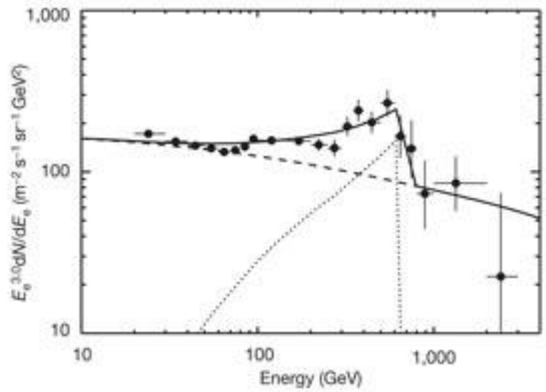
Signs of dark matter?



Two groups of cosmic-ray observers have reported unexpectedly large fluxes of high-energy electrons and positrons. Those excesses suggest either that there are undiscovered astrophysical sources such as radio-quiet pulsars surprisingly nearby or that the positrons and electrons are annihilation products of WIMPs—weakly interacting dark-matter particles hundreds of times more massive than the proton. Standard cosmology predicts that dark nonbaryonic matter dominates the material content of the cosmos. But its constituent particles have yet to be identified. The ATIC balloon collaboration, led by John Wefel of Louisiana State University, reports a significant enhancement in the spectrum of cosmic-ray electrons, peaking near 600 GeV. The peak suggests that 600-GeV WIMPs of the kind predicted by extra-dimensional extensions of standard particle theory might be annihilating with each other to create e^+e^- pairs in very dense concentrations of dark matter not far from our solar system. The ATIC detector cannot distinguish positrons from the much more abundant cosmic-ray electrons. But the magnetic spectrometer aboard the orbiting PAMELA satellite can. Positrons are routinely produced in collisions between cosmic rays and ordinary interstellar matter. The ratio of such positrons to cosmic-ray electrons was expected to fall steeply with increasing energy. Instead, the PAMELA collaboration, led by Piergiorgio Picozza of the University of Rome “Tor Vergata,” reports that the positron fraction grows steadily with energy from 10 GeV to 100 GeV. So it appears that there must be some additional source of high-energy positrons. The collaboration will continue taking data for at least another year, hoping to find spectral structure suggestive of WIMPs or anisotropy pointing to a nearby astrophysical source. Both WIMP annihilations and pulsars are expected to produce high-energy gamma rays. So for the moment, all eyes are on the recently launched *Fermi Gamma-ray Space Telescope* (originally called GLAST), which is designed to pinpoint gamma-ray sources and spectral features but can also confirm the ATIC electron result with higher statistics. (J. Chang et al., ATIC collaboration, *Nature* **456**, 362, 2008; O. Adriani et al., PAMELA collaboration, http://arxiv.org/abs/0810.4995.)