Discrepant features found in cosmic ray energy spectra

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(PhysOrg.com) -- In May a University of Maryland-led team of scientists reported some previously unknown features in the energy spectra of cosmic ray nuclei, which have been studied for almost 100 years. Cosmic rays were discovered in 1912 with an electroscope carried on a manned hot air balloon.

The current observations were made with a NASA-funded balloon-borne instrument that has flown for 156 days above 99.5% of the atmosphere in five separate long-duration flights high over Antarctica, the first for a record-breaking 42 days. Researchers from the Cosmic Ray Energetics And Mass (CREAM) collaboration have reported a difference between spectra of protons and helium and a hardening (flattening) of all nuclei spectra at about 200 GeV/nucleon. These new observations contradict the current paradigm for the origin of cosmic rays in supernovae, which in its simplest form leads to a simple power law spectrum for all elements. Details of the cosmic ray origin and acceleration mechanism are not yet completely understood.

"Whether or not the proton spectrum is the same as that of heavier nuclei has long been a tantalizing question, but the spectral flattening was a surprise," said Eun-Suk Seo, Principal Investigator for the CREAM project and professor at the University of Maryland. "We were looking for a spectral cut off, evidence of the supernova acceleration limit, but instead found a relative increase in flux with energy." Such features could not be observed before, because the energy ranges of previous experiments were limited, and cosmic-ray particles are very scarce at

high energies. Different types of sources or acceleration sites could explain the observed difference in protons and helium spectra.

The observed hardening of nuclei spectra could result from a nearby source, analogous to one explanation for the electron excess. The hardening of nuclei spectra at the rigidity (momentum per charge) similar to the onset of previously reported electron enhancements indicates that a single mechanism might be responsible for both electrons and nuclei. The pervasive discrepant hardening in elemental spectra provides important constraints on cosmic-ray acceleration and propagation. It must be accounted for in any explanation of the mysterious cosmic ray "knee", the steepening, rather than flattening, of the all-particle spectrum near 1015 eV observed in ground based air shower measurements.

The 2,500-pound CREAM instrument was conceived to measure the detailed energy dependence of elemental spectra to the highest energy possible with a balloon-borne instrument. It has been flown above some 128,000 feet altitude over Antarctica using a helium-filled balloon about as large as a football stadium. Its measurements in near space bridge the energy gap between similar lower-energy data and abundant ground-based air shower measurements at higher energies.

CREAM is an international collaboration of researchers from the University of Maryland, Penn State University, Ohio State University, Ewha Womans University in Seoul, Korea, and University of Siena and INFN in Siena, Italy.

For information on NASA's scientific balloon program, visit: nasa .gov/code820/" target="_blank">sites.wff.nasa.gov/code820/

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