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Developing tools for Galactic Cosmic Ray transport: Dark Matter Annihilation in the light of EGRET, HEAT, WMAP, INTEGRAL and ROSAT

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The excess of diffuse galactic gamma rays above 1 GeV, as observed by the EGRET telescope on the NASA Compton Gamma Ray Observatory, shows all the key features from Dark Matter (DM) annihilation: 1) the energy spectrum of the excess is the same in all sky directions and is consistent with the gamma rays expected for the annihilation of WIMPs with a mass between 50-100 GeV; 2) the intensity distribution of the excess in the sky is used to determine the halo profile, which was found to correspond to the usual profile from N-body simulations with additional substructure in the form of two doughnut-shaped structures at radii of 4 and 13 kpc; 3) recent N-body similations of the tidal disruption of the Canis Major dwarf galaxy show that it is a perfect progenitor of the ringlike Monoceros tidal stream of stars at 13 kpc with ring parameters in excellent agreement with the EGRET data; 4) the mass of the outer ring is so large, that its gravitational effects influence both the gas flaring and the rotation curve of the Milky Way. Both effects are clearly observed in agreement with the DMA interpretation of the EGRET excess; Although the EGRET excess of gamma rays provides an intriguing hint for DMA, its connection to the search for signals in antimatter particles is hampered by the propagation model uncertainties, which determine the local fluxes of charged species for a given source distribution. There are two main tools in order to determine the local and interstellar fluxes of Cosmic Rays: DarkSUSY, using a simple, but fast analytical approach and GALPROP, which solves the transport equation for Cosmic Rays numerically. In the standard propagation models there is no preferred propagation direction. In such models the Galaxy acts as a large storage box for charged particles, thus leading to a strong enhancement of the particle fluxes from the halo. However, present data from INTEGRAL and ROSAT strongly suggest that convection dominates over diffusion at low energies and in the source region, implying that particles produced by DMA in the halo have little probability to arrive at the detector. We present an anisotropic convection-dominated model for Cosmic Ray transport and show that the EGRET gamma ray excess, the HEAT positron excess, the INTEGRAL positron annihilation signal, the PAMELA antiproton fluxes and the WMAP-haze are consistent with each other in such models.

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