SH22B-05 1440h

On the time coincidence between H_α-filament eruptions and soft X-ray emissions

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The interrelationships among coronal mass ejections, solar flares, and filament eruptions have been a long standing issue in solar physics. In particular, timing and spatial relationships among such eruptive phenomena play a key role in understanding any possible causality among them. Presently, observational ambiguities often result from insufficient temporal and spatial resolution. However, we expect that observational capabilities will continue to improve, and in the near future, produce large volumes of solar data with high time-cadence and spatial resolution. We present a technique for quantitatively characterizing dynamics in H_α-data. We report on the result of applying this technique to a sequence of 1-min H_α-images from the Kanzelhöhe Solar Observatory. We chose H_α-data for our initial application because many solar eruptive phenomena have observable signatures in chromospheric dynamics and long periods of H_α-observations are readily available. The data set contains quiescent filaments and a filament eruption accompanied by a two-ribbon flare. The analysis reveals the spatially and temporally correlated phenomena on the H_α-solar disk. The H_α-dynamics are compared with variations in the integrated soft X-ray flux detected by the GOES 8 satellite.

Work supported by ONR, NSF ATM 0205157, and ATM 9903515.

SH22B-06 1455h

Photospheric Sources of Very Fast (>1100 km/s) CMEs Between 1999 and 2001

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We identified photospheric sources for 39 very fast (faster then 1100 km/s) front-side coronal mass ejections, which occurred between 1999 and 2001. For our study we used data on CMEs and their sources provided by the CME Catalog, SOHO spacecraft (LASCO, EIT, MDI), Big Bear Solar Observatory (Halpha, magnetograms), Mount Wilson Observatory (sunspot drawings) and Joint USAF/NOAA active region summary. We distinguished three different groups of active regions which are responsible for very fast CMEs: 1) Complex delta spots (delta spots with a Mt. Wilson classification of beta gamma). This group of active regions (21 events) can be represented by active regions 9393 and 9415 and is characterized by the presence of at least two large opposite polarity sunspots located close to each other. 2) Simple delta spots (8 events). A typical configuration of this type can be represented by active regions 8375 and 9236 and consists of one large twisted tadpole-shaped sunspot, surrounded by many small satellite-sunspots. 3) Extended magnetic regions, which consist of two adjacent decaying active regions or a new active region emerging inside a decaying active region (active regions 9046 and 9085). In this presentation we will discuss in detail the evolution and the type of the magnetic structures which are responsible for very fast CMEs originating from delta-configurations.

URL: http://www.bbso.njit.edu/~vayur/results.html

SH22B-07 1510h

Coronal Mass Ejections and Other Activities in the Inner Corona Observed by the LASCO/C1

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We present observations of coronal activities observed in the inner corona from 1 to 3 solar radii by the LASCO (Large Angle Spectrometer and Coronagraph) C1 instrument on SOHO spacecraft. These activities include initiation and acceleration of coronal mass ejections, transient dimming and brightening of active regions, large scale trans-active region loops, expanding of post-eruption loop arcades and et al. A set of CME events will be investigated to reveal their velocity and acceleration profiles in the inner corona.

SH22B-08 1525h

Comparison of the Breakout Model With Flare-Loop and Ionic Composition Data

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We discuss our ongoing analysis of the observational properties of Breakout coronal mass ejections. Presented are quantitative analyses of the post-eruption evolution that produces the commonly observed flare-loop arcades at the limb and the spreading flare ribbons at disk center. The simulation dynamics are compared to observational results of long-duration flares. We also present a novel application of the ionic charge freeze-in analyses to the numerical simulation output. This post-processing allows us to 'predict' the heavy ion charge states (O7+/O6+) from the simulation density, temperature, and velocities. Due to limitations in the energy accounting and initial conditions of the MHD simulation, we do not obtain the observed O7+/O6+ values, but we emphasize the potential of this method and show how it can be used to study relative variation in charge state composition throughout the ejecta volume.

