EISCAT と STELab 同時観測による IPS 観測と解析の検証

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Simultaneous Scintillation Observations at EISCAT and STELab for Comparative Studies of IPS Observations and Analysis Methods

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We made simultaneous observations of the same IPS sources using EISCAT and STEL facilities in order to make comparative studies on IPS observations at different frequencies and on different analysis methods. Since these two facilities use different radio frequencies (EISCAT 932 MHz and STELab 327 MHz), we can study on the strong scattering effects on IPS observations when a line of sight (LOS) approaches the sun where IPS is in weak scattering condition at EISCAT frequency while STEL frequency is in strong scattering. Another comparison was made for essentially different analysis methods of CCRF (cross-correlation function) fitting and tomographic analysis, both of which were developed in order to retrieve intrinsic 3D solar wind structure from LOS integration.

For IPS analyses Born approximation is used for modeling radio scattering process in extended medium, and using this approximation both methods of CCRF fitting and tomographic analysis have succeeded to resolve solar wind structure along a LOS. However this approximation is valid only in weak scattering condition and no evaluations have ever been made about validity to apply this approximation in strong scattering condition: is IPS measurement in strong scattering heavily biased if Born approximation were applied? Our studies have found there are no statistically significant discrepancies between EISCAT and STEL data including observations in strong scattering condition of STEL frequency, especially measurements of slow and medium speed solar wind agree well.

In weak scattering condition we can retrieve intrinsic solar wind velocities distributed along a LOS because the IPS can be represented as a linearly weighted mean by Born approximation. However it has not been understood whether IPS loses information on the solar wind in weak scattering region or not when a LOS traverses through both of strong and weak scattering regions. We got an answer to this question from IPS observations of 1229+020 on September 26th which was observed in strong scattering condition at STEL frequency. For modeling this observation the LOS was segmented into five parts and the best fit velocities in each segment were searched using the CCRF fitting method. We found that this method is sensitive to velocities in not only strong scattering region but also weak scattering region: the best fit velocities for STEL observations show good agreement with EISCAT not only in the strongest scattering region at distances of 24-41 Rs but also at distances of 144 Rs where scattering was weak.

We got substantial agreement of analysis results between two methods of CCRF fitting and tomographic analysis, but major discrepancies are found in spatial resolution. Since CCRF fitting method analyses solar wind structure along a LOS, it has high resolution in perpendicular to the LOS but low resolution along a LOS because of small number of segmentation. This analysis result cannot be verified mutually among different LOS observations. On the other hand tomographic method can make analysis in two dimensions deconvolving LOS integration with multiple LOS's information which provide perspective view of the solar wind from different directions so that the solution will have less ambiguity.