

Project Details

ROSES ID: NNH10ZDA001N

Selection Year: 2011

Program Element: Focused Science Topic

Topic: Factors that Control the Highly Variable Intensity and Evolution of Solar Particle Events

Project Title:

Seed Particle Populations in the Solar Corona

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Summary:

A key factor that is expected to influence the highly variable intensity in the largest solar particle events, usually associated with CMEs, is the availability of a seed particle population. Most mechanisms that effectively accelerate high-energy particles have difficulty accelerating particles directly out of the thermal plasma, or at least are greatly enhanced in their efficiency and effectiveness if there is a suprathermal seed particle population present.

During the last decade, considerable progress has been made in understanding the origin of suprathermal particles in the solar wind. An efficient pump acceleration mechanism has been developed by Fisk & Gloeckler that can account for the observed spectral shape and the intensity of suprathermal tails in the solar wind.

The conditions required for the pump mechanism of Fisk & Gloeckler to operate are quite general and should also prevail in the solar corona and create seed particle populations. We propose to apply the pump mechanism of Fisk & Gloeckler to predict the seed particle populations in the solar corona, and to develop observational tests for the presence of these seed particles. We will develop a model for the acceleration of seed particles in the open corona, where the solar wind originates; this is the region that will be encountered by CME-driven shocks. We will develop a model for the acceleration and release of particles from coronal loops, in impulsive solar energetic particle events. We will also apply our growing knowledge of acceleration at shocks in the solar wind by the pump mechanism to explore the possibility that the pump mechanism could be the dominate acceleration mechanism in producing very energetic particles at CME-driven shocks in the corona.

As has been the case throughout the development of the theory for the acceleration of suprathermal particles in the solar wind, the development of the model for the acceleration of seed particles in the solar corona will only be successful if the assumptions and predictions of the model are continuously checked against observations. The proposed research thus lends itself well to a Focus Team effort, where our assumptions of prevalent conditions and our predictions can be checked against observations, and we have access to and can contribute to the development of other theories and models.

Publication References:

Summary: no summary

Reference: Fisk, L. A.; Gloeckler, G.; (2012), Acceleration of Galactic Cosmic Rays in the Interstellar Medium, The Astrophysical Journal, Volume 744, Issue 2, article id. 127, 9 pp, doi: 10.1088/0004-637X/744/2/127

Summary: no summary

Reference: Fisk, L. A.; Gloeckler, G.; (2012), Energetic particle acceleration in the heliosphere, PHYSICS OF THE HELIOSPHERE: A 10 YEAR RETROSPECTIVE: Proceedings of the 10th Annual International Astrophysics Conference. AIP Conference Proceedings, Volume 1436, pp. 116-123, doi: 10.1063/1.4723598

Summary: no summary

Reference: Gloeckler, G.; Fisk, L. A.; Mason, G. M.; Roelof, E. C.; Stone, E. C.; (2012), Analysis of suprathermal tails using hourly-averaged proton velocity distributions at 1 AU, PHYSICS OF THE HELIOSPHERE: A 10 YEAR RETROSPECTIVE: Proceedings of the 10th Annual International Astrophysics Conference. AIP Conference Proceedings, Volume 1436, pp. 136-143, doi: 10.1063/1.4723601

Summary: no summary

Reference: Gershman, Daniel J.; Zurbuchen, Thomas H.; Fisk, Lennard A.; Gilbert, Jason A.; Raines, Jim M.; Anderson, Brian J.; Smith, Charles W.; Korth, Haje; Solomon, Sean C.; (2012), Solar wind alpha particles and heavy ions in the inner heliosphere observed with MESSENGER, Journal of Geophysical Research, Volume 117, doi: 10.1029/2012JA017829

Summary: no summary

Reference: Fisk, L. A.; Gloeckler, G.; (2012), Particle Acceleration in the Heliosphere: Implications for Astrophysics, Space Science Reviews, Volume 173, Issue 1-4, pp. 433-458, doi: 10.1007/s11214-012-9899-8

Summary: no summary

Reference: Zhao, Liang; Gibson, Sarah E.; Fisk, Lennard A.; (2013), Solar wind proton flux extremes and their association with pseudostreamers, SOLAR WIND 13: Proceedings of the Thirteenth International Solar Wind Conference. AIP Conference Proceedings, Volume 1539, pp. 94-98, doi: 10.1063/1.4810998

Summary: no summary

Reference: Fisk, L. A.; Gloeckler, G.; (2014), The case for a common spectrum of particles accelerated in the heliosphere: Observations and theory, Journal of Geophysical Research: Space Physics, Volume 119, Issue 11, pp. 8733-8749, doi: 10.1002/2014JA020426