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The Electron Injection Spectrum Determined by Anomalous Excesses in Cosmic Ray, Gamma Ray, and Microwave Signals

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Recent cosmic ray, gamma ray, and microwave signals observed by Fermi, PAMELA, and WMAP indicate an unexpected primary source of e+e- at 10-1000 GeV. We fit these data to "standard backgrounds" plus a new source, assumed to be a separable function of position and energy. For the spatial part, we consider three cases: annihilating dark matter, decaying dark matter, and pulsars. In each case, we use GALPROP to inject energy in log-spaced energy bins and compute the expected cosmic-ray and photon signals for each bin. We then fit a linear combination of energy bins, plus backgrounds, to the data. We use a non-parametric fit, with no prior constraints on the spectrum except smoothness and non-negativity. In addition, we consider arbitrary modifications to the energy spectrum of the "ordinary" primary source function, fixing its spatial part, finding this alone to be inadequate to explain the PAMELA or WMAP signals. We explore variations in the fits due to choice of magnetic field, primary electron injection index, spatial profiles, propagation parameters, and fit regularization method. Dark matter annihilation fits well, where our fit finds a mass of ~1 TeV and a boost factor times energy fraction of ~70. While it is possible for dark matter decay and pulsars to fit the data, unconventionally high magnetic fields and radiation densities are required near the Galactic Center to counter the relative shallowness of the assumed spatial profiles. We also fit to linear combinations of these three scenarios, though the fit is much less constrained.

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