

In the next part I will show how particle pairs can appear out of nothing and disappear instantly, unless the energy is available to form them permanently. This is the creation process and is happening all the time, but spectacularly at the start of the Universe. I will also consider different forms of energy and overall energy conservation, how gravity makes planets orbit their stars, and in the same way controls the expansion of the Universe, to make it the wondrous place that you can see on a starry night.

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