Kaluza Klien Particles Channels for Dark Matter

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Abstract: **The question as to how this universe came into being and as to how it has evolved to its present stage, is an old question. The answer to this question unfolds many secrets regarding fundamental particles and forces between them. The most important ingredient of this whole creation namely 'Dark Matter' was for the first time identified by Fritz Zwicky of California Institute of Technology (Caltech) in 1933[1,2]. Search for the Dark Matter reaches to the new dimensions. Signature of dark matter presence can be revealed by detail analysis of very high energy electrons which are coming from outer space. Still the experimental findings are mysterious and need precise tools to investigate dark matter in the lab[3]. The observational existence of dark matter such as gravitational lensing etc in the universe is concrete evidence of its presence. We investigate the nature of Kaluza Klien Particles which are supposed to be the evidence of dark matter existence [4].**

Keywords**: Dark Matter, Standard Model**

I. INTRODUCTION

The insight that the universe is composed of more than four space-time dimensions was first proposed by Theodor Kaluza as a method of uniting electromagnetism with gravity. In the years since, various extra dimensions formulations have been proposed to solve a variety of problems. Recently, it has been applied to the search for the particle identity of Dark Matter (DM). Present confirmation shows that more than 80% of the matter in the universe is non-luminous, non-baryonic and not composed of ordinary standard model particles [5]. The proposal of a particle candidate that might explain this unidentified large piece of the universe has become a desirable characteristic of proposed beyond the Standard Model Theories. In particular, theories containing weakly interacting particles with weak-scale masses (WIMPs) are especially shows potential because they lead to WIMP relic densities near the observed dark matter densities without requiring significant parameter tuning. The extra-dimensional theory known as Universal Extra Dimensions (UED) is one such theory. The WIMP candidate this model proposes is known as Kaluza-Klein Dark Matter (KKDM). Although the nature of this particle varies greatly with the various input parameters of the theory, the properties of this particle can be inhibited by cosmological and collider data, as well as by many current and planned particle detectors. Such experiments seek either to directly observe KKDM interactions with ordinary matter or to indirectly detect its existence through observation of its annihilation products. After decades of search for Dark Matter, particles like Axion, Neutralino, Super Symmetry & UED particles are considered as most prominent non baryonic dark matter candidates which are to be detected in future accelerators.

II. UNIVERSAL EXTRA DIMENSIONS PARTICLES:

Approach for extra-dimensional phenomenology is to look at models where all SM particles can propagate in a higher dimensional space. UED model can suggest dark matter candidate which will be able to explain nature of dark matter and its searches. UED model is conceptually extension of Standard Model. By adding extra dimensions in the SM, it provides a framework to discuss a number of open questions in modern physics. Theoretical and practical motivations to study the UED model include:

- The Model is simple as there are only two parameters (R,Λ_{cut}).
- A possibility to achieve electroweak symmetry breaking without any need to add an explicit Higgs field.
- Proton stability can be achieved even with new physics coming in at low-energy scales. In the Standard Model proton life is 10^{-30} Years whereas in UED proton life is calculated as 10^{35} Years.[6,7]
- The model explains why there are three generations of particles.
- This model is especially true in the region of parameter space favored by having the dark matter in the form of Kaluza Klein particles.
- May be in future experiments at Large Hadron Collider(LHC) it will be possible to detect UED light KK particles.

- The UED model naturally includes a dark matter particle candidate [8].

As we know that Dark Matter particles are neutral non baryonic and not have any color therefore first mode KK particles partners of neutral gauge bosons and neutrinos are most favorable choice as Lightest Kaluza Klien Particles (LKP).

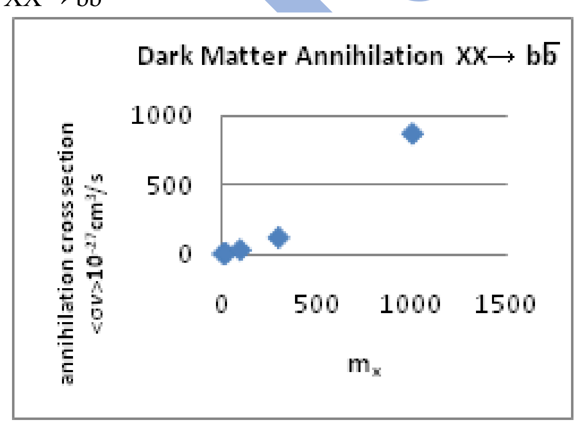
III. UED DARK MATTER CANDIDATES:

