

AIP CONFERENCE PROCEEDINGS 186

RITA G. LERNER
SERIES EDITOR

HIGH-ENERGY RADIATION BACKGROUND IN SPACE

SANIBEL ISLAND, FL 1987

EDITORS:

A. C. RESTER, JR.
UNIVERSITY OF FLORIDA

J. I. TROMBKA
GODDARD SPACE
FLIGHT CENTER

AMERICAN INSTITUTE OF PHYSICS

NEW YORK 1989

CONTENTS

Preface	ix
---------------	----

I. THE RADIATION ENVIRONMENT

Charged Particle Radiation Exposure of Geocentric Satellites	3
E. G. Stassinopoulos	
Transient X-Rays, Gamma-Rays, and Neutrons in Space	64
R. E. Lingenfelter	
Approximate Angular Distributions and Spectra for Geomagnetically Trapped Protons in Low Earth Orbit	75
J. W. Watts, T. A. Parness, and H. H. Hechman	
Solar Particle Composition, Spectra, and Frequency of Occurrence	86
D. V. Reames	

II. PARTICLE INTERACTIONS AND PROPAGATION: DYNAMIC MODELING

Products from Cosmic-Ray Interactions in Extraterrestrial Matter: What They Tell Us About Radiation	
Background in Space	97
M. C. Reedy	
Bremsstrahlung Production by Electrons: Cross Sections and Electron-Photon Transport Calculations	103
S. M. Seltzer	
Interactions of Multi-MeV Gamma Rays with Matter	125
R. L. Coldwell, F. E. Dunnam, M. Katoot, and P. S. Haskins	
Three-Dimensional Monte-Carlo Simulation of Gamma-Ray Scattering and Production in the Atmosphere	132
D. J. Morris	
High-Energy Radiation Environment During Manned Space Flights	146
R. Silberberg, C. H. Tsao, J. H. Adams, Jr., and J. R. Letaw	
High-Energy Outer Radiation and Belt Dynamic Modeling	159
Y. T. Chiu, R. W. Nightingale, and M. A. Rinaldi	

III. DATA BASES

Nuclear Cross Sections for Estimating Secondary Radiations Produced in Spacecraft	177
L. W. Townsend and J. W. Wilson	
Nucleon Interaction Data Bases for Background Estimates	192
J. W. Wilson and L. W. Townsend	

Reference Nuclear Data for Space Applications	203
S. Pearlstein	
ENVIRONET: An Interactive Space-Environment	
Information Resource	210
A. L. Vampola, W. Hall, and Michael Lauriente	
SEL Monitoring of the Earth's Energetic Particle	
Radiation Environment	216
H. Sauer	
 IV. INSTRUMENT BACKGROUND AND DOSIMETRY	
Gamma Radiation Background Measurements from Spacelab 2	225
W. S. Paciesas, J. C. Gregory, and G. J. Fishman	
Radioactivity Observed in Scintillation Counters	
During the HEAO-1 Mission	232
D. E. Gruber, G. V. Jung, and J. L. Matteson	
Background Observations on the SMM High-Energy Monitor	
at Energies > 10 MeV	243
D. J. Forrest	
Long-Term Variations in the Gamma-Ray Spectrometers	
on OSO-7 and SMM Spacecraft	250
J. D. Kurfess, G. H. Share, R. L. Kinzer, W. N. Johnson,	
J. H. Adams, Jr., E. L. Chupp, D. J. Forrest, and C. Reppin	
Comparison of Backgrounds in OSO-7 and SMM Spectrometers	
and Short-Term Activation in SMM	259
P. P. Dunphy, D. J. Forrest, E. L. Chupp, and G. L. Share	
Instrumental and Atmospheric Background Lines	
Observed by the SMM Gamma-Ray Spectrometer	266
G. H. Share, R. L. Kinzer, M. S. Strickman, J. R. Letaw, E. L. Chupp,	
D. J. Forrest, and E. Reiger	
Radioactivity Induced in Gamma Ray Spectrometers	278
C. S. Dyer, P. R. Truscott, N. D. A. Hammond, and C. Comber	
Space Radiation Shielding Analysis and Dosimetry	
for the Space Shuttle Program	289
W. Atwell, E. R. Beever, A. C. Hardy, R. G. Richmond, and B. L. Cash	
The Radiation in a Molniya-Type Orbit	297
J. B. Blake and J. E. Cox	
The HEAO-3 Background: Spectrum Observed by a Large	
Germanium Spectrometer in a Low-Earth Orbit	304
W. A. Wheaton, J. C. Ling, W. A. Mahoney, L. S. Varnell,	
and A. S. Jacobson	
On-Orbit Observations of Single-Event Upsets	
in Harris HM-6508 RAMs: An Update	323
J. B. Blake and R. Mandel	

