Toyokawa IPS Workshop 2007

October 30 (Tue)

Morning 9:00 - 10:20

- Opening remarks (5min)
- Session 1: 15min Talks & Discussion

(Coffee Break 10:20 - 10:40)

Morning 10:40 - 12:00

- Session 1: 15min Talks & Discussion

(Lunch 12:00 - 13:30)

Afternoon 1:30 – 2:50

- Session 2: 15min Talks & Discussion

(Coffee Break 2:50 - 3:10)

Afternoon 3:10 - 4:30

- Session 2: 15min Talks & Discussion

(Dinner 6:00 – 8:00)

October 31 (Wed)

Morning 9:00 - 10:20

- Session 3: 15min Talks & Discussion

(Coffee Break 10:20 - 10:40)

Morning 10:40 - 12:00

- Session 3-4: 15min Talks & Discussion

(Lunch 12:00 - 13:30)

Afternoon 1:30 – 5:00

- Excursion to Toyokawa Observatory & “Toyokawa Inari”

- Closing remarks (5min)

Program

Session 1: IPS Observations and Space Weather Studies

- **Ooty IPS Studies**

  P.K. Manoharan

- **The Mexican Array Radio Telescope (MEXART)**

  Americo Gonzalez-Esparza

- **Observations of interplanetary and ionospheric scintillation using multi-beams Big Scanning Array**

  Chashei I.V., V.I. Shishov, S.A. Tjul'bashev, I.A. Subaev

- **CME studies from STEL IPS observations**

  M. Tokumaru

- **Solar wind forecast at STEL**

  K. Fujiki

- **IPS with MWA**

  Divya Oberoi

- **Discussion**

  Comments: (Faraday rotation) Bernie Jackson, Elizabeth Jensen, Mike Bird

- **A new view of space weather - combining IPS and STEREO HI observations of the solar wind with studies of ionospheric consequences**

  Andy Breen, C. Davis, G. Dorrian, R. Fallows, H. Morgan, M. Bisi, H. Middleton, E. Whittick, D. Bewsher, R. Harrison, S. Crothers, J. Davis, C. Eyles, P. Thomasson, and G. Wannberg

Session 2: Collaboration with Spacecraft Mission

- **Study of CME Propagation in the Inner Heliosphere**

  D. F. Webb, T. A. Howard, T. A. Kuchar, J. S. Morrill, R. A. Harrison, C. J. Eyles, R. A. Howard, B.V. Jackson and J. C. Johnston

- **SMEI - IPS – Ulysses - STEREO: Current UCSD Comparison Progress**

  Bernard V. Jackson

  Mario Bisi, John Clover

- **Collaboration with Hinode and Ulysses**

  T. Sakao, K. Fujiki

- **Discussion**

  Comments: (Ulysses) Alexander Ruzmaikin, (LASCO/STEREO) Angeleos Vorlidias

Session 3: Basic Sciences Using Heliospheric Sounding Measurements

- **Recent coronal sounding experiments with Mars Express, Venus Express and Rosetta**

  M.K. Bird, M. Paetzold, S. Tellmann, B. Haeusler

- **Faraday Rotation: a technique used to determine coronal magnetic structure**

  E. Jensen

- **Extremely long baseline IPS measurements: Technique, results, difficulties and the development of integrated observing programs**

  Andy Breen

- **On the origin of the solar wind: source region and acceleration**

  Masayoshi Kojima

- **Discussion**

Session 4: IPS World Network and Common Database

- **IPS network**

  P.K. Manoharan

- **Common database**

  Divya Oberoi

- **Discussion**

Comments:

(Discrepancies and problems in the IPS data obtained at different sites) Mario Bisi,

(STEL g-value measurements) M. Tokumaru

Participants

IPS

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Recent coronal sounding experiments with Mars Express, Venus Express and Rosetta

M.K. Bird (AIfA, Univ. Bonn, Germany)
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Coronal radio sounding with signals from interplanetary spacecraft at superior conjunction is a powerful diagnostic of the solar wind in its acceleration regime. Changes in frequency and propagation delay reveal the large-scale structure of the coronal electron density and plasma turbulence as a function of solar distance and heliolatitude. The three interplanetary ESA probes Mars Express, Venus Express and Rosetta, are all equipped with dual-frequency downlink carrier signals at S-band (2.3 GHz) and X-band (8.4 GHz). Although not the primary scientific goal of each mission, radio coronal sounding is a recognized secondary objective of the respective radio science experiments MaRS, VeRa, and Rosetta-RSI. The first opportunity for these investigations was the Mars Express conjunction in September 2004. All three spacecraft were tracked by ground stations of the ESA and NASA (DSN) during their respective superior conjunctions in 2006. Comparing the observations with coronal white-light images from SOHO/LASCO reveals examples of Coronal Mass Ejections (CMEs) that traversed the spacecraft/Earth line of sight.

