made a model by training 348 front-side halo CMEs from 1997 to 2001, and predicted geo-effectiveness of 140 CMEs from 2001 to 2003. Finally we could achieve 72.1% accuracy in prediction by using SVM. In the future, we will apply machine learning technology to various space weather predictions to achieve more accurate predictions.

[SE-10] Statistical comparison of interplanetary conditions causing intense geomagnetic storms

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The southward IMF Bz field and convective electric field Ey component are well known interplanetary parameters which control the occurrence of intense geomagnetic storms (Dst ≤ -100 nT). In this study we have made a statistical comparison of interplanetary conditions of these parameters causing intense geomagnetic storms. By investigating the conditions of 82 intense geomagnetic storms from 1998 to 2006, we considered 8 different criteria of interplanetary conditions for the occurrence of gemagnetic storms including what Gonzalez and Tsurutani (1987) suggested - Bz < -10 nT or Ey > 5 mV/m for interval > 3h. Then we applied these criteria to whole interplanetary data during the same period. As a result, we present contingency tables between prediction and observation, and obtain their statistical parameters for forecast evaluation such as probability of detection yes (PODy), false alarm ratio (FAR), Bias and critical success index (CSI). A comparison of these statistical parameters for 8 criteria shows that the best criteria for intense geomagnetic storms is Bz ≤ -8 nT or Ey ≥ 5 mV/m for 2h. In this case, the PODy, FAR, Bias and CSI are estimated to be 0.85 0.41 1.45 0.53, respectively.

[SE-11] Empirical forecast of corotating interacting regions based on coronal hole information

Ji-Hye Lee[1], Yong-Jae Moon[2], Kye-Hwa Yoo[1]

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In this study, we suggest an empirical forecast of CIRs (Corotating interaction regions) based on the information of coronal holes (CHs). For this we used CH data obtained from He I 10830 Å maps at National Solar Observatory-Kitt Peak from 1996 to 2003 and the CIR data that Choi et al. (2009) identified. Considering the relationship among coronal holes, CIRs, and geomagnetic storms (Choi et al. 2009), we propose the criteria for geoeffective coronal holes ; the center of CH is located between N30 and S30 and between E40 and W20, and its area in percentage of solar hemispheric area is larger than the following areas: (1) case 1 : 0.36%, (2) case 2 : 0.66%, (3) case 3 : 0.36 % for 1996-2000, and 0.66 % for 2001-2003. Then we present contingency tables for three cases and their dependence on solar cycle phase. From the contingency tables, we determined several statistical parameters for forecast evaluation such as PODy (the probability of detection yes) , FAR (the false alarm ratio), Bias (the ratio of "yes" predictions to "yes" observations) and CSI (critical success index). Considering the importance of PODy and CSI, we found that the best criterion is case 3 ; PODy=0.78, FAR=0.66, Bias=2.26, and CSI=0.31. It is also found that the parameters near solar minimum are much better than those near solar maximum. As a next step, we are developing a forecast method of geomagnetic storms based on coronal hole information.

[SE-12] Source identification of back side solar proton events

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Solar proton events, whose fluxes are larger than 10 particles cm-2 sec-1 ster-1 for >10 MeV protons, have been oserved since 1976. NOAA proton event list from 1997 to 2006 shows that most of the events are related to both flares and CMEs but a few fraction of events (5/93) are only related with CMEs. In this study, we carefully identified the sources of these events. For this, we used LASCO CME catalog and SOHO MDI data. First, we examined the property of CMEs related with the events. The CMEs are found to eject from the western hemisphere and their velocities are all above 1200Km/s. Second, we searched a major active region in the front solar disk for several days before the proton events occurred by taking into account two facts : (1) The location of the active region is consistent with the position angle of a given CME and (2) there were several flares in the active region or the active region is the largest among several candidates. As a result, we were able to determine active regions which are likely to produce proton events without ambiguity as well as their longitudes at the time of proton events by considering solar rotation rate, 13.2° per day. From this study, we found that the longitudes of five active regions are all between 90°W and 120°W. When the flare peak time is assume to be the CME event time, we confirmed that the dependence of their rise times (proton peak time - flare peak time) on longitude are consistent with the previous empirical formula. These

results imply that five events should be also associated with flares which were not observed because they occurred from back-side. This fact suggests a sufficient possibility that all solar proton events are related with both flares and CMEs. Finally we discuss how to predict back-side solar proton events.

