Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-01 Room:201B Time:May 27 14:15-14:30

On beam-induced kinetic Alfven waves and rapid dissipation of circularly polarized Alfven waves: A 2-D hybrid simulation

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Beam-induced instabilities are one of the most fundamental relaxation processes in collisionless plasmas. The ion beams parallel to the ambient magnetic field are often observed in the solar wind, foreshocks, and in the earth's magnetosphere. Waves excited by these beams are important from the point of view of heating core plasmas and also making nonthermal particles.

We numerically discuss the dissipation of circularly polarized Alfven waves in solar wind plasmas including beam components by using a 2-D hybrid simulation code. Numerical results suggest that, both in the 1-D and 2-D simulations, the presence of large amplitude Alfven waves strongly suppresses the beam instabilities. Furthermore, the Alfven waves are rapidly dissipated in the presence of the beam-induced kinetic Alfven waves, which can exist only in the 2-D system.

Keywords: Alfven wave, ion beam, kinetic Alfven wave, solar wind, foreshock, solar corona

Japan Geoscience Union Meeting 2011
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PEM028-02 Room:201B Time:May 27 14:30-14:45

Supperdiffusion transport of energetic ions accelerated a shock wave

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We study the transport properties of energetic particles in the upstream region of interplanetary shocks considering the possibility of anomalous diffusion, where the density decay profile has not an exponential profile but a power-law behavior. The ACE spacecraft observations at 1 AU show that the energetic ions with energy of 0.55 ˜ 0.76 MeV spatial profiles are well fitted by a power law distribution and we have < dxˆ2 > ˜ tˆa, with a ˜ 1.33 +- 0.01. This implies that particle propagation around a near earth orbit can be intermediate between normal diffusion (a = 1) and ballistic motion (a = 2) even though the power of the magnetic wave is sufficient large to scatter the particles.

Keywords: shock wave, particle acceleration, diffusion process

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-03 Room:201B Time:May 27 14:45-15:00

Energetic particle generation in CIR with and without magnetic decrease structures

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Corotating interaction regions (CIRs), which are the plasma and field compression regions, are typically bounded by a pair of shock waves (forward/reverse shock) at the heliocentric distance $>$ 2AU. The spacecraft observations have found the increases in energetic particle intensities coinciding with CIR events, especially exhibiting the peaks at its boundaries. This implies that the effective acceleration process is taken place at the forward and reverse shocks. Furthermore, the intensity increase near the reverse shock is mostly larger than than those measured near the forward shock.

We perform one-dimensional hybrid simulations which show the evolution of both forward and reverse shocks simultaneously to account for such an asymmetric feature. The result indicates that the reverse shock becomes a quasi-parallel regime by the reduction of tangential field amplitudes due to the solar wind adiabatic expansion. Thus ion injection into diffusive shock acceleration process is more easily established, resulting in the thermal solar wind possibly accelerated up to the suprathermal range.

On the other hand, the magnetic decrease structures (MDs) are well developed in the reverse shock downstream via the interaction of large-amplitude Alfven waves embedded in the fast solar wind with the shock. Since the MD carries more particles away from the shock front, the temporal development of the reverse shock, such as the transition to a quasi-parallel regime, is suppressed. Therefore, in the presence of MDs, the acceleration efficiency at the reverse shock is declined.

By the meeting, we will further investigate the energetic particle profile throughout a whole CIR and compare the results with observational features.

Keywords: CIR, shock, particle acceleration, magnetic decrease

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-04 Room:201B Time:May 27 15:00-15:15

Microstructure of the heliospheric termination shock

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Microstructure of the heliospheric termination shock is investigated by utilizing one-dimensional electromagnetic full particle simulation. A relative pickup ion density of 30% and two different shock angles 90 and 87 deg. are assumed. In addition a run with a 60% relative pickup ion density is performed to investigate a pickup ion dominated shock. There is an exteded foot upstream of the ramp due to reflected pickup ions. In this foot a large shock potential is produced mainly due to the positive bulk velocity of the pickup ions perpendicular to the magnetic field and to the shock normal. The maximum value of the potential is over 30% of the shock ram energy. Pickup ion reflection at the shock is almost 100%; part of the pickup ions are essentially specularly reflected by the magnetic field force term of the Lorentz force in the overshoot, part are reflected in the extended foot due to a combination of magnetic force term and the cross-shock potential. In the 30% pickup ion case about 90% of the total thermal energy in the shock is gained by pickup ions, 10% by the solar wind ions and electrons. The thermal energy gain by pickup ions increases as the pickup ion relative density increases. The pickup ion temperature increases continuously from the upstream edge of the extended foot to the shock ramp and stays then constant through the overshoot and downstream.

