

## **The Solar System Radiation Environment and NASA's Vision for Space Exploration: A Workshop**

Space Studies Board

### Abbreviated statement of task:

An ad hoc committee of the Space Studies Board will sponsor a cross-disciplinary workshop on the radiation environments in the inner solar system and their effects on astronauts and operational systems in space.

### Background:

Following a major presidential space policy announcement in January 2004, NASA has embarked on a long term, human and robotic, space exploration effort, which will include human missions to the Moon and Mars. Science to enable human exploration is inherently crosscutting, involving insights from many fields of science and technology. All of the past science strategy studies have been, by design, discipline-based. That is, they provide scientific goals and priorities for a particular field or set of related disciplines. This approach to setting scientific goals for breakthroughs in individual fields is effective, and the current NRC reports remain timely and relevant today in their respective areas.

However, NASA's new vision for exploration opens up novel and previously unexplored issues whose nature can best be illustrated by the question, "how, and by whom, is the decision to be made that we have acquired the necessary relevant medical, scientific, and technological knowledge needed before we actually send humans to Mars?" No single decadal survey or combination of surveys provides the type of advice needed for the new programs that are anticipated under the new vision for exploration. In addition, no single scientific or engineering discipline can provide the expertise and knowledge necessary to optimally solve these problems. Therefore, a reexamination of the decadal surveys would not provide ideal guidance for enabling science. Instead, cross-cutting advice needs to come from cross-disciplinary groups of experts representing diverse scientific fields rather than from the traditional single-discipline survey committees. The problem of understanding and mitigating the effects of space radiation is a prime example of such a cross-cutting issue.

Understanding and mitigating the deleterious effects of space radiation on both astronauts and operational systems is a complex, multifaceted problem. Progress in countering the harmful effects of different space radiation environments will have to draw on advances in solar and space physics, radiation monitoring, risk assessment, materials science, biomedical science, medical systems engineering, space systems design, and more; it also may be facilitated by the use of robotic "guinea pigs" rather than human subjects. A piecemeal approach to planning research and setting priorities under the guidance of individual scientific disciplines is unlikely to produce robust, reliable solutions. There is a need, both internally in NASA and in the broader scientific and space operations communities, to foster a robust multi-disciplinary approach.

### Statement of Task:

An ad hoc committee of the Space Studies Board will sponsor a cross-disciplinary workshop on the radiation environments in the inner solar system and their effects on astronauts and operational systems in space. The workshop would consist of overview talks and panel discussions in the following areas:

- Physical mechanisms of energetic particle acceleration and transport in the heliosphere
- Characterization of the heliospheric radiation environment, including required data sources
- Radiation health hazards to astronauts
- Radiation effects on materials and spacecraft systems
- Mitigation techniques and strategies, including forecasting and operational schemes

The workshop will bring together experts from a variety of disciplines to identify open questions that will determine the direction of future research on the above topics. Participants will consider in particular the extent that questions in the areas above can be answered by the focused application of current understanding in the relevant physical, biological, and technological fields, and the extent to which basic research will be required to provide the requisite answers. The workshop will concentrate not only on application of current knowledge, but on the basic research into fundamental physical processes that will be necessary for mitigation of the hazards posed by the radiation environment in which manned expeditions to the Moon and Mars will take place. Given the interdisciplinary nature of the workshop, care will be taken to ensure that the highly specialized topics are presented on a level that will be understandable and useful to the members of the various research communities represented at the workshop.

#### Preliminary Work Plan:

The first two days of the workshop will be devoted to a series of invited presentations on topics ranging from the NASA Vision for Space Exploration, the physics of solar eruptive events, the acceleration of solar energetic particles, the effects of radiation and particles on humans and hardware, and the forecasting of hazardous events. Over the next two days, the workshop will break into discussion groups, each focused on a particular area of relevance to the overall effort. Presentations will be encouraged on relevant current research, relevant ongoing and forthcoming ground-based observatories and space missions, and important space missions investigations that are not in the present plans.

Following the workshop, the organizing committee will prepare a short report that will be similar to the recently completed "Exploration of the Outer Heliosphere and the Local Interstellar Medium: A Workshop Report." The report will not contain findings and recommendations, but instead will summarize workshop discussions. Discussions and material presented during the workshop could serve as a basis for a follow-on study of the radiation environments of the Moon, Mars, and the inner heliosphere, which might be modeled on the NRC's 2000 report, Radiation and the International Space Station.

#### Earlier Work:

- Solar and Space Physics and Its Role in Space Exploration (SSB, 2004)
- Radiation and the International Space Station (SSB, 2000)
- A Strategy for Research in Space Biology and Medicine in the New Century (SSB, 1998)
- Microgravity Research in Support of Technologies for the Human Exploration and Development of Space and Planetary Bodies (SSB, 2000)
- Assessment of Directions in Microgravity and Physical Sciences Research at NASA (SSB, 2002)
- New Frontiers in the Solar System: An Integrated Exploration Strategy (SSB, 2002)
- The Sun to Earth--and Beyond: A Decadal Research Strategy in Solar and Space Physics (SSB, 2002)
- Science in NASA's Vision for Space Exploration (SSB, 2005)
- Exploration of the Outer Heliosphere and the Local Interstellar Medium: A Workshop Report (SSB, 2004)

