

## **On the so-called ‘God Particle’**

On July 4, this year the internet buzzed to wake up the world, like a hawker selling the newspapers on the street, with the news, hot from the press, “at last the experimental evidence of the existence of the ‘god particle’ has been found”. I mused myself with the thought, ‘thank God, it was only the particle and not God, for which evidence has been declared. The circumstantial evidence for the existence of the ‘god particle’ had an overture similar to that of the zealot priests pointing to the evidence of the existence of ‘God’ in the pages of the scripture. The news did not make me jump and dance and there was no street party in our neighbourhood or opening of champagne bottles at work. Only one of my colleagues, during the coffee break, made a passing remark with a grin on his face, “the magicians at the CERN are at it again I hear”. I nodded with approval.

On this occasion, the experimentalists trying to prove the existence of this elusive particle were being referred to as, ‘magicians’- now you see it and now you don’t, type of tricks. A handful of theoreticians, may as well be called, ‘sooth sayers’ had been pontificating about the fundamental constituents of matter and forces that govern the Universe, had already predicted its existence and provided details of its properties quite a while ago. People belonging to these two esoteric and elite camps, in cohort, convinced the right people with right purse, that they needed to establish a very large circular structure, called the ‘particle accelerator’, imbedded with immensely complicated electronic and magnetic components all along its circumference to obtain experimental evidence for the so called, ‘god particle’. These particles, like most other elementary particles, are magical, but unlike others these are extremely elusive. The evidence of all elementary particles are circumstantial and indirect, e.g. a trace in a cloud chamber. In these particle accelerators, particles like neutrons or protons, much larger than electrons, are accelerated to make them move faster and faster to gain high kinetic energy. After reaching the maximum speed (energy), within the constraints and limitation of the particular machine (accelerator), these sub-atomic particles are allowed to collide with each other so that they may breakup. As a consequence of this their constituent elementary particles, albeit extremely short lived, might come out of their shells (Neutron or proton) and leave traces in a specially made cloud in a specially designed chamber. Such traces, with specific bends and lengths, according to the soothsayers, will constitute the proof of the existence of specified elementary particles. While small structures, requiring relatively smaller energy protons were required to smash out most elementary particles, it would, according to the calculations of the soothsayers, would require an enormous accelerator structure to smash out the so called, god particle’ from its proton shell. The magicians got working and produced the biggest experimental jig ever produced for any scientific experiment. The accelerator circle was big enough to encircle the city of greater Dhaka and is famously known as Large Hadrons Collider (LHC). Despite its complexity and enormosity, every bit of it was made with extreme precision to allow protons to be accelerated in opposite directions almost at the speed of light and collide with each other at the right moment. Thousands of scientists were involved in the search for this elusive particle and after fourteen years and an estimated cost of 7 billion pound sterling the announcement came as a welcome relief for the EU tax payers.

Or did it? The ‘soothsayers’ immediately announced that it was only the beginning. More, much more elaborate, complex and powerful accelerator and higher computing powers would be

needed to understand and unearth the mysteries of the matter and forces that interact with matter and constitute the Universe – A ploy to secure jobs for the boys perhaps?

Perhaps this is not the case. Man's quest satisfying his eternal and innate thirst for knowledge is overpowering. Imprisonment and threat on life did not stop Galileo to search and tell the world the truth about our planetary system. The threat of life and ex-communication did not deter Darwin to stop searching for the truth on the origin of species. So, there is no reason why the inquisitive mind stops searching for the origin of matter.

We were led to believe by the soothsayers around the world, including the Scottish theoretical physicist, Peter Higgs, that this unique elementary particle must exist as one of the constituents of the sub-atomic particle, proton, otherwise the so called 'standard theory' will not hold water. This standard theory some how, gives a rational, or rather a logical explanation of the matter and forces of nature. But, it is not the 'holy grail' – the theory of everything. It does not account for the so called dark matter (80% of the missing matter?) and the nature of the force that brings the apple to the ground – the gravitational force.

