Feature

Strings of Physics

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New Delhi (India Science Wire): Like melodious music of a violin or a veena, we are all perhaps ultimately vibrations of tiny invisible strings, says renowned theoretical physicist Prof Ashoke Sen.

Once upon a time it was thought everything in the universe was made of *pancha tatva* or five elements of earth, water, fire, sky and air. Then the understanding graduated to the indivisible atoms of Dalton.

Come Rutherford, scientists came to know about protons, electrons and neutrons - sub-atomic particles. In the past few years it has emerged that it is even smaller particles, fundamental particles, like quarks that make up protons and neutrons.

Now, there is String Theory, which says that quarks themselves are not the most fundamental particles. On the contrary, they are but manifestations of tiny strings. “The elementary particles are strings. They are not different strings. They are one kind of string vibrating in different modes” says Prof Sen.

A professor at the Harish Chandra Research Institute in Allahabad, Prof Sen is an authority of string theory. Apart from offering a deeper understanding of the fundamental particles, the theory also promises to fill gaps in the Standard Model of particle physics, which had hitherto been used to describe the various particles and forces in the universe.

The Model does describe succinctly what the universe is all about and what holds it together. It is a comprehensive theory that explains hundreds of particles and their complex interactions. Several experiments have verified it to a large extent. However, it does not explain everything. For example, gravity is not included in the Standard Model.

According to the Standard Model, fundamentally there are six quarks, six leptons, 13 force carrier particles and four fundamental forces: gravity, electromagnetism, strong and weak forces. When we slip and fall down we experience gravity; whenever we use a mobile or television we use electromagnetic force. But, weak and strong forces are strange and unfamiliar.

Why weak and strong forces are so different? Prof Sen explains “we are familiar with gravitational and electromagnetic forces since they are long distance forces. They act even from far away. Strong and weak forces are, instead, short range forces. Typically, they do not operate beyond the range of an atom. They become visible and their actions become dominant only when we probe deep inside the atom. Strong force cannot be felt beyond the order of 1 femtometre, which is one-millionth of a nanometre.’’

Standard model had held currency all these while even though it did not include gravity. That was because gravity is a very weak force and was of not much relevance till recently. However, things are now changing.

Prof Ashok Sen says, “The reason gravity has not bothered us so much is because it is very weak. But, one can imagine an experiment which will involve accelerating particles to an energy which is much higher than what we have achieved today and colliding them together where gravity will be as strong as the other forces and in that context if you want to know what would be the result of the experiment you cannot explain it without understanding gravity.”

Non-inclusion of gravity is not the only problem with the standard model. For example, the model predicted that neutrinos, the tiny particles with no charge, would also be without any mass. Recent studies on neutrinos show them to have non-zero mass that put to question the validity of Standard Model.

The String Theory incorporates gravity along with the other three forces (electromagnetic, weak and strong forces). This makes it more comprehensive than Standard Model.

If we take the strength of Strong force to be 1, then Weak nuclear force strength will be only 10-15, the strength of Gravitational force 6 X 10-39, and Electromagnetic force 1/137. But both Strong and Weak force cannot operate beyond 10 -15 metre, whereas the action range of electromagnetic and gravity is infinite.

Billed as one of the top five physicists in the world today, Dr Ashoke Sen won the three million dollar Fundamental Physics Prize, established by Russian billionaire Yuri Milner. He is also a recipient of India’s top most scientific award, Shanti Swarup Bhatnagar award. He was honoured with Padma Shree by Government of India in 2001. (India Science Wire)