SH22C MCC: 3006 Tuesday 1600h

Interplanetary Physics III and Scarf Award *(joint with SA, SM)*

Presiding: **J T Gosling,** Los Alamos National Laboratory

SH22C-01 1605h INVITED

Low Energy Anomalous Cosmic Ray Observations: New Insights and Challenges to our Understanding of Heliospheric Particle Transport

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In an ongoing series of papers, we report modeling results and observations from 1991 to 1999 related to the inner and outer heliospheric transport of anomalous cosmic rays (ACRs) having significantly lower energies (0.3 to 40 MeV/nucleon) than have been previously studied. The measurements (which are from the last $A > 0$ recovery phase) provide crucial information on the transport of H, He, and O at energies below the ACR spectral peaks. A consistent picture that has emerged from our systematic study of these data—primarily from the Voyager 1 & 2 probes, but also including various 1 AU spacecraft—includes the following key features: (1) The initial ACR recovery at all observable rigidities takes about 1 year, suggesting that the dominant timescale is that which arises from the global variation of the interplanetary (IP) transport properties (not the rigidity-dependent "relaxation" time needed for equilibrium to develop). (2) The IP transport properties of the outer heliosphere reach a quasi steady state by mid-1994, which lasts until renewed modulation becomes evident around 1999. (3) The distinct exponential growth of the low-rigidity ACR intensities and the nearly constant intensities at higher rigidities are primarily due to the motion of the Voyager spacecraft through spatial intensity gradients, not to continued temporal evolution. (4) Most of these effects can be modeled in a time-dependent manner with a spherically symmetric transport model, suggesting a reduced role for drifts at low rigidities in the outer heliosphere. (5) Latitudinal intensity gradients for ACRs having rigidities below 2 GV are negative (not positive as expected for the $A > 0$ phase), again consistent with weak drifts for these particles and suggesting an important contribution from the latitudinal dependence of the solar wind velocity. In this paper we will summarize these observations and interpretations, highlighting those aspects that are felt to be generally unrecognized. The possible adjustments to our present understanding of the transport of ACRs through IP space will be outlined and we will emphasize the opportunities there are for modelers and theoreticians to utilize the largely untapped resource that our large dataset represents. Until these unique lower-energy ACR measurements are explained, a complete understanding of the transport and acceleration of energetic particles in the heliosphere cannot properly be claimed.

URL: http://space.umd.edu/VOYAGER/

SH22C-02 1625h

Energetic Particles Upstream From the Earth's Bow Shock: Multipoint Observations by Cluster and Polar

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One of the primary goals of the Cluster mission is to use multipoint observations to separate temporal and spatial variations in the measured fields and particle fluxes. An example is found in observations by the Cluster RAPID instruments of 30-1500 keV particle populations upstream of the Earth's bow shock. When the Cluster constellation is closely spaced (~600 km), the energetic particle fluxes observed by the four spacecraft are nearly identical because the locations differ by less than one gyroradius of the lowest energy particles. The measured magnetic field vectors at the four spacecraft are also virtually identical, and connect to a single region on the bow shock surface. We contrast this with recent cases in which the Cluster separation is much greater (~6000 km) and the magnetic field connects the four spacecraft to different points on the shock. In this way, the particle acceleration processes at several points on the shock may be monitored simultaneously. Similar energetic particle measurements in the dayside outer magnetosphere by the Polar spacecraft are compared with the Cluster observations with a special focus on the differences in relative ion composition between the upstream populations and the magnetospheric particles.

SH22C-03 1640h

The Interstellar Hydrogen Shadow: Observations of Interstellar Pickup Ions Beyond Jupiter

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This study analyzes the first observations of heliospheric pickup ions beyond the orbit of Jupiter. The Cassini Plasma Spectrometer observes H+, He+, He++, and O+ pickup ions of interstellar origin between 6.4 and 8.2 AU. Surprisingly, however, there is a strong depletion of pickup H+ compared to He+, in contrast to the interstellar H/He ratio of approximately 10. We show that this depletion is produced by a combination of gravitational focusing of He by the Sun and a newly observed "interstellar hydrogen shadow" that diminishes the source of pickup H as Cassini moves through the region behind the Sun relative to the local interstellar flow. Most H atoms cannot penetrate

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into this downstream shadow region since to get there they must pass close by the Sun where they have a high probability of being ionized and swept out with the solar wind.

SH22C-04 1655h

Interstellar Magnetic Field and its Influence on the Heliospheric Interface.