The existence of the 'god particle' is of paramount importance, because according to likes of Higgs, its existence allowed them to explain why matter exists at all. Additionally, it is postulated that this particle may also explain the gravitational force and help us locate the so called, dark matter'. Its importance was considered to be so great that none other than the famous noble laureate physicist Leon M Lederman published a popular science book on this phantom particle in 1993. The book entitled, 'If the Universe is the Answer, what is the Question?' gives some predicted properties of this most illusive and shy particle. According to the gospel of Liebermann, the experimental proof of the existence of the 'god particle' would be extremely difficult to obtain and will need drastic improvements in particle accelerator technology. He wanted to christen this 'difficult to visualize' particle, cryptically, as the 'goddamn' particle, but we were informed that his publisher objected to this title for political reason and instead coined the name 'god particle'.

The experimentalists at CERN (Centre for Experimental Research) in Switzerland had been trying to accelerate protons, moving in opposite directions in circles using the LHC for some time. Of late, all efforts were focussed on proving the existence of the 'god particle'. According to the high priests of the convent of the particle physics, collisions need to take place at an extremely high speed (very near to that of light) for smashing out and detect the 'god particles'. Although the 'particle in question' is supposed to have a high mass compared to that of other elementary particles already detected and identified, like fermions, leptons, quarks etc, these are predicted to be very short lived (trillionth of a second). When Fabiola Gianotti, the present head of the experimental section of LHC were presented with the results bearing the evidence of this particle she exclaimed with a gasp and utmost surprise and joy uttering, 'my god! The sensation-hungry journalists took the first opportunity to take it literally to announce the news of the discovery of the, 'god particle'. Did the community of the particle physicists object to the name? Why should they? There is a joke amongst the high priests, 'discovering something are only 20% of the job, the rest is finding right words to promote it and attract further funding for further research'.

The famous scientist Paul Dirac coined the name, 'Higgs Boson' long before it was known as the 'god particle' to honour the Indian scientist Satyendra Nath Bosu. One may ask what 'Boson' has to do with Bosu? The word comes from the name 'Bose', the English version of the surname 'Bosu'. It is to be noted that Prof. SN Bosu was the head of the Physics department of the then Dacca University in west Bengal (now the University of Dhaka in Bangladesh) during 1921-1945. He collaborated with Einstein and developed a statistical formalism, famously known as, Bose-Einstein Statistics'. According to the theory, amongst other properties, this particle, along with a few other elementary particles which constitutes neutrons and protons, must follow the Bose-Einstein statistical law. So, in the same manner as other elementary particles, such as photons, gluons, W and Z bosons etc, which also abide by this statistical law, this so called 'god particle' was naturally called a 'Boson' after the name Bose, but it has to be the 'Higgs Boson' who postulated its existence as early as in 1964. It is noted that some elementary particles such as, electrons, quarks, leptons etc follow a different kind of statistical law, known as 'Fermi-Dirac Statistic' after the name of the Italian scientist Enrico Fermi. Here, we will be concentrating our discussion only on the 'god particle' whose behaviour is governed by Bose-Einstein statistic.

