Baryon Asymmetry, Dark Matter, WIMP and Super Massive Black Holes

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Abstract :

CPT theorem is reinterpreted in the context of commonly observed phenomenon of free neutron beta decay and extrapolated to explain the Baryogenesis in the early Universe that has led to the observed Baryon Asymmetry in the present Universe. Anti-neutron and Protonium are proposed as a suitable Dark Matter WIMP candidates. Anti-neutrons are proposed as the basic components from which Super Massive Black Holes (SMBH) at the Galactic centers are formed.

Introduction:

The abundance of matter and absence of anti-matter is one of the unsolved problems of Physics. Another problem is the nature of the Dark Matter [1]. It is also observed that the SMBH have mass of the order of billions of solar masses. It raises question on how so much matter has accreted quickly to produce such a massive object, it seems difficult since so much matter in a small volume that could collapse quickly into an SMBH is not observed in space [2].

We attempt to explain the missing anti-matter and provide additional candidates for Dark Matter that have not been considered previously [3] and provide a mechanism for SMBH formation.

Assumptions:

It is stated that the CPT theorem holds for all physical phenomenon [4].

Observed Phenomenon:

Suppose n^0 stands for neutron, p^+ for proton, e^- for electron, ν_e for electron neutrino, γ for photon and the barred notation for corresponding anti-particle. It is observed that the free neutrons undergo beta decay with the formula [5]:

$n^0 -> p^+ + e^- + \overline{\nu}_e + \gamma$

The protons are stable and don't undergo any observed change.

Conjecture 1:

If we reverse the parity P, conjugate the charge C and reverse the time, then by CPT theorem we should observe that the anti-neutron would undergo a decay in **reverse time** as follows:

$\overline{n}^0 -> \overline{p}^- + \overline{e}^+ + \nu_e + \gamma$

Hence in **normal time**, this decay will not happen. i.e., in normal time the anti-neutron is a stable anti-baryon and anti-proton could decay as:

$\overline{p}^{-} + \gamma \rightarrow \overline{n}^{0} + e^{-} + \overline{\nu}_{e}$

If this is the case then during Baryogenesis after the Big Bang the universe was filled with anti-matter equal to normal matter. Some of the neutrons underwent decay to protons and electrons but the anti-neutrons remained unaltered. At the same time some of the anti-protons were converted to anti-neutrons after absorbing energy if suitable energy in the form of photons was available, otherwise they too remained unaltered.

Results:

This conjecture could provide candidates for answers to some of the questions like composition of Dark Matter and Super Massive Black Holes (SMBH) at the center of Galaxies.

The anti-neutrons could interact with gravitational forces but not the electromagnetic forces since they don't have any leptons associated with them. Since anti-neutrons are stable and don't repel each other they could potentially clumped together to form larger and larger anti-neutron aggregates and these might be one of the Weakly interacting Massive Particles (WIMP) and further if sufficient aggregation occurs then SMBH would from at the Galactic centers from these anti-neutron aggregates. The SMBH would then be the nucleus around which galaxies and stars composed of normal matter form.

The above line of thought however creates a bigger question that if anti-neutrons are the WIMPs (and hence Dark Matter) then it is observed that the Dark matter is 5 times more than the normal matter [6] . Then the question arises as to why the normal observed baryonic matter is so less?

Conjecture 2:

In cold intergalactic spaces where the temperature is very low, Protons and anti-Protons coexist in the form of stable Protonium.

This might be possible since Proton and Anti-Proton in Protonium would annihilate each other only if they come closer than 1 fm and if they are mutually revolving around each other in cold near zero Kelvin temperature, their angular momentum might not allow either to come close enough to annihilate each other. Protonium has been created at CERN [7]. Since Protonium is

made up of only hadrons, it will not interact electromagnetically. It would let the light from distant galaxies pass through unimpeded. It would be electrically neutral and only interact gravitationally. Hence in the intergalactic space and Galactic Halo, it would be an ideal WIMP or dark matter candidate.

Results:

The above two conjectures allow us to form a theory of WIMPs inside and outside a Galaxy. Inside a Galaxy, the anti-neutrons are predominant form of WIMPs. They form the SMBH at the Galactic centers. Outside the Galaxies, the Dark Matter is composed of cold Protonium. It is undetectable since it is composed of only hadronic matter. When this Protonium comes under the influence of higher temperatures or plasma near the Galaxies, some of the Protonium could self annihilate, the high energy photons released in the annihilation reaction could convert some of the anti-protons to anti-neutrons and electrons. The result would be a hot neutral plasma, hence if we find high temperature plasma near galactic halo away from any heating source like a star, then it could be a tell tale signature of Protonium annihilation [8].

Upon cooling, the plasma consisting of electrons and protons would combine to produce molecular Hydrogen. The stable anti-neutron produced would migrate to the Galactic center under the influence of gravity. It would subsequently accrete to the SMBH making it more and more massive. The Hydrogen created in the process would provide the raw material for star formation. The theory thus predicts that Hydrogen forms near the Galactic periphery.

Conclusion:

We have provided a simple explanation of Baryon Asymmetry and provided candidates for Dark Matter and a mechanism for the formation of SMBH.

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