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[94.01] Low-Energy Cosmic Rays

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Cosmic rays with energies below about 10 GeV/nucleon have been measured with high precision as a result of experiments on the HEAO, Ulysses, and ACE spacecrafts. The observations provide energy spectra, elemental abundances, and isotopic composition for elements up through Z=30. They include both stable and radioactive nuclides that are synthesized in stars or are produced by nuclear fragmentation during diffusion at high energies through interstellar medium. From these data one obtains a rather detailed picture of the origin of low-energy cosmic rays. For refractory species, the cosmic-ray source composition closely resembles that of the Sun, suggesting that cosmic rays are accelerated from a well-mixed sample of interstellar matter. A chemical fractionation process has depleted the abundances of volatile elements relative to refractories. Using various radioactive clock isotopes it has been shown that particle acceleration occurs at least 10^5 years after supernova nucleosynthesis and that the accelerated particles diffuse in the Galaxy for approximately 15 Myr after acceleration. Energy spectra and secondary-to-primary ratios are reasonably well accounted for by models in which particles gain the bulk of their energy in a single encounter with a strong shock. Among the large number of species that have been measured, ^{22}Ne stands out as the only nuclide with an abundance that is clearly much different than solar. To test models proposed to account for this anomaly, the data are being analyzed for predicted smaller effects on abundances of other nuclides. In addition to providing a detailed understanding of the origin and acceleration of low-energy cosmic rays, these data are providing constraints on the chemical evolution of interstellar matter.

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