New Advances in Physics, Vol. 12, No. 2, December 2018, pp. 129-132

Twelfth Anniversary Cuts

B.G. Sidharth*

1. Let us refer to the paper "New Fine Structure Energy Levels" in New Advances in Physics [1].

   The point of this paper is that because of the photon mass the Coulomb potential goes over to the Yukawa potential

$$\frac{1}{r} \to \frac{e^{-\mu r}}{r} \tag{1}$$

   If the photon mass were 0, then μ in (1) would vanish and we recover the Coulomb potential. However there is another way of looking at it. The Coulomb potential as is known, on the left side of (1) has an infinite range. If however the universe were finite then we would recover the Yukawa potential in (1) with

$$r \sim \frac{1}{\mu} \tag{2}$$

   in suitable units.

   Interestingly we can show that from (2) we can recover

$$r \sim 10^{27}\, cm \tag{3}$$

   which gives the radius of the universe! (Cf.also ref.[2]). From this point of view it would appear that a small photon mass $\sim 10^{-65} g$ would effectively be the same as a finite universe of radius $\sim 10^{27}\, cm$.

2. The Ultra High Energy Behaviour of Fermions and Bosons have been discussed in a few papers in New Advances of Physics and elsewhere (Cf. refs.[3, 4]). One of the conclusions was that it is only lefthanded particles that can decay because as pointed out in the above papers, at ultra high

* G.P. Birla Observatory & Astronomical Research Centre, B.M. Birla Science Centre, Adarsh Nagar, Hyderabad - 500 063, (India)

energies particles exhibit a handedness. This can be seen in a simple way, as follows.

The Dirac 4-spinor can be written as

$$\begin{pmatrix} \phi \\ \chi \end{pmatrix} \tag{4}$$

where at lower energies ϕ dominates, while at very large energies, it is χ that dominates. This is the region where the Cini-Toushek transformation holds. Specifically as shown in the above references, we can write a wave function as, $\psi = a\, \psi_R + \beta\psi_v$ where $\alpha \approx 0$ at high energies so that $\psi = \psi_L + \epsilon\psi_R$.

Further, what may be called heavy neutrino like behaviour leads to decay. Surprisingly this has been confirmed in the LHC, Geneva. It is only the lefthanded Λ_0^b particles that had decayed.

A team working on the LHCb experiment in 2015 looked at the decay of trillions of subatomic particles known as lambda zero b baryons emerging from collisions at the Large Hadron Collider and made the announcement in the journal Nature. "Only subatomic particles with a left-handed spin decay as a result of one of the fundamental forces, confirming that the Universe has a left-hand bias." This inexplicable finding can be explained by Sidharth's anticipatory work.

3. In another paper, Particles and Antiparticles, in EJTP [5, 6] and other papers, it was pointed out that anti neutrinos would have a mass slightly different from neutrinos themselves contrary to the belief that particles and their antiparticles have the same mass. Surprisingly this conclusion has since been observed in the MINOS experiments in USA.

4. Equation (4) above also could explain baryon asymmetry. In the initial stages of the Big Bang, at ultra high energies, that is antiparticles would dominate. But as the universe cools, ϕ begins to dominate and we get the predominance of particles.

5. There have been many papers of the author on graphene in IJTP, IJMPE, and elsewhere [7, 8, 9, 10, 11]. The conclusions of these papers are that the noncommutative geometry inherent in the hexagonal lattices of graphene imply some interesting consequences. Firstly they provide a theoretical explanation for the Quantum Hall Effect. Secondly they imply that there would be a minimum conducting current that arises from the two dimensional nature of the graphene lattices. This would be a free current

though it would be very weak. Thirdly the graphene structure gives an explanation for the origin of electromagnetism itself in terms of noncommutativity. Finally it was pointed out that these properties are not unique to graphene alone, but also to any other two dimensional crystal because they depended only on the noncommutative nature of the space, rather than the specific hexagonal shape. Shortly thereafter, as a confirmation, the same properties were found in Stanene.

Finally, in this connection, it may be pointed out that the author has also argued that these 2D crystals provide a test bed for High Energy experiments, much as a wind tunnel does in fluid flows via the Reynold numbers.

Earlier, in the 1990s, the author had predicted the strange neutrino behaviour of 2D and 1D structures with respect to motion of electrons [12] but these were taken note of only after the discovery of nanotubes and graphene.

6. It was argued by the author that the cosmic background radiation is due to the Zero Point Field which permeates the universe and leads to radiating like radio waves. These have been observed by NASA's ARCADE experiment. Further it was argued that it is this same Zero Point Energy or Dark Energy in the author's formulation which peeks at roughly three millimeters corresponding to the cosmic microwave background [13].

   Needless to add, that the author's original cosmological model with this dark energy, predicted an acelerating universe when the so called standard Big Bang model asserted the exact opposite [14]. This was observationally confirmed the very next year by Perlmutter, Riess and Schmidt.

7. It was pointed out how it is possible to go beyond the standard model using Sidharth's ideas by incorporating a small neutrino mass [15].

8. An anomaly in dark matter was recently pointed out by Nobel Prize winning astronomer Adam Riess who later confirmed the same. This anomaly can be easily explained if we could do away with dark matter and instead retain a varying G, a small variation [Sidharth and Das].

9. Sidharth (with A Das) argued that it is possible to in principle to manipulate decay rates of radioactive elements, either increasing them or decreasing them in a suitable experimental setup.

10. A study (with A Das) of unidirectional beams neglecting inter particle interactions, for example neutrons leads to very interesting results based

on Sidharth's 1999 paper in Journal of Statistical Physics [12]. We are able to obtain a Bose-Einstein like condensation but at energies slightly different from the absolute zero and also achieve transmutation of Fermions to Bosons.

11. The possibility of superluminal neutrino (with a probability) has also been investigated.
12. In a talk delivered at University of Udine in July 2018, Sidharth pointed out that we could explain General Relativity in terms of normed spaces rather than curvature. Extracts from this talk have appeared in PSTJ Journal in 2018 [16].

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