Project Details

ROSES ID: NNH05ZDA001N
Selection Year: 2006
Program Element: Focused Science Topic

Topic: Shock acceleration of solar energetic particles by interplanetary CMEs

Project Title:
A Self-Consistent Investigation of SEP Production in Gradual Events Based on Realistic Models of Turbulence and IMF

PI Name: Ilia Roussev
PI Email: iroussev@ifa.hawaii.edu
Affiliation: University of Michigan
Project Member(s):
- Sokolov, Igor ; Co-I; University of Michigan
- Gombosi, Tamas I.; Co-I;University of Michigan
- Lee, Martin A; Co-I; University of New Hampshire
- Cohen, Christina M. S.; Collaborator; California Institute of Technology
- Mewaldt, Richard A.; Collaborator; California Institute of Tech
- Giacalone, Joe ; Collaborator; University of Arizona
- Kota, Jozsef ; Collaborator; University of Arizona
- Kuhn, Jeff R; Collaborator; Institute for Astronomy
- Klimchuk, James A; Collaborator; NASA Goddard Space Flight Center

Summary:
We propose to study the shock acceleration of solar energetic particles (SEPs), and their transport, coupled to the dynamics of CME-driven turbulent shock waves in the heliosphere. Our goal is to develop a self-consistent model, which integrates the best theories developed for every aspect of the SEP production and transport problem. This will include a realistic model of turbulence near the shock front and effects of SEP spectrum anisotropy. The new SEP-turbulence model will be coupled with a realistic model of CME evolution to enable the LWS community to tackle important problems related to the shock acceleration of SEPs by CME shocks.

Our research studies will target fundamental features of gradual SEP events, such as formation and evolution of CME-driven shocks, particle injection at the shock, excitation of turbulence by the self-generated Alfv n waves, particle diffusion due to the enhanced turbulence, and particle escape upstream of the shock, among other phenomena. The strength in our integrated approach is that it will enable us to quantify the particle acceleration and scattering by the self-excited Alfv n turbulence, and particle transport along and across the interplanetary magnetic field (IMF). We will extend the capability of the kinetic code of the University of Arizona to include a realistic model of self-excited turbulence, since this code is well suited to handle a finite particle spectrum anisotropy. The particle transport upstream of the shock wave will be studied using a newly developed statistical code based on the Monte-Carlo approach. All the models coupled together will allow us to account for the acceleration and transport of charged particles in realistic 3D turbulent IMF. The results of our studies will be compared with available data from SoHO, ACE, and other satellites in order to improve the CME-SEP-turbulence model accordingly. The whole research effort is expected to contribute towards better understanding, predicting, and mitigating the exposure of human explorers to harmful radiation of solar origin. The proposed self-consistent investigation of SEP production in gradual events based on realistic models of turbulence and IMF directly relates to Focused Science Topic T3a of the LWS TR&T solicitation.

We are also devoted to contributing significant time and effort towards improving science education, particularly in solar-heliospheric physics, and we offer an Initiative for a Novus-Seculorum Program in solar Research and Education (INSPiREd). We propose to organize specialized summer schools, which will introduce and involve students in an integrated-system perspective of the Sun-Earth system. The schools will also provide a venue for teaching and research faculty to improve the scope, impact, and outreach of the existing academic programs. These objectives will make the INSPiREd an important complementary addition to the existing education and public outreach activities at NASA, NSF, and US academic institutions.

Publication References:

no references