Keywords: termination shock, pickup ion

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-05 Room:201B Time:May 27 15:15-15:30

Evidence of strong deformation of the Earth's magnetosphere under low Ma solar wind

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The density of the solar wind (SW) around the Earth's magnetosphere at times decreases to only several percent of the usual value, and such density extrema results in a significant reduction of dynamic pressure and Alfven Mach number (Ma) of the SW flow. While simple expansion of the Earth's magnetosphere by the low dynamic pressure was assumed in previous studies, a recent simulation study predicted a remarkable dawn-dusk asymmetry of the magnetotail in shape under low Ma SW and Parker-spiral IMF configuration (Nishino et al., Phys. Rev. Lett., 2008). Therefore, direct observations of the magnetopause under these conditions have been awaited. Here we show evidence of strong deformation of the magnetotail under low Ma SW and Parker-spiral IMF conditions, based on Geotail observations on both the dawn and dusk sides. The tail magnetopause on the duskside remained at the usual position despite extremely low dynamic pressure in the SW, while the magnetotail on the dawnside drastically expanded dawnward, both of which are consistent with the simulation result. The strong deformation of the magnetotail can be universal phenomenon, because it is attributed to the extremely low Ma (low beta) SW environment that may also take place around the Earth's magnetosphere passed by coronal mass ejections (CMEs) as well as around Mercury and in the interstellar medium outside the heliopause.

Keywords: low Ma solar wind, solar wind - magnetosphere interaction, deformation of the magnetosphere, Geotail observations, global MHD simulation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-06 Room:201B Time:May 27 15:30-15:45

Expansion fronts of solar wind ions and electrons at the wake boundary

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The solar wind interaction with an insulating, non-magnetized body such as the moon is characterized with the particle absorption and the surface charging. The solar wind particles that hit the moon are absorbed by the surface, creating a plasma cavity called the lunar wake behind the moon. At the boundary of the downstream wake, it has been often explained as ”due to their greater thermal speed, the ambient electrons fill in the evacuated wake region faster than the ions, thereby creating an ambipolar electric field that retards the velocities of electrons and increases the velocities of the ions in a self-consistent way” (e.g., Farrell et al., GRL 1996).

According to the electromagnetic 2-dimensional particle-in-cell simulation with surface charging, it has been found that the ions enter the void faster than the electrons, producing positive excess of charge at the wake boundary in the vicinity of the obstacle (x = 1 Ro, where Ro is the radius of the obstacle). It is due to the negative electric potential of the nightside surface of the body, which retards the solar wind electrons coming to the wake boundary. Negative excess of charge is found in the central wake at farther downstream (x = 2 - 3 Ro). It should be noted that the simulation was for small object whose radius is several times as large as the Debye length, and the effect of the surface charging might be limited for a larger obstacle. The nightside surface charging is due to the electron thermal speed higher than the solar wind bulk speed, which is a basic nature of the solar wind plasma, and is caused mainly by higher energy component of the electrons, while the density profile is mainly constituted by the lower energy component that can be easily retarded by the surface charging.

Keywords: wake, electrons, expansion front, surface charging, PIC simulation, ambipolar electric field

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-07 Room:201B Time:May 27 15:45-16:00

Generation mechanism of the 100-second magnetic field variations observed by Kaguya

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Kaguya/LMAG often detected low-frequency magnetic variation of 100-sec periods when the moon was in the solar wind. The low frequency waves were examined by using the 1-sec averaged magnetic field data obtained by Kaguya/LMAG during the period from January 1, 2008 to November 30, 2008. The data were Fourier transformed every 600 sec. The waves were observed in 10 percent of the observation period. The dominant frequency was 0.01 Hz. The waves were observed at the terminator and the magnetic anomaly of the moon. The waves are supposed to be generated by the protons reflected by the moon through cyclotron resonance with the MHD waves in the solar wind.