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A new view of space weather - combining IPS and STEREO HI observations of the solar wind with studies of ionospheric consequences

Andy Breen[1], Chris Davis[2], Gareth Dorrian[1], Richard Fallows[1], Huw Morgan[4], Mario Bisi[3], Helen Middleton[1], Emma Whittick[1], Danielle Bewsher[2], Richard Harrison[2], Steve Crothers[2], Jackie Davis[2], Chris Eyles[5], Peter Thomasson[6], and Gudmund Wannberg[7]

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The availability of data from the Heliospheric Imager instruments on the STEREO spacecraft provide the first detailed view the Sun-Earth line. Such observations reveal structure and movement of large-scale features, and are perfectly complemented by ground-based radio scintillation (IPS) measurements of speed and direction of small-scale structure. In this paper we present results from a co-ordinated programme of measurements bringing together STEREO HI, IPS and ionospheric tomography. We combine STEREO HI observations of structures in solar wind with IPS measurements of solar wind speed from EISCAT and MERLIN, while ionospheric tomography data and modelling are used to study the response of the Earth's ionosphere to solar wind variations. We discuss the observations and our methodology, before going on to draw conclusions for the events observed and discuss the lessons learned for future observing campaigns.

Extremely long baseline IPS measurements: Technique, results, difficulties and the development of integrated observing programs

Andy Breen

The Aberystwyth group has been making extremely long baseline (>1500 km) IPS measurements using EISCAT and MERLIN since 2002. The results reveal subtle variations in solar wind speed and suggest deviations from radial flow (or, at least, regions of meridional tilt in the magnetic field) but are not always easy to interpret without information on the global structure of the solar wind around the region probed. This presentation discusses the observations made, the analysis method, the results obtained to date and the problems encountered in analysis and interpretation, before going on to consider how comparison with observations from other systems (e.g. Toyokawa/UCSD reconstructions of the global solar wind, tomographic reconstructions of the corona based on LASCO images and STEREO|HI observations) can be used to interpret these observations more accurately.

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Observations of interplanetary and ionospheric scintillation using multi-beams Big Scanning Array

Chashei I.V., Shishov V.I., Tjul'bashev S.A., Subaev I.A.

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Technique and data reduction are described of interplanetary plasma monitoring using observations of interplanetary scintillation (IPS) at Big Scanning Array of Lebedev Physical Institute (frequency 111 MHZ). Ionospheric scintillation (ISS) are observed simultaneously with IPS. We observe and analyzed daily IPS and ISS of the whole statistical ensemble of radio sources passing the array diagram. Results are presented obtained in the frame of monitoring program during the years 2003-2007 as for quiet so for disturbed conditions.

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The Mexican Array Radio Telescope (MEXART)

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The Mexican Array Radio Telescope (MEXART) consist of a 64x64 (4096) full wavelength dipole antenna array, operating at 140 MHz. The aim of this instrument is to daily scan the sky at 140 MHz in order to track large-scale solar wind disturbances propagating between the Sun and the Earth using the IPS technique. The MEXART is performing its final calibration and its real time measurements can be obtained directly from its web server: www.mexart.unam.mx. The MEXART also participates in the Virtual Earth-Sun Observatory (VESO) at the web site www.veso.unam.mx. This site shows a real time integrated data-base obtained from four instruments of the Instituto de Geofisica-UNAM studying Sun-Earth connection phenomena (solar radio interferometer at 4.5 GHz, MEXART, Cosmic Ray detector and Geomagntic measurements). The VESO instruments provide data from four different points of the complex chain of the solar terrestrial relations and will allow the study of some intense solar events causing geomagnetic activity. The VESO project is part of the celebration of the International Heliophysical Year (IHY) in Mexico.

SMEI - IPS – Ulysses - STEREO: Current UCSD Comparison Progress

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UCSD currently makes available an "extraction" of Ulysses and STEREO velocity and density measurements from our solar wind models using the STELab IPS dataset on the Web at: http://ips.ucsd.edu/index_ss.html. In addition we provide an extrapolation of potential magnetic fields (radial and tangential) at the Ulysses spacecraft and STEREO. As of early September 2007, these analyses show that Ulysses has passed the heliospheric current sheet in these analyses. As yet we do not know how well these reconstructions we make available compare with the Ulysses in-situ analyses from the same period nor how well these analyses compare with densities obtained from SMEI brightness during this interval. The STEREO spacecraft solar wind models show considerable differences from the measurements at Earth. We plan to make progress in these comparisons and present them by the time of the workshop. We expect the comparison differences to provide a better understanding of heliospheric global structure and a refinement of our heliospheric models.

I will coordinate this brief presentation with others at UCSD who plan to attend so that we do not cover the same material.

Ooty IPS Studies and IPS Network

P.K. Manoharan

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The interplanetary scintillation (IPS) observations obtained from the Ooty Radio Telescope on a large number of radio sources provide the day-to-day changes of the solar wind speed and density turbulence in the inner heliosphere. This presentation reviews some of the results, obtained from IPS studies at Ooty, on the radial evolution of the three-dimensional solar wind during the solar cycle #23. The second part of the talk will discuss the possible solar wind studies and collaborations with the multi-frequency IPS network.

