The Tipping Point: Avoiding Catastrophe for a New Generation of Solar and Space Physicists in an Era of Unparalleled Discovery

Our society is witnessing an expansive era of discovery in our exploration of the cosmos. Robotic explorers have given us a detailed knowledge of Earth's space environment and its interaction with the Sun, including the threat of space weather to the satellite technologies on which we are becoming increasingly dependent. For example, NASA's Solar Dynamics Observatory, STEREO, and IRIS missions have given researchers views of the Sun's surface and atmosphere with unprecedented resolution, giving new insights into the causes and effects of solar eruptions. The recent THEMIS and Van Allen Probes missions have helped answer fundamental questions about radiation belts and geomagnetic storms, which can damage GPS satellites and electrical grids. Robotic probes have mapped the heliosphere—the part of the galaxy dominated by the Sun's influence, and we are now reaching beyond our solar system as the Voyager spacecraft move into the uncharted realm of galactic space.

New missions hold promise to sustain this remarkable pace of discovery. A solar probe will fly within 10 solar radii of the Sun, which will be humankind's first visit to a star. A constellation of four spacecraft in Earth orbit will investigate magnetic reconnection, a process involving the often explosive release of energy stored in cosmic magnetic fields that is important for understanding space weather and the sources of harmful radiation. The Interstellar Mapping and Acceleration Probe will explore the evolving boundaries of our solar system within the galaxy and discover the fundamental origin of high-energy particle radiation from their enigmatic sources.

We stand thus on the verge of unparalleled discovery in solar and space physics. At the same time, however, we face an imminent threat to the nation's future leadership in these areas: the loss of the next generation of scientists. Many scientists—particularly our youngest investigators including students—rely on relatively small research grants to support their research outside the budgets of NASA missions. These funding opportunities are disappearing, and without this critical funding, many scientists in solar and space physics are being forced to leave the field. This trend will only get worse, which will cripple our ability to carry out important research in many areas, and will impair our ability to gain the fullest return from our impressive array of missions.

In scientific research as in many endeavors, innovation and discovery go hand in hand. New discoveries require innovation, and innovations lead to discovery. Our country has led in both areas throughout the space age through innovative and well-managed programs such as NASA's Living With a Star, Solar-Terrestrial Probes, Heliophysics Explorer, Heliophysics Research, NSF's Space Weather and Geospace Research and basic and applied research programs in other agencies (e.g., DOD, DOE, NOAA). However, many foreign countries such as India, China and South Korea are now rapidly gaining ground. The US cannot afford to lose a new generation of solar and space physicists, and with them the technological innovations that we have become a world leader in producing.

The trend in research funding opportunities in recent years is alarming and has already begun to force out a generation of scientists. There has been a rapid decrease in the number of non-

mission related research grants at NASA in the last few years in solar and space physics. Success rates for solar and space science proposals at both NASA and NSF have fallen from typical values of 30 - 40% in 2006 to a disastrous 10 - 20% now, and will be lower still this coming year. *If this contraction is sustained, we face the potential loss of a large fraction of the researchers in the field within just five to ten years.*

It is critical that our nation maintains its leadership and competitiveness in solar and space physics. *The solution to the catastrophic situation facing the new generation of solar and space scientists in the United States can be found in the strategic Decadal Survey of Heliophysics.* The Heliophysics Decadal survey's highest recommendation is the implementation of a new, integrated, multiagency initiative called DRIVE (Diversify, Realize, Integrate, Venture, Educate) "that will develop more fully and employ more effectively the many experimental and theoretical assets at NASA, NSF, and other agencies."[1] The augmentations needed for DRIVE should be implemented in the 2015 budget. The management of NASA, NSF and other agencies has balanced increasingly difficult budget scenarios. The augmentations needed for DRIVE cannot come at the expense of the fleet of missions or planned development that continues to open new opportunities for scientific discovery and technical innovation. Real and significant augmentations to the Heliophysics budget are needed to move DRIVE forward and thus avoid the potential loss of a generation of scientists in solar and space science. Our nation cannot afford this unrecoverable loss that would undermine the current era of scientific discovery and thereby position other countries to take the leadership role in Heliophysics and to reap the scientific and technological benefits.

[1] NRC Solar and Space Physics Decadal Survey: A Science for a Technological Society

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