Keywords: Moon, Kaguya, MHD wave, magnetic field, MAP/PACE LMAG, solar wind

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-08 Room:201B Time:May 27 16:00-16:15

Electrostatic Solitary Waves (ESWs) observed by Kaguya monopole antennas near the Moon

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In KAGUYA (SELENE) LRS[1], WFC-L [2] observes waveforms of plasma waves in 100Hz-100kHz and a lot of electrostatic solitary waves (ESWs) have been observed. Some results have been reported [3]. Although orthogonal dipole antennas are generally used in the observations, sometimes a pair of monopole antennas were used. We reports observations mainly by the latter antennas.

Propagation velocities, potentials, spatial scales, and so on of ESWs can be evaluated through analyses of waveforms observed by the monopole mode. The ESW waveforms have often components perpendicular to the background magnetic field and the potential structure is perpendicular to the background magnetic field. These values are evaluated after fitting the observed data to the ideal two-component ESW fields. The propagation velocities, the sign of the potential, potential depth, and so on of some examples received regions reported in [3] will be reported.

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Keywords: Moon, Kaguya, Electrostatic Solitary Waves, Wake

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-09 Room:201B Time:May 27 16:30-16:45

Solar radio type-I radio bursts generated during CMEs and their related magnetic structures

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Type-I noise storm is one of the solar radio phenomena observed in a meter wavelength. Type-I bursts are sometimes observed with coronal mass ejections (CMEs). Nevertheless, the relationship between type-I bursts and CMEs has not been understood well. The observation facing to the disc center is most suitable to identify radio bursts because of the emission directivity, while the limb observation enables to capture easily coronal loop structures and their dynamics. We have investigated an active region which was located around the solar disk center using the ground based radio burst observation and coronal imaging observations of the STEREO satellites that located around 65 to 70 degree from the Sun - Earth line. Such coordinated observations at different angles from the active regions are essential for studying the type-I noise burst.

Generation and decrease of type-I bursts were observed around 100 - 200 MHz on Feb. 7, 2010. STEREO observed several CMEs and radio flux of type-I bursts enhanced after the first CME and decreased before the second CME in this event. A potential-field source-surface simulation using SOHO/MDI magnetograms suggests that there was a multipolar magnetic system around the active region and CMEs occurred around the magnetic neutral line of the multipolar system.

We have tried to explain our observation results using a CME model in which CMEs occur in multipolar topologies (Antiochos et al, 1999). In this model, a current sheet is made in the post CME loop after the eruption of the first CME. This current sheet is usually much less sheared and their reconnection proceeds slowly. Therefore, this current sheet reconnection region can provide energetic particles weakly for a long time and it can explain the long duration of the type-I emission. We assume that a flux emergence which leads to the second CME might cause deformation or destruction of the current sheet of the radio source region, and suppressed the radio burst emission. This explanation is consistent with the fact that the type-I dissipation occurred when the first CME front had reached at a height of several solar radii, which was so distant from the height of expected radio source region that the first CME could not modulate the radio source region by itself.

Keywords: solar radio burst, ground based observation, active region, CME

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-10 Room:201B Time:May 27 16:45-17:00

Speed profiles of ICMEs detected by IPS observations

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We have investigated property of traveling interplanetary coronal mass ejections (ICMEs) by using interplanetary scintillation (IPS) observations using 4 ground-based stations of radio telescope. IPS observations allow us to determine solar wind condition between 0.2 and 1AU.

In this study, we analyzed data of the solar wind disturbance factor, so-called g-value, derived from our IPS observation. From this analysis, we made a list of IPS disturbance event days and all-sky maps of g-values. With assumptions that (1) an IPS disturbance event day correspond to a CME in the period of solar minimum, (2) motion of ICMEs is radial and (3) ICME is located on enhanced g-value region, we compared our list (or all-sky maps) with other catalogs, i.e. SOHO/LASCO CME catalog [URL: http://cdaw.gsfc.nasa.gov/CME_list/index.html] and ICMEs catalog [Richardson and Cane, 2010]. We identified fourteen IPS disturbance event days which relate to both near-Sun halo CME and near-Earth ICME in periods of 1997, 1998, 2008 and 2009. For these event days, we calculated speed profiles of ICMEs traveling at three locations, i.e. near-Sun, interplanetary space and near-Earth.

