Solar wind acceleration properties from IPS observations

Masayoshi Kojima[1]; Ken'ichi Fujiki[1]; Masaya Hirano[2]; Munetoshi Tokumaru[1]; Tomoaki Ohmi[1]; Kazuyuki Hakamada[3]

[1] STE Lab., Nagoya Univ.; [2] STEL, Nagoya Univ; [3] Natural Sci. and Math., Chubu Univ.

http://stesun5.stelab.nagoya-u.ac.jp/

Since the rapid acceleration of fast solar wind and extremely hot ion temperature at a few solar radii above a coronal hole were discovered, acceleration and heating mechanisms have been improved. However the acceleration profile is not well studied, because interplanetary scintillation measurements are largely biased by wave motions in near Sun region and the acceleration profile is different for the stream from different kind of coronal hole. Therefore it is important to elucidate the acceleration profiles as well as to obtain an empirical relation between the wind velocity and the coronal parameters for modeling the solar wind acceleration. Theoretical and empirical models which determine the solar wind speed from the coronal parameters have been proposed by several workers such as a coronal hole size (Nolte et al., 1976), a flux expansion rate (Wang and Sheeley, 1990) and magnetic field energy supply (Fisk et al., 1999). We investigated the fast solar wind acceleration profile at the heliocentric distance range of 0.1-0.9 AU and obtained that the acceleration is not finished within 20 Rs. We obtained average velocities of 770--780 km/s at distances of 0.13-0.3 AU, which are 19+/-17 km/s lower than at 0.3--0.9 AU. This result, taking together with measurements of SOHO/LASCO, EISCAT and MERLIN (Breen et al., 2002), Helios (Schwenn et al., 1978) and Ulysses (McComas et al., 2000), indicates that the fast wind is accelerated almost to its final flow velocity within 20 Rs but not negligible small acceleration exists beyond 20 Rs which tends to become smaller at farther heliocentric distances. Combining with the work by Nolte et al., we found that the solar wind speed becomes dependent on coronal hole size if the size is smaller than 5E10 km^2. Furthermore we have revealed that a parameter ratio between the photospheric magnetic field intensity B and a flux tube expansion rate in the corona f has extremely high correlation with the wind velocity. This correlation holds in various speed solar winds from various kind of coronal holes. The physical meaning of the parameter B/f can be understood by combining the models by Wang and Sheeley and by Fisk et al., that is, it means how efficiently the energy from magnetic field reconnection at the lower coronal is deposited to the solar wind acceleration in an expanding flux tube.