the next solar cycle. As a result, we found that the radio flux data tend to have lower fractal dimensions than the sunspot number data, which means that the radio emission from the sun is more regular than the solar activity expressed by sunspot number. Based on the relation between radio flux of 3.75 GHz and sunspot number, we could calculate the expected maximum sunspot number of solar cycle 24 as 156, while the observed value is 146. For the maximum time, estimated mean values from 7 different observations are January 2013 and this is quite different to observed value of February 2014. We speculate this is from extraordinary extended properties of solar cycle 24. As the cycle length of solar cycle 24, 10.1 to 12.8 years are expected, and the mean value is 11.0. This implies that the next solar cycle will be started at December 2019.

[구 SS-06] Spatial and Statistical Properties of Electric Current Density in the Nonlinear Force-Free Model of Active Region 12158

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The formation process of a current sheet is important for solar flare from a viewpoint of a space weather prediction. We therefore derive the temporal development of the spatial and statistical distribution of electric current density distributed in a flare-producing active region to describe the formation of a current sheet. We derive time sequence distribution of electric current density by applying a nonlinear force-free approximation reconstruction to Active Region 12158 that produces an X1.6-class flare. The time sequence maps of photospheric vector magnetic field used for reconstruction are captured by a Helioseismic and Magnetic Imager (HMI) onboard Solar Dynamic Observatory (SDO) on 10th September, 2014. The spatial distribution of electric current density in NLFFF model well reproduce observed sigmoidal structure at the preflare phase, although a layer of high current density shrinks at the postflare phase. A double power-law profile of electric current density is found in statistical analysis. This may be expected to use an indicator of the occurrence of a solar flare.

[구 SS-07] Comparison of the Damped Oscillations in between the Solar and Stellar flares

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We explore the similarity and difference of the quasi-periodic pulsations (QPPs) observed during the solar and stellar X-ray flares. For this, we identified 59 solar QPPs in the X-ray observed by the Reuven Ramaty High-Energy Solar Spectroscopic Imager (RHESSI) and 52 stellar QPPs from X-ray Multi Mirror Newton observatory (XMM-Newton). The Empirical Mode Decomposition (EMD) method and least-square-fit with the damped sine function are applied to obtain the periods and damping times of the QPPs. We found that (1) the periods and damping times of the stellar QPPs are 7.80 and 13.80 min, which are comparable with those of the solar QPPs 0.55 and 0.97 min. (2) The ratio of the damping times to the periods observed in the stellar QPPs are found to be statistically identical to the solar QPPs, (3) The damping times are well describe by the power law. The power indices of the solar and stellar QPPs are 0.891±0.172 and 0.953±0.198, which are consistent with the previous results. Thus, we conclude that the underlying mechanism responsible for the stellar QPPs are the natural oscillations of the flaring or adjacent coronal loops as in the Sun.

[구 SS-08] Simulation of a solar eruption with a background solar wind

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We construct a solar eruption model with a background solar wind by performing three-dimensional zero-beta magnetohydrodynamic (MHD) simulation. The initial configuration of a magnetic field is given by nonlinear force-free field (NLFFF) reconstruction applied to a flux emergence simulation. The background solar wind is driven by upflows imposed at the top boundary. We analyzed the temporal development of the Lorentz force at the flux tube axis. Based on the results, we

demonstrate that a solar eruption is caused by the imbalance between magnetic pressure gradient force and magnetic tension force. We conclude that this imbalance is produced by a weak but continuously existing solar wind above an active region.

[구 SS-09] Development of Full ice-cream cone model for HCME 3-D parameters

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The determination of three dimensional parameters (e.g., radial speed, angular width, source location) of Coronal Mass Ejections (CMEs) is very important for space weather forecast. To estimate these parameters, several cone models based on a flat cone or a shallow ice-cream cone with spherical front have been suggested. In this study, we investigate which cone model is proper for halo CME morphology using 26 CMEs which are identified as halo CMEs by one spacecraft (SOHO or STEREO-A or B) and as limb CMEs by the other ones. From geometrical parameters of these CMEs such as their front curvature, we find that near full ice-cream cone CMEs are dominant over shallow ice-cream cone CMEs. Thus we develop a new full ice-cream cone model by assuming that a full ice-cream cone consists of many flat cones with different heights and angular widths. This model is carried out by the following steps: (1) construct a cone for given height and angular width, (2) project the cone onto the sky plane, (3) select points comprising the outer boundary, (4) minimize the difference between the estimated projection speeds with the observed ones. We apply this model to 12 SOHO halo CMEs and compare the results with those from other stereoscopic methods (a geometrical triangulation method and a Graduated Cylindrical Shell model) based on multi-spacecraft data.

[구 SS-10] Comparison between quasi-linear theory and particle-in-cell simulation of solar wind instabilities

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The protons and helium ions in the solar wind are observed to possess anisotropic temperature profiles. The anisotropy appears to be limited by various marginal instability conditions. One of the efficient methods to investigate the global dynamics and distribution of various temperature anisotropies in the large-scale solar wind models may be that based upon the macroscopic quasi-linear approach. The present paper investigates the proton and helium ion anisotropy instabilities on the basis of comparison between the quasi-linear theory versus particle-in-cell simulation. It is found that the overall dynamical development of the particle temperatures is quite accurately reproduced by the macroscopic quasi-linear scheme. The wave energy development in time, however, shows somewhat less restrictive comparisons, indicating that while the quasi-linear method is acceptable for the particle dynamics, the wave analysis probably requires higher-order physics, such as wave-wave coupling or nonlinear wave-particle interaction. We carried out comparative studies of proton firehose instability, aperiodic ordinary mode instability, and helium ion anisotropy instability. It was found that the agreement between QL theory and PIC simulation is rather good. It means that the quasilinear approximation enjoys only a limited range of validity, especially for the wave dynamics and for the relatively high-beta regime.

태양계

[구 SS-11] Seasonal Variations of the Zodiacal Light toward the Ecliptic Poles at the Infrared Wavelengths

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The zodiacal light (ZL), combination of the sunlight scattered by and the infrared light emitted by the interplanetary dust (IPD) particles, changes with time due to the asymmetric distribution of the particles with respect to the Earth's orbit. Especially, the variation of the ZL brightness toward the ecliptic poles are useful to probe the