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Abstract of Doctoral Thesis

Title : Indirect signature of Kaluza–Klein dark matter

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The lightest Kaluza–Klein particle (LKP), which appears in the theory of universal extra dimensions, is one of good candidates for cold dark matter (CDM). When LKP pairs annihilate, there are some modes which produce high-energy gamma rays, electrons and positrons as final products, and we categorize them into two components. One of them is the “Line” component, which directly annihilates into gamma-ray pair, and electron-positron pair for each product. Another one is the “Continuum” component, which consists of secondarily produced gamma rays, electrons and positrons via some decay modes. We assume the LKP mass is in the range from a few 100 GeV to 1000 GeV, and calculate the gamma-ray and electron plus positron fluxes and analyze the resulting spectra. In this paper, we investigate the observability of such signals based on observational data obtained by recent measurements.

The results from analysis of gamma-ray spectrum show that if the energy resolution of a detector is 2% or worse, the characteristic peak structure caused by the line component may be diffused, and immersed in the continuum component. Then, we can set constraints on the boost factor (B_f). By considering the electron plus positron spectrum and fitting the result of positron fraction data obtained by AMS-02 observation, B_f can be estimated in the range from about 30 to 300. By comparison of the expected flux from LKP annihilation using these values with recent observational data, the results indicate the light LKP may be excluded. In addition, if B_f is common everywhere in the Galactic halo, the value of B_f derived from positron fraction fit to the AMS–02 data may be rejected by analysis of the HESS data. On the other hand, by analyzing gamma-ray spectrum, the upper limit on B_f may go down to about 2 taking the whole energy region into account. However, the observational data for the TeV or higher energy region are still limited, and the possible LKP signal is not conclusive. Thus, we expect near-future missions with better sensitivity will clarify whether the LKP dark matter should exist or not.