It all came about from the prophecies of the soothsayers. A handful of such visionaries, dotted around the world (including Higgs), were asking the very fundamental question, "What is matter after all? How it exists and how it interacts with forces of nature?" It is generally believed that answers to such questions may lead to the understanding of the mysteries of the Universe, such as what is the mechanism by which apple falls to the ground (gravitation), why time flows only in one direction etc. To find the answers to such queries the theoretician (soothsayers) invented a 'hitherto unfathomable (by ordinary people) mathematical machines (formalisms). They put in all the observable data on the interactions of matter with forces into this machine and turned the handle. The results that came out of such machines and further manipulations are mind boggling and beyond the understanding of most of us. It was predicted that out of the 3 basic constituents of mater, electron, proton and neutron, the last two are not elementary particles at all. They themselves are made of a handful of other elementary particles: 3 pairs (particles and anti-particles) of quarks: up/down, charm/strange, and top/bottom, 3 pairs (particles and anti particles) of leptons: electron/neutrino, meuon/neutrino, tau/neutrino and some force carrying particles, also known as energy fields (it is noted that energy and matter are interchangeable quantity, like two sides of a coin). The energy carrying particles are: photons, which are related to the electromagnetic force, gluons (strong force), which bind neutrons and protons in the nucleus and W and Z bosons (weak force), which cause the mater to bond loosely over a very short distance. Evidence of all the particles predicted by the standard model has been observed (all circumstantial). However, the model does not tell how the matter exists and does not take account of the gravitational force, which may be attributed to elementary particles called gravitons. To account for these, there has to be 'Higgs bosons' which are supposed to accumulate at a point within the energy field and suffuse to give the point the property of 'solidity', the thing we parameterize as 'mass'. Albeit, it is a strange phenomenon, its existence has given credibility to the standard model. It is believed that with the proof of the existence of Higgs boson the standard model may be extended to include gravitational force and, in not too distant a future, the particle physicist may be able to explain the dark matter, the 80% of the hitherto invisible and undetected matter in the universe.

The experimental evidence of the existence of the ‘god particle’, costing a very long time, huge amount of money and manpower did not create as much enthusiasm among the general mass and the politicians as the magicians expected. The reason is simple. Its existence was already known and there was no reason not to believe in this. This is simply because all the other predicted elementary particles had been experimentally detected and their properties have been verified by other little brothers of LHC dotted across the northern hemisphere of the globe. Prediction of Higgs boson i.e. the ‘god particle’ comes from the same camp. We just had to wait for the particle collider to get a bigger ‘oomph’ to enable smash out the shy particle from the proton shell. It appears that the experimental evidence produced by the so called ‘magicians’ has satisfied the ‘idle curiosity’ of the so called soothsayers.

I am glad to say that ‘idle curiosity’ it is not. The quest for knowledge of ‘who we are and how we come to exist’ are the questions which opened up the dawn of civilization and the effort to quench the perennial thirst for the knowledge has paved the way to the status called, ‘human being’ that we have acquired and enjoy with pride. Accountants of the world may write off the cost of installing and running the LHC as a bed debt to the tax payers. Cost analyses may be carried out for efforts to invent new techniques or processes for producing more efficient food for the hungry world, effective medicine for sick people of the third world countries, inoculations for all etc. But how can one stick a price tag on knowledge?

It is worth reminding that the internet-World Wide Web (WWW), which has brought the world into our palms and changed our lives and style of living irreversibly is one of the windfalls from research and development on elementary particles at CERN. The big question is should more money and resources be injected into projects such as that at CERN to make the colliders more powerful so that one day, in not too distant a future, existence of ‘gravitons’, the gravity giving particles, ‘gluons’ the force giving particle, vast amount of ‘dark matters’ etc may be detected and their existence be included in the, ‘standard model’. This will be the realization of the Holy Grail – the theory of everything. We may not reach the goal, as the goal may be a mirage, but the quest for this ‘Holy Grail’ has its own reward. As the saying goes, ‘the success of a journey is not in journey’s end, but the journey itself’. I quote Stephen Hawking, the celebrated scientist and the author of the best selling book, ‘ A brief history of Time’: "If we do discover a theory of everything it would be the ultimate triumph of human reason—for then we would truly know the mind of God”.

