Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

PEM28-01 Room:102A Time:May 20 15:30-15:45

Solar wind control of lunar external magnetic enhancement: A case study

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We study an interaction between the solar wind (SW) and the magnetic anomalies on the lunar surface using SELENE (Kaguya) data. It has been known that magnetic enhancements are at times detected near the limb external to the lunar wake, which is thus called lunar external magnetic enhancement (LEME), as a result of direct interaction between the SW and the lunar crustal fields. Previous observational studies, based on statistical trends that stronger interplanetary magnetic field (IMF) and higher SW density favor the LEME in high solar zenith angle (SZA) region, suggested a fluid-type interaction as a candidate for formation mechanism of the LEME. However, neither the IMF orientation nor the crustal field direction has not been taken into account in the previous analyses.

We show evidence that relation between the IMF and crustal field orientation is also one of the key factors that control the extent of LEME, focusing on one-day observations (12 revolutions) that include data above South Pole-Aitken (SPA) basin which is characterized by strong crustal fields in a wide region. Strong LEMEs are detected at 100 km altitude around SPA basin under the stronger and northward IMF condition, while they weakens under southward IMF. We examined the crustal field model (uncompressed by the SW) constructed from the SELENE magnetometer data to know the orientation of the crustal field at 300 km, 100 km, and lower altitude. In the region where the peak of the magnetic enhancement is detected at 100 km altitude, the model crustal field at 300 km altitude is directed northward, while the model field at 100 km and lower altitude had a southward component in some revolutions. This suggests that the lunar crustal field is compressed by the SW dynamic pressure, and that its large scale component is essential to the formation of the LEME. In addition, our results show that pile-up of the IMF above the crustal fields becomes more effective under parallel field configuration, and suggests that magnetic reconnection between the IMF and the lunar crustal field may take place under anti-parallel field configuration.

Keywords: Solar wind-Moon interaction, Lunar magnetic anomalies, Magnetic pile-up, SELENE

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PEM28-02 Room:102A Time:May 20 15:45-16:00

Radio scintillation observation of solar corona with Venus orbiter Akatsuki

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Radio occultation observation of solar corona was conducted in June, 2011 using Japanese Venus probe Akatsuki. The observations covered solar offset distances of 0.5–20.5 solar radii. The amplitude scintillation spectra revealed the nature of disturbances in the inner heliosphere.

Keywords: sun, solar corona, radio wave, Akatsuki, scintillation

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PEM28-03 Room:102A Time:May 20 16:00-16:15

Kinematic properties of slow ICMEs and modification of an equation for a drag model

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We report kinematic properties of slow interplanetary coronal mass ejections (ICMEs) detected by interplanetary scintillation (IPS) observations, and propose a modified equation for the ICME motion. Understanding of ICME propagation is very important for space weather forecasting. We believe that the radial motion of ICME is governed by a drag force due to interaction with the background solar wind and the magnitude of the force is proportional to the difference between speeds. Earlier studies dealt mainly with propagation of ICMEs moving faster than the solar wind, while observational studies for propagation of slow ICMEs were rare. The IPS observations have been carried out since the early 1980s using the 327MHz radio-telescope system of the Solar-Terrestrial Environment Laboratory, Nagoya University. These observations allow us to probe into the inner heliosphere with a cadence of 24 hours. We take advantage of the IPS observations to determine speeds and accelerations of slow ICMEs. In this study, we identified 59 ICMEs from the IPS observations during 1997-2011. Here, we define that V_{SOHO}, V_{IPS} and V_{bg} are the initial speed of ICME, speed of that in the interplanetary space, and speed of background solar wind, respectively. Using the values of these, we classify the 59 ICMEs into three types of ICMEs, *i.e.*, fast (V_{SOHO}-V_{bg} $>$ 500 km s^{-1}), moderate (0 km s^{-1} $<$ V_{SOHO}-V_{bg} $<$ 500 km s^{-1}), and slow (V_{SOHO}-V_{bg} $<$ 0 km s^{-1}). Here, we eliminate ICMEs exhibiting unusual values of V_{IPS}-V_{bg} $>$ 500 km s^{-1} for the moderate and of V_{IPS}-V_{bg} $>$ 100 km s^{-1} for the slow as events having a strange acceleration, and analyze the remaining 19 fasts, 28 moderates, and 5 slows. Our analyses for slow ICMEs show that a_{ave}=-k_1(V-V_{bg}) is more suited than a_{ave}=-k_2(V-V_{bg})|V-V_{bg}| to describes their motion, where a_{ave} is the average acceleration, k_1 and k_2 are coefficients, and V is propagation speed of ICME. This result is the same as that for ICMEs having V_{SOHO}-V_{bg} $>$ 0 km s^{-1} (*i.e.* a group of the fasts and moderates). In addition, we also found from examinations of all ICMEs above that the value of the coefficient k_1 has velocity dependence. On the basis of these, we propose a modified equation for the ICME motion.