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The strength and direction of the interstellar magnetic field (ISMF) in the Local Interstellar Cloud (LIC) have not been directly measured and remain the less known parameters affecting the interaction of the solar wind (SW) with the local interstellar medium (LISM). The values as small as $\sim 1.5\,\mu$G are consistent with the observations of the pulsar dispersion and rotation measures, whereas the estimates of the heliospheric confinement pressure yield the upper limit of $\mathbf{B}_\infty \sim 3-4\,\mu$G. The latter values are derived assuming that ISMF is directed perpendicular to the LISM velocity vector $\mathbf{V}_\infty$ with respect to the Sun. We analyze the consequences of the SW encounter with LISM possessing magnetic fields in a wide range of strengths and directions. Both axisymmetric ($\mathbf{B}_\infty \parallel \mathbf{V}_\infty$) and 3D configurations are considered. It is shown that the topology of the bow shock strongly depends on its being fast or slow. Special attention is given to slow bow shocks in the quasi-field-aligned cases, where their existence is stipulated by charge exchange processes in the upstream region. The comparison of theoretical results predicted in this case by our model with the Hubble Space Telescope measurements showed very good agreement. Thus, stronger magnetic fields, which are necessary to satisfy the general equilibrium between the Local Bubble and LIC gases, cannot be excluded from consideration. Fields of such strengths are involved in the model of the LIC origin due to Cox & Helenius (2003). We also analyze various superfast cases, including those where fast parallel shocks cannot exist, while switch-on shocks should be excluded in the presence of certain symmetry restrictions. This usually results in the appearance of additional discontinuities between the bow shock and the heliopause. We show that this scenario is not necessarily valid if the interplanetary magnetic field is taken into account. In this case the ISMF lines exhibit complex three-dimensional topology, which may influence the general picture of the cosmic ray diffusion into the heliosphere. Regimes are also investigated, where $\mathbf{B}_\infty$ is nearly perpendicular to V_∞. They are accompanied by the reconnection of the interplanetary and interstellar magnetic field lines and reveal stronger dependence on the ISMF strength than in field-aligned cases.

SH22C-05 1710h

Are Solar Electron Burst Acceleration Sites Highly Localized?

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More than 300 solar electron bursts have been observed at energies below 1.4 keV by the SWEPAM experiment on ACE. All of these bursts are strongly beamed outward along the heliospheric magnetic field. In addition, a backscattered component is also commonly present. A large fraction of these bursts are closely associated with type III radio bursts that extend down in frequency close to the local plasma frequency. Electron burst durations range from about 1 to greater than 30 hrs. Burst beam intensity-time profiles below 1.4 keV usually are relatively smooth and structureless at all energies, although notable exceptions to this rule occur. In contrast, impulsive solar energetic ion events commonly contain significant dispersionless (in energy) temporal structure. That structure has been interpreted as evidence that heliospheric field lines are commonly braided and that the ion acceleration site at the Sun is spatially localized. One possible interpretation of the SWEPAM electron measurements is that the electron burst acceleration sites typically are considerably less spatially localized than are the impulsive ion acceleration sites.

SH22C-06 1725h

Electron Dynamics in Perpendicular Shocks

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A full particle electromagnetic code in the Darwin approximation is used to investigate the dynamics of the electrons in a fast magnetosonic shock. We assume a perpendicular geometry where x points into the shock and the electromagnetic field structure is $\mathbf{E} = (E_x, E_y, 0)$ and $\mathbf{B} = (0, 0, B_z)$. The 1D3V code has open boundaries with upstream and downstream particles traversing the left and right boundaries, respectively, while the shock structure remains in the simulation box. Two shock strengths are considered, including a near critical shock with alfvenic Mach number $M_a \sim 2$ and a supercritical shock with $M_a \sim 3$–4. The simulation is initiated by loading the particles according to profiles modeled from conservation laws (Rankine-Hugoniot). Particles and fields are then left to evolve and, once the ion dynamics develops, a self-consistent shock structure forms. Importantly, due to the partial decoupling of ions and electrons which occurs in the magnetic ramp, the electrostatic field E_x builds up a large spike whose role is to slow down the ions. In the supercritical case a significant fraction of ions are reflected and accumulate in the foot, which leads to the process of cyclical shock reformation. We record the trajectories of selected electrons in order to analyse their behavior in the cross field structure of the ramp. We specially look for a possible "superadiabatic heating", a process described by previous authors [Balikhin and Gedalin (1994); Ball and Galloway (1998)]. The latter is expected to occur for extreme cases where the gradient of the electrostatic potential, which reflects the ions, is so strong that the electrons are accelerated across a large fraction of the ramp during one cyclotron gyration. The required potential difference across the ramp $\delta\phi^*$ depends upon its half width Δ, namely $e\delta\phi^*/mv_e^2 \approx (0.2/\beta_e)\,(\Delta/\lambda_e)^2(r+1)^2$. Here, λ_e is the electron inertia length c/ω_{pe} and r is the compression ratio. Our study improves upon the above mentioned works in the sense that we use profiles of the electromagnetic fields that are self-consistently built instead of just adhoc profiles.