Mind of God! This legendary and alive scientist has, at last, resorted to bringing in the concept of god. But how do we comprehend the concept of a ‘mind of god’ with our own minds of limited scope?\_Perhaps our mind is not as limited as we may make out to be. It appears to be limitless and the knowledge of the mind of God is the knowledge about our own mind– conscious mind. It brings in the old philosophy of ‘know thyself – thou art that (god)’. Is it not just saying that the discovery of the theory of everything will expand our consciousness; we will actually know our selves. Doesn’t it imply that the concept, ‘mind of god’ coined by Prof. Hawking is, in effect, the mind of God’s man? In this level of complexity the prophets of the particle physics are probably dabbling in a twilight world of physics, philosophy and spiritualism. The conflict of concept of the true nature of photons, one of the elementary particles continued for centuries, until it was resolved by the Copenhagen agreement aided by a mathematical machine called quantum electrodynamics (QED). For Einstein, such resolutions were superficial and truth lies far deeper

that we can comprehend. The magicians have, however, proved how superficial these resolutions are. Simple experiments with two slits and a source of light have proved conclusively (within the realm of human logic) that if one wants to detect a particle of photon (using a photo detector) one detects particles – an elementary particle. On the other hand if he uses a photographic screen and expose the light passing through the two slits. He observes light and dark fringes, conclusive evidence of the detection of waves. Although both are elementary particles, there is a subtle difference between the photon and the god particle. The former has no rest mass (it never rests), where as the later has a substantial mass. Despite this difference, is it possible to argue that it appears as a particle because we have made and set up device to detect particles in a cloud chamber, it does not exist at all in reality but only in our mind? It may be that the concept helps the prophets who are trying to know the ‘mind of God’, construct the standard theory.

New prophets are emerging time to time. Some are proclaiming that the standard theory or the so called ‘theory of every thing’ may be constructed without the need for invoking elementary particles like, Higg’s bosons (god particle). This theory is being developed by a new class of theoretical physicists. One of the pioneers of this theoretical René sons is an Indian (Bengali) physicist Prof. Ashoke Sen, currently working in Allahabad (UP). He is the current Milner prize winner for particle physics (Russian equivalent of Nobel Prize and worth 3 times more than that in money terms). This is a complex mathematical theory known as the ‘string theory’ which, it is claimed, may be able to explain almost everything we know about the matter and energy in the Universe. The ‘string theory’ is based on the idea that the elementary constituents of matter are not point particles, as the standard model predicts or assumes, but one dimensional objects or strings. This theory automatically combines quantum mechanics, and general theory of relativity, i.e. Einstein's theory of gravity. It also has the potential for explaining the other known forces of nature e.g. the strong, weak and electromagnetic forces". The mathematical theory itself still cannot be proved or disproved since proton smashers like those at CERN have still not attained the enormous energies needed to test the string theory. But wait a minute. There are more. We now here that even the elementary particles like those of the ‘god particle’ are not quite fundamental particles, they decay into other, perhaps, truly fundamental particles. Electrons are no more considered as truly fundamental particles. They have charge, spin and angular momentum and they must be made of ‘chargons’, ‘spinons’ and ‘momentumons’.

The questions may be asked, “Does the emergence of the string theory, and newer concepts of elementary particles threatens the validity or need for the ‘standard model’ theory? Does the god particle or most of the elementary particles exist because we wish them or need those to exist? Where does the truth lie?” The answer to the last question must be the standard one, “we are not going from falsehood to truth, but we are going from the truth to a greater truth”. Thanks to research on particle physics which has given us ‘WWW’. No one knows what other windfall will come about through the search for our identity- the force of nature and the make up of the universe. We must continue to support and take interest in fundamental research at CERN and other places. We never know what will be the next windfall from such research for the benefit of mankind.

As for understanding the nature of the ‘god particle’ by educated laymen like us, it is like understanding the meaning of the words, ‘Hing, Ting, Chot’ in the King’s dream as eloquently described in Tagore’s poem on the same title. The theory which describes the model which

accounts for the elementary particles, including the ‘god particle’ is, for us and for all intent and purposes, like the explanation of the king’s dream by the octogenarian saintly Sadhu, the soothsayer – we feel we have, at last, understood the meaning of life!

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