Keywords: Colonal Mass Ejection, Interplanetary Coronal Mass Ejection, Interplanetary Scintillation

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PEM28-04 Room:102A Time:May 20 16:15-16:30

Structure of a termination shock: Parameter survey

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Structure of a termination shock is investigated by utilizing one-dimensional full particle-in-cell simulation. Parameter dependence of the shock structure on solar wind plasma beta, distribution function of the pickup ions, Alfven Mach number, ion-to-electron mass ratio, and electron plasma to cyclotron frequency ratio is discussed, while a relative pickup ion density and shock angle are fixed to 30% and 87 deg., respectively. When the solar wind plasma beta is low (=0.17), modified two-stream instability (MTSI) gets excited in the extended foot sustained by reflected pickup ions and both solar wind electrons and ions are heated. If the solar wind plasma beta gets five times higher (=0.85), on the other hand, the MTSI is weakened and the pre-heating of the solar wind plasma in the extended foot is suppressed. When the distribution function of the upstream pickup ions are given by Maxwellian, instead of a spherical shell, the size of the extended foot becomes larger and heating of downstream solar wind ions is less efficient. If the Alfven Mach number becomes high (=28), a self-reformation of the shock front occurs. This results in a wiggled structure of the downstream solar wind ions, but the reformation seems not to contribute to strong acceleration of pickup ions.

Keywords: termination shock, pickup ion

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PEM28-05 Room:102A Time:May 20 16:30-16:45

Probing solar coronal fields using the Sun's shadow in cosmic ray intensity observed with the Tibet air shower array

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Very high energy cosmic rays travel nearly straight in the interplanetary space between the Sun and the Earth. The Sun shields these particles and casts a tiny shadow in the cosmic ray intensity measured at the Earth, so-called the "Sun's shadow". We continuously observed the Sun's shadow in 10 TeV cosmic ray intensity with the Tibet air shower array over an entire period of the Solar Cycle 23. We find a good correlation between the intensity deficit in the Sun's shadow and the solar activity changing with the 11-year cycle. The intensity deficit decreases (increases) in the solar activity maximum (minimum) period. In this paper, we present a variation of the Sun's shadow observed in a period from 1996 through 2009 and discuss the effect of the large-scale structure of the coronal magnetic field on the shadow by means of numerical simulations. We calculate trajectories of antiparticles ejected from the Earth to the Sun in the model magnetic field and reproduce the Sun's shadow. For the magnetic field in the solar corona, we adopt the PFSS (Potential Field Source Surface) and CSSS (Current Sheet Source Surface) models and examine which model can reproduce better the observed Sun's shadow. The PFSS model ignores effects of the electric current in the solar corona, while the CSSS model takes account of the large-scale horizontal and volume currents. The large-scale magnetic field structures derived from two models are significantly different. We find that the intensity deficit in the simulated Sun's shadow is very sensitive to the coronal field structure. It is clear from the statistical consideration that the Sun's shadow observed by the Tibet air shower array is better reproduced by the CSSS model than by the PFSS model. The Tibet air shower experiment succeeded for the first time in evaluating the coronal field models by using the Sun's shadow observed in the very high energy cosmic ray intensity.

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