CONSTRAINING THE LOW-ENERGY COSMIC-RAY SPECTRUM

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While the cosmic ray spectrum is easily observed at high energies, below about 100 MeV cosmic rays are excluded from the inner solar system by the magnetic field coupled to the solar wind. This means that the cosmic ray spectrum below 100 MeV cannot be directly observed. However, there are several secondary observables which can tell us about low energy cosmic rays, including certain interstellar molecules, the abundances of light element isotopes such as ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, and ^{11}B, and gamma rays. These observables arise as the result of cosmic ray ionization, spallation, and the excitation of nuclear states, respectively. We are attempting to devise a low energy spectrum that is both physically motivated and able to reproduce the above observables.

Recent results[a] from H_3^+ have shown that the cosmic-ray ionization rate in diffuse interstellar clouds is typically about 2×10^{-16} s^{-1}. In order to reproduce this value, we have used a spectrum which is the summation of three power laws. With this spectrum, we produce light element abundances that are in rough accord with values measured in meteorites and interstellar gas. For gamma rays, we predict a diffuse Galactic flux that is slightly below observable limits using current telescopes. In order to accelerate the low energy particles in our cosmic ray spectrum (those primarily responsible for ionization), we estimate a required energy budget of about 0.25×10^{51} ergs (100 yr)$^{-1}$. The only mechanism capable of providing this much power is a supernova, and our calculation suggests that a substantial amount of the energy released in supernovae explosions must go into accelerating cosmic rays.

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[a] Indriolo, N., Geballe, T. R., Oka, T., & McCall, B. J. 2007, ApJ, 671, 1736