IPS with MWA and towards a common IPS data format

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I would like to cover two aspects in my talk.
1. I would like to introduce the audience to the Murchison Widefield Array (MWA) project, a a 512 element 80-300 MHz next generation interferometer expected to come online in early 2009. A 32 element prototype is expected to be deployed by the end of this year. Solar and Heliospheric science form one of the primary science objectives of the array. The talk will describe the plans for IPS with the MWA and briefly touch upon other solar and heliospheric objectives.

2. There is a desire in the IPS community to work towards a common data format across different instruments. The MWA project is currently working on defining the data format for IPS. I would like to use this opportunity to work towards a proposal for a common data format flexible and versatile enough to accommodate the needs of different instruments and analysis methods. I will highlight the requirements from such a format and try to come up with a proposal for a common format detailed enough to initiate further discussions.

Study of CME Propagation in the Inner Heliosphere

D. F. Webb[1,2], T. A. Howard[3,4], T. A. Kuchar[1,2], J. S. Morrill[5], R. A. Harrison[6], C. J. Eyles[6,7], R. A. Howard[5], B.V. Jackson[8] and J. C. Johnston[2]

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Results from an investigation of the propagation characteristics of coronal mass ejections (CMEs) using data obtained by the Coriolis Solar Mass Ejection Imager (SMEI) and STEREO SECCHI imaging experiments on each STEREO spacecraft are presented. The LASCO and SECCHI COR1 and 2 coronagraphs observe the early development of CMEs out to 30 Rs, or about 8^o elongation. The SECCHI Heliospheric Imager (HI) instruments, two on each STEREO spacecraft, have circular fields of view (FoVs) centered on the ecliptic plane, with HI-1 and -2 having FoVs 10^o and 35^o in radius, respectively. Their FoVs are designed to overlap with each other and with the coronagraphs, essentially providing a continuous view of CMEs from the Sun to 1 AU. SMEI is an all-sky imager that detects and tracks CMEs from elongations $>20^o$. Thus, both HIs and SMEI have the potential to observe the same CME simultaneously. We discuss preliminary analyses of several such events observed in 2007, in particular their kinematic and structural evolution out to $\sim100^o$. We present results from measurements of geometry and kinematic evolution as the transient evolves from the CME observed by coronagraphs to the I(nterplanetary)CME observed by the heliospheric imagers, and discuss implications for the physics of their evolution. We also discuss the implications of these results for understanding the propagation of CMEs along the Sun-Earth line and, thus, for space weather.

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On the origin of the solar wind: source region and acceleration

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Since Hewish et al. (1964) discovered the interplanetary scintillation (IPS) phenomena, the IPS method has been one of the few devices which can be used to observe solar wind in three-dimensional space. However, because of the line-of-sight integration effect of IPS, solar wind had to be studied with blurred images. In the late 1990s, we developed a new method of IPS observation and analysis which can deconvolve the line-of-sight integration effect. Today we can obtain unbiased solar wind images with high spatial resolution from IPS observations.

We propose several important issues of the solar wind which should be studied with the IPS. On of them is the origin of the slow solar wind. The origin of the slow solar wind is an interesting subject on its own, and is also important in relation to the origin of the solar wind including the fast solar wind, especially if the slow wind originates directly from a coronal hole. Another crucially important issue is to find universal physical parameters which can determine velocities of all kinds of solar wind from various sources such as slow wind from a helmet streamer, slow wind from an equatorial small coronal hole, the fast wind from a polar coronal hole. In order to elucidate the solar wind acceleration mechanism it is essential to determine the solar wind acceleration profile from corona to 1AU. However there are difficulties to measure the solar wind bulk speed in near sun region because of propagating wave effect. We wish we can discuss on this problems.

CME studies from STEL IPS observations

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Interplanetary scintillation (IPS) measurements are useful for studying global properties of coronal mass ejection (CME) and its propagation dynamics, since they enable to map the solar wind between the sun and the earth's orbit. We have challenged this CME study using IPS measurements with the 327-MHz four-station system of the Solar-Terrestrial Environment Laboratory of the Nagoya University. In this talk, we report some interesting aspects of CME which have been revealed from our IPS studies. Our results suggest that there are two different origins of density enhancement associated with the CME. While the CME-solar wind interaction is considered as one of key factors to control the propagation dynamics, our results suggest that some acceleration force to cancel the deceleration due to the interaction effect interaction may continue to act up to 0.5 AU. We also discuss future perspectives of CME study using IPS observations.

Solar wind forecast at STEL

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Interplanetary scintillation (IPS) is a useful tool which allows us to measure the solar wind in three dimensional space inaccessible to in situ observations. We have been operating multi-station IPS observations at a frequency of 327 MHz at the Solar-Terrestrial Environment Laboratory, Nagoya University, Japan. Although the IPS measurement is an integral of solar wind velocities and density fluctuations along the line-of-sight, which causes degradation of accuracy, we have succeeded to develop computer assisted tomography (CAT) method to remove the effect of line-of-sight integration. The IPS CAT technique can be applied to space weather forecast. The solar wind velocity and density fluctuation inside the Earth orbit, a few days before encountering the Earth, are obtained with IPS observation. Solar wind forecast is carrying out automatically in daily basis. In this talk, we report the IPS CAT technique and its application to solar wind forecast.