In this talk, we report speed profiles of ICMEs which is derived from analysis of IPS disturbance event days.

Keywords: Interplanetary space, Coronal mass ejections, Space plasma, Ground-based observation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-11 Room:201B Time:May 27 17:00-17:15

Solar wind data assimilation using 3D MHD simulation

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Solar wind propagates among interplanetary space embedding large disturbed structures. They have significant effect on planetary environment. In order to understand their propagation and development in the simulation constrained by observations, we try data assimilation for solar wind case. Solar wind propagation is simulated by solving a three-dimensional magneto-hydrodynamic (MHD) equations with inner boundary condition is based on SOHO/MDI magnetic field observation and related wind velocity, density, and temperature by empirical models. Solar wind velocity from interplanetary scintillation (IPS) observation is put into the simulation by weighting as a function of observation and system (model + inner boundary) errors. The latter is simulated to obtain as a function of heliospheric radius. Including the attempt to improve the assimilation reflected region, we will show present status of solar wind data assimilation.

Keywords: solar wind, data assimilation, simulation, MHD

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-12 Room:201B Time:May 27 17:15-17:30

Solar activity cycle and its anomaly observed by radio

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The 24th solar activity cycle has started and number of active regions and relative sunspot numbers are increasing. However, their rate of increase is rather slow compared to previous cycles. Active region sizes are small, lifetimes are short, and no big (X-class) flares occurred so far. We study this anomalous situation using data from Nobeyama Solar Radio Observatory.

Total radio fluxes from the Sun have been observed by radio polarimeters since November 1951. Data covering almost 60 years in microwave regions are available. Due to well established calibration method, these data can be used as indices of long term solar activity similar to or better than relative sunspot numbers. Minimum values of radio fluxes were recorded in 2009 and now flux values are increasing. However, increasing rate is rather small compared to previous cycles.

Radio imaging observations have been done by Radioheliograph (NoRH) since 1992. We can compare radio images during the latest minimum period with that of the previous one. Solar activity cycle is not only increase and decrease of sunspot numbers, but also latitudinal variations of sunspots and dark filaments, and polar activities. We need to study global activities of the Sun. For this purpose, we synthesized radio a butterfly diagram using 6,500 daily radio images taken by NoRH at 17 GHz.

Beside lower latitude bright active regions, polar regions are bright in radio. This polar activity is anti-phase with the lower regions. The current polar brightness is weaker than the previous minimum. Also we can clearly see north-south asymmetry in polar brightness. Dark features correspond to dark filaments which divide magnetic polarity. Large structure of dark features represents global magnetic structure on the Sun. This structure seems to repeat in 11 years, but low latitude active regions started to activate after 13 years. Synchronization between global cycle and active region cycle seems to be lost or weakened.

When large sunspots appear on the Sun, radio images show very bright, compact and highly circularly polarized emission sources. These are due to gyro-resonance emission. Gyro-resonance emission observed by NoRH at 17 GHz is emitted at 2,000 Gauss iso-gauss layer above sunspot umbrae. In the current solar cycle, number of such sources is very small. These sources always show 3-minutes oscillation. From detailed measurement of oscillation period, we can get temperature of sunspots. Study of such sources during the last solar cycle show that oscillation period, hence sunspot temperature, depends on solar cycle phase. It is quite interesting to study sunspots in the current anomalous solar cycle.

