Final Report
on
NASA Grant NAG5-727

“Relative to the Caltech
Electron/Isotope Spectrometer - IMP”

Covering Activities From
April 1, 1985 to September 30, 1996

Submitted: October 14, 1997

Introduction: The Electron Isotope Spectrometers (EIS) on IMP-8
was designed to provide measurements of low energy isotopes from H to O
(1 ≤ Z ≤ 8) over the energy range from ~2 to ~40 MeV/nuc, as well as low
energy electrons from ~0.2 to ~6 MeV. These measurements supported
studies of the acceleration and transport of energetic particles
originating on the Sun, in interplanetary space, in the Galaxy, and in
Earth's and Jupiter's magnetosphere.

IMP-8 was launched in October 1973 and still continues to provide
key particles and fields measurements from orbit about the Earth. The
IMP-8 EIS continued to operate flawlessly until 8/3/92, when a partial
failure was suffered in a bias supply, which reduced the ability of the
instrument to measure high energy particles. The EIS was subsequently
turned off in 1995. A nearly identical instrument was flown on IMP-7
from 10/92 to 7/96, and many studies combined results from both
instruments. For completeness, this report summarizes scientific results
and publications from the entire IMP-7&8 effort, not just from the period
covered by NAG5-727. The investigators on these two instruments were
E.C. Stone (Principal Investigator), and R. E. Vogt and R. A. Mewaldt (Co-
investigators).

Scientific Results: The EIS instruments provided new results on
a wide range of topics in space physics and astrophysics. A summary of
some of the topics addressed is provided on the following page. For a
complete summary, see the papers in the attached bibliography.

PhD Theses: Four Caltech graduate students based their PhD thesis
work on data from the IMP-7 &8 EIS instruments, and several additional
graduate/undergraduate students and technical personnel received
valuable training during the design, development, and calibration of these
instruments. The PhD theses are listed in the attached bibliography.

Bibliography: A complete bibliography of papers and talks based on
EIS data is attached.
IMP EIS Science Highlights

Solar Energetic Particles

- Discovery of heavy-ion enrichments in $^3$He-rich flares
- Measurements of $^2$H and $^3$He in solar energetic particles
- Measurements of solar flare electron spectra

Anomalous Cosmic Rays (ACRs)

- First measurement of the isotopic composition of ACRs
- Time variations of ACR oxygen over 20 years
- Interplanetary radial gradients with Pioneer and Voyager
- Proof that ACR oxygen is singly-charged (with COSMOS)
- Evidence for ACR hydrogen at 1 AU

Galactic Cosmic Rays (GCRs)

- Comparison of GCR $^2$H and $^3$He with galactic propagation models
- Composition & energy spectra of low energy $1 \leq Z \leq 8$ nuclei
- Study of neutron and γ-ray induced backgrounds in silicon detectors

Interplanetary Particles

- First measurement of Jovian 0.2 to 3 MeV electron spectra at 1 AU
- Discovery the particles in CIR events flow back towards the Sun
- Direct determination of interplanetary diffusion coefficients

Magnetospheric Electrons

- Discovery of the magnetopause energetic electron layer
- Study of energy flow at the magnetopause and geomagnetic activity
- Evidence for sub-storm associated magnetic reconnection
The Caltech Electron/Isotope Spectrometers on IMP-7 and 8; 1972–1996

PUBLICATIONS


**Thesis**


The Caltech Electron/Isotope Spectrometers on IMP-7 and 8; 1972–1996

TALKS


