Editorial: Topical Volume on Developing the Solar Probe Plus Mission

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Published online: 30 November 2016
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The Solar Probe Plus mission is a remarkable and historic step in the exploration of humankind. We have visited all of the planets and a number of other smaller moons and bodies; we have explored the magnetospheres, not just of Earth but also of all the planets; and we have explored our heliosphere and even flown a spacecraft beyond its boundary and into interstellar space itself. However, only with the launch of Solar Probe Plus will we actually visit our own star—the Sun—repeatedly traveling to within 9 solar radii (R_S) of its surface ($10R_S$ heliocentric) and directly through its corona. From here, we will at long last be able to solve the key mysteries that have puzzled scientists for over 50 years: how the corona is heated and how the solar wind and solar energetic particles are accelerated.

The call for a “Solar Probe” to directly sample the near-Sun environment began at the start of the space age. Just a few months after NASA was founded in July 1958, the National Research Council (NRC) Space Studies Board’s Physics of Particles and Fields in Space Committee (Chaired by John Simpson) issued an interim report with recommendations for future NASA missions. These included a spacecraft to study the particles and fields environments near the Sun. Since then NASA conducted numerous studies with various Science and Technology Definition Teams (STDTs).

In 2003, after many decades of NRC Decadal Surveys, NASA studies, and STDT reports, *The Sun to the Earth—and Beyond. A Decadal Research Strategy in Solar and Space Physics*, NRC, National Academy Press, was published in 2003, stressing the critical science of such a mission and recommending its “implementation as soon as possible.” This led to the formation of a new STDT that culminated in its 2005 report—*Solar Probe: Report of the Science and Technology Definition Team*, NASA/TM-2005-212786. That Solar Probe mission design was similar to many prior designs with the probe first needing to travel out to Jupiter for a gravitational assist that would throw it into a solar polar orbit that would zip past the Sun, reaching $4R_S$ of the Sun’s center for one or two orbits. This mission was costly and relied on Radioisotope Thermal Generators (RTGs) for power.

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After some time for consideration, NASA convened the same STDT and challenged them to find a better and cheaper way to accomplish the same science goals. This led to a completely new mission design and the final 2008 STDT report—*Solar Probe Plus: Report of the Science and Technology Definition Team*, NASA/TM-2008-214161. The new mission design launches inward not outward and uses seven Venus flybys to step its 24 ecliptic orbits down from a perihelion of $35R_S$ in its first orbit (roughly twice as close to the Sun as any prior spacecraft) to under $10R_S$ for the final three orbits. Remarkably, this new mission was less than half the cost of the prior design and, with its many solar flybys, it was actually scientifically superior... hence the name Solar Probe Plus (SPP).

NASA began funding some pre-Phase A technology development to “buy down” implementation risk at the Johns Hopkins University Applied Physics Laboratory (APL) that had conducted the engineering work for the final STDT reports and which was designated by NASA to be the mission implementing organization. Then, in late 2009, NASA released an Announcement of Opportunity that led to the selection of four science investigations described in this topical volume.

This topical volume comprises five papers that describe the SPP science, instruments, and mission as it is being developed, between the Mission Preliminary Design Review (PDR) in January 2014 and the Mission Critical Design Review (CDR) in March 2015. The volume provides the basis for the broader Heliophysics community to understand and prepare for the SPP mission and the incredible new and discovery science that will come from it. We sincerely hope that future researchers, authors and students will use this information to help in their studies. Paper 1 (Fox et al.) provides an overview of the entire SPP program including the SPP science, hardware, and mission. Paper 2 describes the Fields Investigation for Solar Probe Plus (FIELDS) (Bale et al.), Paper 3 the Wide-field Imager (WISPR) investigation (Vourlidis et al.), Paper 4 the Solar Wind Electrons Alphas and Protons Investigation (SWEAP) (Kasper et al.), and Paper 5 the Integrated Science Investigation of the Sun (ISOIS) energetic particle investigation (McComas et al.). We note that the prior acronym—ISIS—that is used throughout the papers in this volume has now been formally changed to ISOIS (pronounced as in the original Egyptian “EE-sihs”).

More than just a transformational science mission, SPP has captured the hearts and minds of people the world over—inspiring students to become scientists and engineers and showing that no challenge is too daunting. The truly outstanding team of people who are making the SPP mission such a great success includes countless scientists and engineers worldwide who have never ceased in their efforts to make this mission a reality; this volume is dedicated to every one of them with our sincerest thanks!

Acknowledgements This mission would not be possible without the truly outstanding efforts, contributions, and dedication of many hundreds of team members, reviewers, and participants from institutions such as NASA, Universities, National Laboratories, Non-Profits, and Corporations across the country and around the world. We are delighted to acknowledge and thank all of these important contributors:

D. Aalami, M. Abatcha, R. Abbott, E. Abel, R. Abiad, E. Abrams, K. Acabchuk, K. Aceves, E. Adams, G. Adams, J. Adams, N. Adams, U. Adediran, T. Ahmed, E. Ahronovich, J. Aichele, M. Airola, J. Albers, D. Alexander, N. Alexander, O. Alexandrova, A. Alford, D. Allen, J. Allen, N. Almeleh, S. Aloezos, E. Alvarez, H. Ambrose, J. Andersen, C. Anderson, D. Anderson, J. Anderson, R. Anderson, S. Anderson, M. Andre, B. Andrews, M. Angert, N. Angold, B. Antkowiak, C. Apland, W. Aponte, R. Armiger, D. Arnold, J. Arribas Starkey-El, D. Artis, M. Asher, O. Atabek, J. Atchison, D. Athman, J. Aube, A. Austin, G. Austin, B. Avon, N. Bachtell, L. Bacon, K. Bahr, S. Baierlein, B. Bailes, V. Bailey, L. Baird, A. Baisden, M. Balat-Pichelin, L. Balderrama, S. Bale, J. Balgassi, N. Ball, B. Ballard, M. Ballarotto, K. Balon, D. Barefoot, L. Barley, T. Barley, D. Barlow, J. Barnes, R. Barnes, C. Barrett, R. Barry, P. Basnyat, A. Bates, S. Battel,

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Finally, it is impossible to generate such a list, even with the help of lead team members from as many institutions as we have done here, without missing a least a few important names—for those of you who we have missed, we are truly sorry and thank you also. Finally, we want to thank Wendy Mills and Kim Runkles, who helped edit this volume.