■ Session : 별탄생 (SF)
4월 29일(수) 09:00 - 10:15 제3발표장

[SF-01] Kinematics of H2O Masers in Massive Star-forming Region W51M

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The W51M region contains numerous strong H2O maser sources, which are associated with outflows from massive proto-stars. The purpose of our research is to study the kinematics of maser spots in W51M as a probe to the site of multiple star formation and to contribute to the understanding of massive star formation. The distance measurement of W51M with annual parallax will be also possible as a prospect. For this study, we have acquired data sets of VLBI observations at 22 GHz with Japanese VERA (VLBI Exploration in Radio Astrometry) telescopes from 2003 to 2006. We are now proceeding with the imaging analysis for astrometric solutions, which will be the measure of internal kinematics in W51M. In this paper, we report the result from single-beam imaging data of an epoch previously not analyzed. Our results on W51M kinematics will be discussed and compared with the preliminary one reported by Kan-Ya et al. (2007).

[SF-02] Discovery of a VeLLO in the ``Starless'' Dense Core L328

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We report the discovery of a Very Low Luminosity Object (VeLLO) in the ``starless'' dense core L328, using the Spitzer Space Telescope and ground based observations from near-infrared to millimeter wavelengths.
The Spitzer 8 mm image indicates that L328 consists of three subcores of which the smallest one may harbor a source, L328-IRS while twoother subcores remain starless. L328-IRS is a Class 0 protostar according to its bolometric temperature (44 K) and the high fraction (~72 %) of its luminosity emitted at sub-millimeter wavelengths. Its inferred ``internal luminosity'' (0.04 - 0.06 L⊙) using a radiative transfer model under the most plausible assumption of its distance as 200 pc is much fainter than for a typical protostar, and even fainter than other VeLLOs studied previously. Note, however, that its inferred luminosity may be uncertain by a factor of 2-3 if we consider two extreme values of the distance of L328-IRS (125 or 310 pc).
Low angular resolution observations of CO do not show any clear evidence of a molecular outflow activity. But broad line widths toward L328, and Spitzer and near-infrared images showing nebulosity possibly tracing an outflow cavity, strongly suggest the existence of outflow activity. Provided that an envelope of at most ~0.1 M⊙ is the only mass accretion reservoir for L328-IRS, and the star formation efficiency is close to the canonical value ~30%, and L328-IRS has not yet accreted more than~0.05 M⊙, at the assumed distance of 200 pc, L328-IRS is destined to be a brown dwarf.

[SF-03] Dynamical Timescale inferred from Chemical Distribution in TMC-1

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We present a study of a low-mass star-forming region, Taurus Molecular Cloud-1 (TMC-1), with Spitzer Space Telescope (infrared), MAMBO at IRAM 30m Telescope (dust continuum), FCRAO 14m Telescope (CS (J=2-1) and N2H+ (J=1-0)), and SRAO 6m telescope (C17O (J=2-1) and C18O (J=2-1)). The cold, dark cloud TMC-1 ridge is an ideal source for studying chemical evolution before star formation occurs. According to previous molecular line studies, the cyanopolyyne peak (southeast part of TMC-1) is chemically younger than the ammonia peak (northwest part) due to its lower density. However, in our study, the column density calculated from dust continuum emission, the best tracer of density, is similar at the cyanopolyyne peak and ammonia peak suggesting that the difference in density in two peaks does not cause the differentiation of chemical distributions. The cyanopolyyne peak shows smaller CO depletion compared to the ammonia peak supporting the fact that cyanopolyyne peak is chemically younger. Therefore, we suggest that the differentiated chemical distribution is explained not by difference of density but by dynamical timescale to reach the same density.