

Research in Astrophysics from Space (E)  
Origins of Cosmic Rays: Resolving Hess' Century-Old Puzzle (E18)

## ELEMENTAL ABUNDANCE MEASUREMENTS AND THE ORIGIN OF GALACTIC COSMIC RAYS

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We have measured the elemental abundances of the rare cosmic-ray nuclei  $^{29}\text{Cu}$ ,  $^{30}\text{Zn}$ ,  $^{31}\text{Ga}$ ,  $^{32}\text{Ge}$ ,  $^{34}\text{Se}$ ,  $^{36}\text{Kr}$ , and  $^{38}\text{Sr}$  using data from two Antarctic balloon flights totaling 50 days at float of the Trans-Iron Galactic Element Recorder (TIGER) instrument, and from 12+ years of flight in space of the Cosmic Ray Isotope Spectrometer (CRIS) aboard the Advanced Composition Explorer (ACE). The geometrical factors of TIGER and CRIS are  $1.6\text{m}^2\text{sr}$  and  $0.025\text{m}^2\text{sr}$ , and the energy ranges covered are 0.8-100 GeV/nuc and 0.15-0.6 GeV/nuc at the top of the atmosphere, respectively. The two data sets are comparable, with TIGER and CRIS collecting 460 and 410 nuclei respectively with  $Z>29$ , and the abundances obtained are in generally good agreement. After accounting for fragmentation of cosmic rays during propagation from the source into the instruments, we find that the abundances are consistent with a source consisting of a fractional mix of about 0.8 standard Solar-System composition and 0.2 ejecta from massive stars. This mixture supports a model of cosmic-ray origin in OB associations, as has previously been inferred from the isotopic composition of the more abundant elements, Ni and lighter. These TIGER and CRIS data also support a cosmic-ray acceleration model in which elements present in interstellar grains are accelerated preferentially compared with those found in interstellar gas, with both volatile and refractory element abundances exhibiting a mass dependence. This emerging model of cosmic-ray origin and acceleration will be further tested with an instrument similar in concept to TIGER, but with much larger geometrical factor. Super-TIGER development is under way, with its first balloon flight planned for December 2012.

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