

Project Details

ROSES ID: NNH19ZDA001N

Selection Year: 2019

Program Element: Focused Science Topic

Topic: Variable Radiation Environment in the Dynamical Solar and Heliospheric System

Project Title:

The Influence of Solar Wind Structures on Energetic Particles in the Heliosphere Over a Wide Energy Range

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Project Member(s):

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- Bruno, Alessandro; Co-I; Catholic University of America (CUA)
- Koval, Andriy; Co-I; University of Maryland Baltimore County
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Summary:

Science Goals and Objectives: We propose to study the effects of solar wind structures (SWS) on energetic particle populations at multiple points in the heliosphere extending from suprathermal ions to Galactic cosmic rays (GCRs), building on studies by proposal team members that include investigations of solar energetic particle (SEP) and GCR modulations by SWS (shocks/interplanetary coronal mass ejections (ICMEs) and corotating high-speed streams). These studies will be extended to solar cycle 24 and the rise of cycle 25, providing a survey of the influence of SWS on energetic particles over 5 solar cycles. A catalog of ICMEs at Ulysses (Richardson, 2014) will be used to examine the radial/latitudinal variation of the associated short-term GCR depressions (Forbush decreases, Fds). We will also study SWS effects on particles at Helios at 0.3-1 AU, Parker Solar Probe (PSP), and at Mars, together providing a global picture of the impact of SWS on particles from near the Sun to Jupiter's orbit. We will also investigate small-scale SWS associated with energetic particle modulation, for example, whether discontinuities, planar magnetic structures, magnetic islands and mini flux ropes could contribute to modulation in shock sheaths in addition to turbulence. We will use analytical Fd models accounting for the effects of the shock-sheath and ICME, and statistical methods, to relate Fd characteristics to SWS properties. Multi-point solar and heliospheric observations will be used to determine whether mid-term (

Methodology: We will use in situ measurements from spacecraft including ACE, Wind, SOHO, STEREO, Helios, IMP 8, Ulysses, GOES (including a recalibrated SEP data set), PAMELA and PSP, and MSL/RAD on the surface of Mars. Particle measurements will be used to characterize SWS effects on particle intensity, anisotropy and spectra. Field and plasma measurements will characterize large and small scale SWS such as shocks, sheaths and ICMEs. Observations of solar phenomena and solar wind models (e.g., WSA-ENLIL+cone) will be used to provide context.

Proposed contributions to the Team effort: This proposal is relevant to the FST goals to determine the influence of solar and heliospheric plasma dynamics on high-energy particle radiation environments within the heliosphere, and of major solar eruption events on the high-energy particle environment near Earth and in interplanetary space. We will provide a comprehensive analysis of the radiation environment and its solar wind context. We will correlate neutron monitor and spacecraft data to determine how high-energy particle events contribute to the radiation environment in the heliosphere, and how SWS influence SEP temporal evolution and spectra. Products will include a global synopsis of the effect of SWS on particles including GCRs, catalogs of Fds at Helios, PSP, Mars and Ulysses, and a normalized GCR counting rate database that will link observations from Helios, IMP 8 and Ulysses with current observations e.g., from SOHO/EPHIN and planetary missions.

Publication References:

Summary: Blah

Reference: Paouris, E., A. Kouloumvakos, A. Vourlidis, A. Papaioannou, V. K. Jagarlamudi, T. Horbury (2023), "The space weather context of the first extreme event of Solar Cycle 25, on September 5, 2022, *Astrophys. J.*, 956, 58, doi: 10.3847/1538-4357/acf30f

- **Investigation Type:** Other Investigations
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Reference: Belov, A., N. Shlyk, M. Abunina, A. Abunin, A. Papaioannou, I. G. Richardson, D. Lario (2023), "Study of the radial-dependence of Forbush Decreases at 0.28–1 AU using data from the Helios 1 and 2 spacecraft", MNRAS, 521, 4652, doi:10.1093/mnras/stad732.

- **Investigation Type:** Other Investigations
- Blah

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