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Matter scores over anti-matter

Can matter pop out of nowhere? asks S.Ananthanarayanan.

Physicists have seen instances of just that when high energy particles of light gives rise, ‘spontaneously’, to pairs of electrons and positrons.

The positron is what is called the ‘antiparticle’ of the electron. It has the same mass as the electron, but has the opposite charge. The photon, or particle of light that gives rise to the pair must have at least the energy equivalent of the mass of the two particles. And the opposite charge of the two particles takes care of the need to conserve charge.

Antiparticles

A celebrated mathematical theory for the electron presented a remarkable feature - it permitted a valid solution even with an electron with a positive charge! At the time only the electron, which has negative charge, was known and the peculiar feature did not make sense at once. But the electron with the positive charge, christened the positron, was soon discovered and validated the theory!

Theory, in fact, predicted such ‘opposite’ or ‘anti’ particles for a host of other particles and all of them were soon discovered in experiment.

Annihilation on contact

When particles meet their antiparticles the two disappear into a puff of energy! This keeps happening in cosmic rays, or high-energy particles that enter the earth’s atmosphere. Interactions in the atmosphere create high energy photons that give rise to electron-positron pairs. The electrons or positrons, in turn, encounter positrons or electrons and give rise, again, to photons!

An Anti-universe

The particles that constitute matter all have antiparticles and in fact matter itself is possible with the particles interchanged with their antiparticles. In place of hydrogen, which is built of a proton and an electron, for instance, we can have an ‘anti-hydrogen’ made up of an anti-proton and a positron. In this way, there can be a whole universe made up of matter consisting of ‘anti-atoms’.

Should such an anti-universe ever encounter a proper universe, can you imagine the fireworks they would set off?

Is the universe symmetric?

On the face of it, the physical laws seem to be symmetric – the world should be quite possible even when seen through a looking glass, or with all positive charges exchanged for negative

charges and vice versa. A consequence of this is that the processes that first gave rise to matter, the ‘big bang’, should have created equal quantities of matter and antimatter.

Unfortunately, there is no evidence that any concentration of antimatter exists anywhere in the universe. Nor could it, even in theory, for it is unlikely that any quantity of antimatter would have escaped annihilation by equal an quantity of ordinary matter.

Asymmetry in nature

A way ou**t** of this bind turned up when it was found that in some reactions of elementary particles did not behave the same way on ‘reflection’ or on ‘charge reversal’. A model of the constituents of matter based on this showed that nature was not quite ‘even-handed’ and could prefer the creation of matter over antimatter.

Work at the Stanford Linear Accelerator Centre in California has found that results of high energy experiments tally with the matter-anti-matter ratio found in the universe.