EPSC Abstracts,
Vol. 2, EPSC2007-A-00165, 2007
European Planetary Science Congress 2007

Solar wind in the outer Heliosphere by IPS observations

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Planetary magnetospheres exist within the supersonic solar wind and are strongly influenced by variations in the solar wind blowing on them. We have carried out IPS observations at decameter wavelengths with UTR-2 radio telescope using new theoretical and experimental approaches. They allow us to study effectively the solar wind at the large distances from the Sun (up to 5 AU, Jupiter's orbit).

The solar wind parameters are obtained by fitting model power spectra to observed ones. The phase screen model is usually used for this purpose at the high frequencies. However, at the large elongations and at the low frequencies the scattering medium is essentially expanded and the most scattering layer is situated near an observer, so use of the phase screen model is not correct. More correct ways are provided by multiple scattering theory methods such as the Feynman path-integral technique. We have adapted the Feynman path-integral technique to calculate model power spectra and to obtain the solar wind parameters. Also, the UTR-2 radio telescope has been equipped with new wide-band radiometers. These allow us to obtain scintillation power spectra with dynamic range of 3 to 4 orders, unachievable before at decameter wavelengths.

Since 2003 we have been observing the IPS scintillations, regularly. The brief results of the observations are the next. In most cases we detect the presence of several solar wind flows with different velocities, densities and thicknesses along the line of sight. We managed to trace the movements of high-speed streams of different origins.

In November-December 2005 we observed fast streams moving across the lines of sight to the radio sources 3C144, 3C154, 3C196, 3C254. The variations of the solar wind velocity and the scintillation index were in good agreement with the behavior of the plasma density measured by SOHO. A high-speed streams caused by transient events on the Sun are well known to exist in the solar wind. A shock caused by the powerful solar flare 17.03.2003 and the filament outburst 18.03.2003 reached Earth's orbit on March, 20 and was registered by Genesis Discovery Mission as a jump of the solar wind density and speed. We carried out IPS observations during March 21-24 when the shock went by the Earth and was moving in the outer Heliosphere. To probe the solar wind we used two radio sources 3C380 and 3C254 with the strongly different elongations and ecliptic latitudes. The agreement between the solar wind velocity obtained by IPS and that measured directly by Genesis Discovery Mission renders support to our method of analysis.

Our investigations have shown the high efficiency of IPS method at decameter wavelengths for studies of the solar wind in the outer Heliosphere. The obtained results and methods are very helpful for investigations of the solar wind effect on planets. Future investigations will require significant improvements in spatial resolution which can be reached by using the larger number of scintillating radio sources.