Keywords: solar activity cycle, radio observation, Nobeyama Radioheliograph, radio butterfly diagram

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-13 Room:201B Time:May 27 17:30-17:45

Long term variations of magnetic multipoles of the sun

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457 3-D maps of the coronal magnetic field are constructed by the Radial-Field Model devised by myself and synoptic charts of the photospheric magnetic field (PMF) observed at the NSO, Kitt Peak in the state of Arizona during 1645 Carrington rotation (Aug. 17, 1976) and 2101 Carrington rotation (Sep. 5, 2010). In this procedure the scalar magnetic potential of the PMF is expanded into spherical harmonic series. 457 coefficients of each Gnm and Hnm, where n = 0 – 90, and m = 0 – n, are calculated. G10 corresponds to the magnetic dipole, and Gnm and Hnm are called as magnetic multipoles. The motion picture of the long term variations of Gnm is constructed during three solar activity cycles by these 457 Gnm. It is found, from this motion picture, that (1) the magnetic dipole component, G10 is more or less steady after its polarity change. (2) some of the magnetic multipole components, m = 0 and n = m, grow up after the shrink of the dipole component. The motion picture is useful for the understanding of the temporal variaion of Gnm.

Keywords: solar magnetic field, magnetic dipole, magnetic multipole, long term variation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-14 Room:201B Time:May 27 17:45-18:00

Solar cycle evolution of the Sun's shadow in 10 TeV cosmic ray intensity observed with the Tibet air shower array

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In this paper, we report for the first time a clear solar cycle variation of the Sun's shadow in the 10 TeV cosmic-ray intensity observed over an entire period of the Solar Cycle 23 between 1996 and 2009. In this variation, the average intensity deficit in the shadow changes in a high negative correlation with the Heliocentric Current Sheet (HCS) tilt-angle, i.e. the intensity deficit decreases (increases) in the solar activity maximum (minimum) period. The amplitude of the variation is as large as one half of the deficit intensity expected when all cosmic rays arriving from the optical Sun disk are excluded from the observation. Based on numerical simulations of the trajectory of antiparticles ejected from the earth to the Sun in the model magnetic field, we find that the Sun's shadow diminishes during the solar activity maximum period due to antiparticles' orbits being deflected in the complicated and disordered coronal field and excluded from hitting the photosphere. During the solar minimum period, on the other hand, we find trajectories in the solar polar region being focused and guided toward the photosphere resulting in the enhancement of the shadow. We also find the Geocentric Solar Ecliptic (GSE) longitude of the shadow center changing in two succeeding solar minimum periods. The average GSE longitude in 1996-1997 is +0.039+-0.038 deg, while it is -0.49+-0.036 deg in 2007-2009 being 25 % larger than the geomagnetic deflection of the Moon's shadow. This is due to the poloidal component of the ordered coronal field deflecting cosmic ray trajectories in an opposite sense to the geomagnetic deflection in 1996-1997, while it deflects trajectories in the same sense in 2007-2009.

Keywords: Sun's shadow, solar magnetic field, solar cycle variation, galactic cosmic rays, air shower

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PEM028-15 Room:201B Time:May 27 18:00-18:15

Long-term variation in distribution of solar wind density fuluctuations for 1997-2009

Munetoshi Tokumaru[1*], Masayoshi Kojima[1], Ken'ichi Fujiki[1]

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Interplanetary scintillation (IPS) observations made with the 327-MHz multi-station system of the Solar-Terrestrial Environment Laboratory (STEL) are analyzed to investigate distribution of solar wind density fluctuations(Delta Ne) and its evolution during 1997-2009. The computer assisted tomography (CAT) method is used in the present study to deconvolve line-of-sight integration of solar wind speed and g-value data obtained from IPS observations. The results show that the high-(low-) latitude region is dominated by small (large) Delta Ne plasma, which corresponds to the fast(slow) solar wind. The solar wind speed data show a clear change associated with the solar cycle, and this is in good agreement with our earlier study (Tokumaru et al., 2010). In contrast, the Delta Ne data don't show such a solar cycle change, and they shows a gradual increase in fractional area of small Delta Ne region throughout the period. This trend is observed for all latitudes, and is distinct after 2005 for low latitudes. It is found that all IPS data obtained here except for those in 2000 are generally consistent with the empirical relation; Delta Ne ~ $V^{-0.5}$, (where V is the solar wind speed) reported by Asai et al.(1998). The important point to note is that a marked reduction in Delta Ne occurs in 2009 for the low speed wind, V $<$350 km/s. Since number of IPS data for this speed range may be insufficient to conclude, we need to confirm this reduction in Delta Ne from further observations.

Keywords: solar wind, interplanetary scintillation, solar cycle, Sun's magnetic field, turbulence