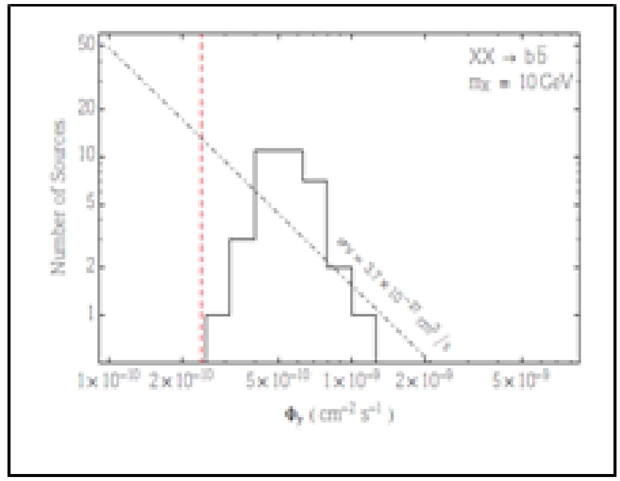
The model is applicable to the solution of the dark matter problem when one assumes conservation of momentum in the extra dimension. In space time continuum this leads to conservation of KK number (N_{KK}), which is given by its mode number. The Standard Model (SM) particles have $N_{KK} = 0$ and massive state of set have $N_{KK} = 1$. The folding and boundary conditions required to compactify the extra dimension breaks the conservation of KK number, but if symmetric boundary conditions are chosen, there remains symmetry in KK parity (under which particles of odd KK number are odd). The main consequence of the KK parity is that each interaction vertex in the theory must contain an even number of odd KK parity states. This leads to the stability of the lightest particle in the 1st KK level. This lightest particle is the UED Dark Matter candidate [9]. For the case of first KK mode gauge bosons, electroweak symmetry breaking induces mixing of heavy partners of the B and W_3, denoted by $B^{(1)}$ and $W_3^{(1)}$, in a way similar to the standard model.

IV. MASS OF LKP:

It was earlier suggested that mass of LKP is in the range of TeV [10] the case where LKP is $B^{(1)}$ its mass is between $900 \le m_{LKP} \le 1200$ GeV and if it is $\upsilon^{(1)}$ than its mass will be $1.3 \le m_{LKP} \le 1.8$TeV. It was suggested with various channel of interaction and annihilation and self annihilation of neutrinos that LKP are available in a long range of mass. Annihilation of dark matter can produce either Fermions or Higgs in following way

$XX \rightarrow b\bar{b}$





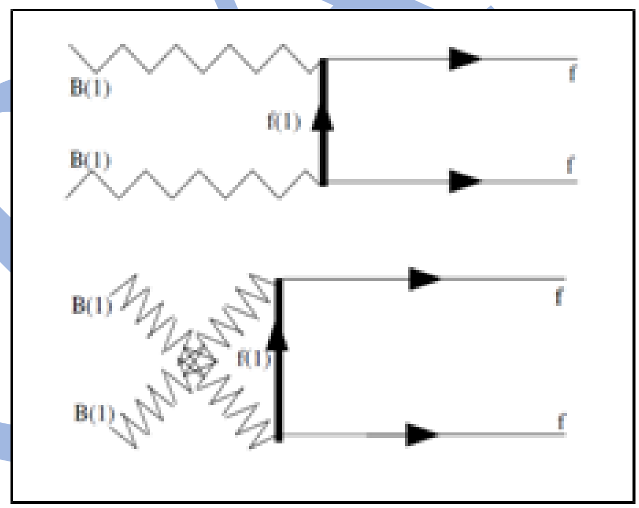


Fig.1-3: Annihilation cross section v/s mass of LKP dark matter is presented in the first figure(left) The flux distribution is estimated in the figure 2(right) by analyzing number of sources. In figure 3(bottom) the annihilation channel for $B^{(1)}$ particle is described.

V. CONCLUSION:

The data analyzed here is collected by Fermi Gama Ray Space Telescope as well as ground-based atmospheric Cherenkov telescopes; both are capable of placing constraints on the nature of dark matter by searching for their annihilation products. It is concluded that 40% of the brightest high altitude source exhibits shows same spectral shape as produced by 30-60 GeV dark matter particles annihilating to $b\bar{b}$. The further investigation of more data is needed to prove dark matter by this model [11].

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