17TH ANNUAL INTERNATIONAL ASTROPHYSICS CONFERENCE
ORAL ABSTRACTS

Asgari-Targhi, Mahboubeh	***A comprehensive study of solar wind structure and dynamics based on Alfven wave turbulence*** Mahboubeh Asgari-Targhi, Harvard-Smithsonian Center for Astrophysics, USA Adriaan A. van Ballegooijen, Harvard-Smithsonian Center for Astrophysics, USA We present a reduced magnetohydrodynamic description of an open magnetic field line at the center of a coronal hole extending along the solar rotation axis from the coronal base outward into the heliosphere. Alfven waves are generated at the coronal base and reflect as a result of variations in Alfven speed and solar wind outflow velocity at different heights. The interactions between counterpropagating waves create turbulence that heat and accelerate the solar wind. We consider two models of the solar wind. In the first model, the plasma density and Alfven speed vary smoothly with height along the modeled flux tube. However, we find that the energy dissipation rate of the turbulence is insufficient to maintain the temperature of the background atmosphere. In the second model, we introduce additional density variations along the open field that approximates the effects of compressive MHD waves in the solar wind. We find that such spatial variations in density may enhance the turbulence dissipation rates, and thereby increase the heating rate and the acceleration of the solar wind.
Che, Haihong	***How Nanoflares produce the Kinetic Waves and Weak Coronal Radio Bursts and Non-Thermal Electrons in the Solar Wind*** H. Che,UMCP/GSFC, USA Increasing observations suggest that the solar wind originates from the photosphere and is associated with nanoflare-like impulsive events. These observations present new theoretical challenges on how the coronal origin of solar wind affects its in situ properties and is one of the key to understand the relationship between the Sun and the heliophysics. I first review the pioneering observations that establish the connection between solar wind and nanoflares; then I discuss the recent theoretical and simulation advances, in particular on how the nonlinear dynamics of nanoflare-accelerated electrons produce the kinetic waves and radio bursts, and shape the non-thermal electron velocity distribution which is believed to be responsible for the solar wind acceleration.
van Ballegooijen, Adriaan	***The Heating of Coronal Loops in Solar Active Regions*** A. A. van Ballegooijen, Center for Astrophysics, USA M. Asgari-Targhi, Center for Astrophysics, USA The active region corona is believed to be heated by magnetohydrodynamic (MHD) waves or other magnetic disturbances that propagate into the corona from the convection zone below. However, the details of energy transport and dissipation are not well understood. In this talk we review two popular mechanisms: Alfven waves and braided magnetic fields. We present results from recent modeling of magnetic disturbances in coronal loops using a reduced MHD model. Waves are launched from a collection of kilogauss flux tubes in the photosphere at the two ends of the loop, and we investigate how the waves from neighboring flux tubes interact in the chromosphere and corona. We find that Alfven wave turbulence can produce enough heat to maintain a peak temperature of about 2.5 MK with only small deviations from the potential field. The heating rates vary strongly in space and time, but the heating events are not strong enough to produce the observed higher temperature loops. An alternative magnetic braiding model is considered in which the coronal field lines are subject to slow random footpoint motions, but we find that such long period motions produce much less heating than the shorter period waves launched within the flux tubes. We discuss several possibilities for resolving the problem of producing sufficiently hot loops in active regions.