V. DETECTORS AND EXPERIMENTAL PROGRESS

The Space Radiation Environment at 840 km	329
E. G. Mullen, M. S. Gussenoven, and D. A. Hardy	
The Cosmic Radiation Effects and Activation Monitor	343
C. S. Dyer, A. J. Sims, R. J. Hutchings, D. Mapper, J. H. Stephen, and J. Farren	
Characterization of Space Radiation Environment in Terms of the Energy Deposition in Functionally Important Volumes	350
L. A. Braby, N. F. Metting, W. E. Wilson, and C. A. Ratcliffe	
The GRAD High-Altitude Balloon Flight Over Antarctica	359
G. Eichhorn, R. L. Coldwell, F. E. Dunham, A. C. Rester, J. I. Trombka, R. Starr, and G. P. Lasche	

VI. BIOLOGICAL EFFECTS

Biophysical Aspects of Heavy Ion Interaction in Matter	369
W. Schimmerling, M. Wong, B. Ludewigt, M. Phillips, E. L. Alpen, P. Powers-Risius, R. J. Guzman, L. W. Townsend, and J. W. Wilson	
Delayed Effects of Proton Irradiation in Macaca	
Mulatta Primates (22-Year Summary)	381
D. H. Wood, K. A. Hardy, A. B. Cox, Y. L. Salmon, M. G. Yochmowitz, and R. E. Cordts	
Responses of <i>Carausius Morosus</i> to Spaceflight Environment	393
G. Reitz, H. Bücker, R. Facius, G. Horneck, W. Ruther, R. Beaujean, and W. Heinrich	
The Protons of Space and Brain Tumors I: Clinical and Dosimetric Considerations	407
G. V. Dalrymple, W. A. Nagle, A. J. Moss, Jr., L. A. Cavin, J. R. Broadwater, E. L. McGuire, C. S. Eason, J. C. Mitchell, K. A. Hardy, D. H. Wood, Y. A. Salmon, and M. G. Yochmowitz	
The Protons of Space and Brain Tumors II: Cellular and Molecular Considerations	412
W. A. Nagle, A. J. Moss, Jr., G. V. Dalrymple, A. B. Cox, J. F. Wigle, and J. C. Mitchell	
New Astronaut Radiation Exposure Limits and Implications of Proposed Changes in Quality Factors	432
D. S. Nachtwey and R. J. M. Frey	
Promotion of a New Radioprotective Antioxidative Agent	434
J. Matsubara, A. Ikeda, and T. Kinoshita	

VII. FUTURE NEEDS AND STRATEGIES

Space Station: Infrastructure for Radiation Measurements in Low Earth Orbit	445
B. D. Meredith	

Scientific Considerations in the Design of the Mars Observer Gamma-Ray Spectrometer	453
J. R. Arnold, W. V. Boynton, P. Englert, W. C. Feldman, A. E. Metzger, R. C. Reedy, S. W. Squyres, J. I. Trombka, and H. Wanke	
Particle Background Effects for the Hubble Space Telescope (HST) and the Lyman Far Ultraviolet Spectroscopic Explorer	468
B. E. Woodgate and W. B. Fowler	
Radiation Environment Evaluation for ESA Projects	483
E. J. Daly	