SH22C-07 1740h

Quasi-Perpendicular Shocks: Full Particle Simulations With Realistic Ion to Electron Mass Ratio

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In quasi-perpendicular shocks with a Mach number below the whistler critical Mach number M_w the whistler precursor wave train is an essential part of the shock. M_w depends on the magnetic field - shock normal angle Θ_{Bn} and on the ion to electron mass ratio. It has been proposed that above M_w nonlinear wave steepening of the upstream whistler cannot be balanced anymore by dispersion and dissipation, and that this leads to shock nonstationarity. Full particle (PIC) simulations of shocks above the whistler critical Mach number with a reduced ion to electron mass ratio have indeed resulted in shock nonstationarity. We present PIC simulations of collisionless shocks over a wide range of Θ_{Bn} and Mach number with the realistic ion to electron mass ratio. It will be shown that the modified two-stream instability (MTSI) between incident solar wind electrons and incident and reflected solar wind ions occurs in the foot of the shock and leads to a considerable modification of the shock structure. This has consequences for the nonstationarity, for the various lenghth scales, and for the reflection rate of the specularly reflected ions. Simulations with an ion to electron mass ratio of about 400 or less cannot show these processes, since the growth rate of the MTSI depends strongly on mass ratio.

SH31A MCC: Level 2 Wednesday 0830h

Roles of Electromagnetic Waves in Reconnecting Space and Laboratory Plasmas I Posters *(joint with SM)*

Presiding: **H Ji,** Princeton Plasma Physics Laboratory, Princeton University**; W Daughton,** Los Alamos National Laboratory

SH31A-1076 0830h POSTER

3D Kinetic Simulations of the Onset of Collisionless Magnetic Reconnection

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We study the onset of collisionless magnetic reconnection by performing kinetic simulations of Harris current sheets. Simulations of two-dimensional systems show that the saturation level of the tearing mode is very low if no initial perturbation is added. Two-dimensional simulations in the current aligned plane show the development of the fastest lower-hybrid drift instabilities on the electron gyroscale, followed by electromagnetic modes with wavelengths intermediate between the ion and the electron gyroscale and, finally, the velocity shear (non-linear consequence of the lower-hybrid modes) triggers a flapping mode that kinks the current sheet. Finally, we perform three-dimensional simulations to investigate the effect of the current aligned modes on the onset of the reconnection process. The simulations are performed with CELESTE3D, an implicit PIC suitable for large scale and high mass ratio simulations, and with a massively parallel explicit PIC code able to study in more detail the microphysical processes.

SH31A-1077 0830h POSTER

Kinetic Simulations of Magnetic Reconnection in Plasma With Different β Values

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We present kinetic simulations of collisionless magnetic reconnection in Harris current sheets. We simulate plasmas with different β values by varying the guide fields: high guide field correspond to low β. For all values of $\beta > m_e/m_i$, fast reconnection is made possible by the separation of the electron and ion dynamics in the reconnection region. The primary mechanism that relaxes the frozen-in conditions is given by the non-gyrotropic electron pressure terms for all the guide fields considered. The reconnection rate is then enhanced by the Whistler dynamics in high β plasmas and by the Kinetic Alfvén Waves dynamics in lower β plasmas. In the latter case, the ion sound radius takes the place of the ion inertial length as the length scale of interest. The guide field diminishes the reconnection rate and decreases the reconnection saturation level. The ion and electron flow pattern, acceleration, and heating are strongly influenced by the guide field. The