rigorously not only via ground-based photometric, spectroscopic, polarimetric, and radar observations, but also via the in-situ observation by the Chinese Chang'e-2 spacecraft. However, one of the most fundamental physical properties, the geometric albedo, is less determined. In order to derive the reliable geometric albedo and further study the physical condition on the surface, we made photometric observations of Toutatis near the opposition (i.e., the opposite direction from the Sun). We thus observed it for four days on 2018 April 7-13 using three 1.6-m telescopes, which consist of the Korean Microlensing Telescope Network (KMTNet). Since the asteroid has a long rotational period (5.38 and 7.40 days from Chang'e-2, Zhao et al., 2015), the continuous observations with KMTNet matches the purpose of our photometric study of the asteroid. The observed data cover the phase angle (Sun-asteroid-observer's angle) of 0.65-2.79 degree. As a result, we found that the observed data exhibited the magnitude changes with an amplitude of ~0.8 mag. We calculated the time-variable geometrical cross-section using the radar shape model (Hudson & Ostro 1995), and corrected the effect from the observed data to derive the geometric albedo. In this presentation, we will present our photometric results. In addition, we will discuss about the regolith particles size together with the polarimetric properties based on the laboratory measurements of albedo-polarization maximum.

Hudson, R. and Ostro, S. J. 1995 Science 270, 84
Zhao, Y. et al. 2015 MNRAS 450, 3620

[구 SS-03] Investigation of surface homogeneity of (3200) Phaethon

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We present observational evidence of the surface homogeneity on Phaethon based on the time-series multi-band photometry and spectrometry. The observations of Phaethon were conducted in Nov.-Dec. 2017. We confirmed that Phaethon is a B-type asteroid, as was previously known, and its rotational color variation was not detected. During our observation period, the sub-solar latitude of this asteroid was approximately 55 °S, corresponding to the southern hemisphere of the body. Thus, we found that the southern hemisphere of Phaethon has a homogeneous surface from our observation results. In addition, we compared our spectra with archival data to investigate the latitudinal surface properties of the asteroid. The result showed that it doesn't have a latitudinal color variation. To verify this assumption, we investigated its solar-radiation heating effect, and the result suggested that this asteroid underwent a uniform thermal metamorphism regardless of latitude, which is consistent with our observations. Based on this result, we discuss the homogeneity of the surface of the body.

[구 SS-04] Interaction of Magnetic Flux Ropes in Relation to Solar Eruption

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Twisted magnetic flux tubes (also called magnetic flux ropes) are believed to play a crucial role in solar eruptive phenomena. The evolution of a single flux rope with or without the influence of an overlying field of a simple geometry has been extensively studied and its physics is rather well understood. Observations show that interacting flux tubes are often involved in solar eruptions. It was Lau and Finn (1996) who intensively studied the interaction between two flux ropes, whose footpoints are anchored in two parallel planes. In this too simplified setting, the curvature of the flux rope axial fields is totally ignored. In our study, the footpoints of flux ropes are placed in a single plane containing a polarity inversion line as in the real solar active region. Our simulation study is performed for four cases: (1) co-axial field and co-axial current (co-helicity), (2) counter-axial field and co-axial current (counter-helicity), (3) co-axial field and counter-axial current (counter-helicity), and (4) counter-axial field and counter-axial current (co-helicity). Except case 3, each case is found to be related with certain eruptive features.

[구 SS-05] Cross-Correlation of Oscillations in A Fragmented Sunspot

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Oscillations in a sunspot are easily detected through the Doppler velocity observation. Although the sunspot oscillations look erratic, the wavelet analysis show that they consist of successive wave packets which have strong power near three or five minutes. Previous studies found that 3-min oscillation at the chromosphere is a visual pattern of upward propagating acoustic waves along the magnetic field lines. Resent multi-height observations help this like vertical study, however, we also focus on horizontal facet to extend three dimensional understand of sunspot waves. So, we investigate a fragmented sunspot expected to have complex wave profiles according to the positions in the sunspot observed by the Fast Imaging Solar Spectrograph. We choose 4 points at different umbral cores as sampling positions to determine coherence of oscillations. The sets of cross-correlation with three and five minutes bandpass filters during a single wave packet reveal interesting results. Na I line show weak correlations with some lags, but Fe I and Ni I have strong correlations with no phase difference over the sunspots. It is more remarkable at Ni I line with 3-min bandpass that all sets of cross-correlation look like the autocorrelation. We can interpret this as sunspot oscillations occur spontaneously over a sunspot at photosphere but not at chromosphere. It implies a larger or deeper origin of 3-min sunspot oscillation.

[구 SS-06] The Standard Processing of a Time Series of Imaging Spectral Data Taken by the Fast Imaging Solar Spectrograph on the Goode Solar Telescope

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The Fast Imaging Solar Spectrograph (FISS) on the Goode Solar Telescope (GST) at Big Bear Solar Observatory is the imaging Echelle spectrograph developed by the Solar Astronomy Group of Seoul National University and the Solar and Space Weather Group of Korea Astronomy and Space Science Institute. The instrument takes spectral data from a region on the Sun in two spectral bands simultaneously. The imaging is done by the organization of intensity data obtained from the fast raster scan of the slit over the field of view. Since the scan repeats many times, the whole set of data can be used to construct the movies of monochromatic intensity at arbitrary wavelengths within the spectral bands, and those of line-of-sight velocity inferred from different spectral lines. So far there are two standard observing configurations: one recording the Hα line and the Ca II 8542 line simultaneously, and the other recording the Na I D2 line and Fe I 5435 line simultaneously. We have developed the procedures to produce the standard data for each observing configuration. The procedures include the spatial alignment, the correction of spectral shift of instrumental origin, and the lambdameter measurement of the line wavelength. The standard data include the movie of continuum intensity, the movies of intensity and velocity inferred from a chromospheric spectral line, the movies of intensity and velocity inferred from a photospheric line. The processed standard data will be freely available online (fiss.snu.ac.kr) to be used for research and public outreach. Moreover, the IDL procedures will be provided on request as well so that each researcher can adapt the programs for their own research.

[구 SS-07] He I D3 and 10830 observations of the flare-productive active region AR 12673 on 2017 September 7

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The active region NOAA AR 12673 is the most flare productive active region in the solar cycle 24. On 2017 September 07, it produced an X1.3 flare, three M-class, and several C-class flares. We successfully observed several C-class flares from 16:50 UT to 22:00 UT using the 1.6m Goode Solar Telescope (GST; formerly NST) at Big Bear Solar Observatory (BBSO). The GST provides us with unprecedented high-resolution data of the Sun since 2009. Interestingly, we observed the active region in He I D3 and 10830 lines simultaneously. The data shows several interesting features: (1) D3 emission seems to be much weaker than 10830 emission around 21:29 UT; (2) a small loop seen in 10830 is moving upward and is brightened around 21:16 UT, but it is not clear in D3; (3) there are waves in the penumbra seen in 10830 line center; (4) there is a jet with twisting motion. In this presentation, we will give the results of our analysis and interpretations.