Viall, Nicholeen	***The Formation of the Slow Solar Wind and the Ground State Space Weather*** Nicholeen Viall, NASA/GSFC, USA Larry Kepko, NASA/GSFC, USA Spiro Antiochos, NASA/GSFC, USA Angelos Vourlidas, JHU/APL, USA Sue Lepri, University of Michigan, USA Aleida Higginson, University of Michigan, USA Jon Linker, Predictive Science Inc., USA We present an analysis of mesoscale solar wind structures and show that they are tracers of slow solar wind formation. We analyze remote white light observations of the young solar wind, just after it is released into the Heliosphere, and we analyze in situ L1 measurements to reveal an important connection between the dynamics of the corona and of the solar wind. We show observations of quasi-periodic plasma release into the heliosphere occurring throughout the corona - including regions away from the helmet streamer and heliospheric current sheet. Our results have critical implications for the magnetic topology involved in slow solar wind formation and magnetic reconnection dynamics. We conclude that magnetic reconnection is an inherent aspect of slow solar wind formation. It produces ubiquitous mesoscale plasma structures throughout the slow solar wind. Though much smaller than coronal mass ejections or co-rotating interaction regions, the mesoscale slow solar wind structures are ever-present, and constantly impact the magnetosphere. The slow solar wind and embedded structures are therefore the ground state space weather- both a driver of smaller-scale, but ubiquitous geospace dynamics, as well as the medium through which large solar storms propagate.
Wang, Linghua	***The Electron Acceleration by ICME-driven Shocks at 1 AU*** Linghua Wang, Peking University, China We present two case studies of the in situ electron acceleration at the 11 February 2000 shock and the 22 July 2004 shock with the strongest electron flux enhancement at 40 keV across the shock, respectively, among all the quasi-perpendicular and quasi-parallel ICME-driven shocks observed by the WIND 3DP instrument from 1995 through 2014 at 1 AU. We find that for this quasi-perpendicular (quasi-parallel) shock on 11 February 2000 (22 July 2004), the shocked electron differential fluxes at ~0.4-50 keV in the downstream generally fit well to a double-power-law spectrum, J ~ E^{-beta}, with an index of beta ~ 3.15 (4.0) at energies below a break at ~3 keV (~1 keV) and of beta ~ 2.65 (2.6) at energies above. For both shock events, the downstream electron spectral indices appear to be similar for all pitch angles, significantly larger than the index prediction by diffusive shock acceleration. In addition, the downstream electron pitch-angle distributions show the anisotropic beams in the anti-sunward traveling direction, while the ratio of the downstream over ambient fluxes appears to peak near 90 deg pitch angles, at all energies of ~0.4-50 keV. These results suggest that in both shocks, shock drift acceleration likely plays an important role in accelerating electrons in situ at 1 AU. Such ICME-driven shocks could contribute to the formation of solar wind halo electrons at energies <~2 keV, as well as the production of solar wind superhalo electrons at energies >~2 keV, in interplanetary space.
Zharkova, Valentina	***Particle Acceleration in 3D Current Sheets with Multiple O and X Null Points*** V.V. Zharkova and Q.Xia, Northumbria University, UK We investigate particle acceleration in 3D RCSs containing multiple O and X-null points. The inclusion of multiple O-null points, or magnetic islands, combined with different dynamics (coalescent or squashed islands) reveals the following points: a) acceleration of protons and electrons in the current sheet with multiple X nullpoints, or magnetic islands associated with O-nulls with a strong guiding field remain asymmetric towards the midplane; b) both types of particles mainly gain energy either in a vicinity of X-null points or inside O-null points, depending on the initial energy of particles; c) particles can escape O-null points, or magnetic islands, only through the neighbouring X-null points; d) as result, electron clouds are formed about the X-nullpoints betweenO-nullpoints; e) eparticles can gain relativistic energy in a single O-nullpoint; and f) particles escape from an RCS along the midplane. The energy gains in coalescent O-nullpoints are smaller than from the squashed ones. Electrons are shown to form clouds about X-nullpoints between the O-nullpoints. Particle acceleration signatures in 3D current sheets with multiple X and O-null points are probed with observational features in the solar corona and heliosphere.

Zirnstein, Eric	***The Role of Pickup Ion Dynamics Outside of the Heliopause in the Limit of Weak Pitch Angle Scattering: Implications for the Source of the IBEX Ribbon*** E. J. Zirnstein, Princeton University, USA J. Heerikhuisen, University of Alabama in Huntsville, USA M. A. Dayeh, Southwest Research Institute, USA We present a new model of the Interstellar Boundary Explorer (IBEX) ribbon based on the secondary energetic neutral atom (ENA) mechanism, under the assumption that there is negligible pitch angle scattering of pickup ions (PUIs) outside the heliopause. Using the results of an MHD-plasma/kinetic-neutral simulation of the heliosphere, we generate PUIs in the outer heliosheath, solve their transport using guiding center theory, and compute ribbon ENA fluxes at 1 AU. We implement several aspects of the PUI dynamics, including (1) parallel motion along the local interstellar magnetic field (ISMF), (2) advective transport with the interstellar plasma, (3) the mirror force acting on PUIs propagating along the ISMF, and (4) betatron acceleration of PUIs as they are advected within an increasing magnetic field towards the heliopause. We find that ENA fluxes at 1 AU are reduced when PUIs are allowed to move along the ISMF, and ENA fluxes are reduced even more by the inclusion of the mirror force, which pushes particles away from IBEX lines-of-sight. Inclusion of advection and betatron acceleration do not result in any significant change in the ribbon. Interestingly, the mirror force reduces the ENA fluxes from the inner edge of the ribbon more than its outer edge, effectively reducing the ribbon's width by about 6 deg. and increasing its radius projected on the sky. This is caused by the asymmetric draping of the ISMF around the heliopause, such that ENAs from the ribbon's inner edge originate closer to the heliopause, where the mirror force is strongest.