Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

PEM05-31 Room:303 Time:May 21 15:45-16:00

Solar-Wind Proton Anisotropy Versus Beta Relation

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We address an outstanding problem of the proton temperature anisotropy versus plasma beta inverse corrrelation in the solar wind. The measured proton temperature anisotropy from the Wind spacecraft at 1 AU is regulated by the oblique (the mirror and oblique fire-hose) instabilities. This observation is inconsistent with the prediction of linear kinetic theory which suggests that the ion-cyclotron and parallel fire-hose instabilities would dominate over the oblique instabilities within a certain range of parallel plasma beta. In the present paper, we put forth a new idea to explain the solar wind observations of the proton anisotropy which do not agree with the current theories. Making use of the fact that the local magentic field intensity near 1 AU undergoes intermediate-scale temporal variations, we carry out the quasilinear analysis of the temperature anisotropy-driven instabilities with a time-varying local magentic field, assuming arbitrary initial temperature ratios and parallel betas. It is found that the simulated solar wind proton data distribution in (beta$_{parallel}$, T$_{perp}$/T$_{parallel}$) space is bound by the mirror and oblique fire-hose instabilities, which is superficially similar to the observation.

Keywords: Solar wind proton, Anisotropy-beta relation, Temperature anisotropy-driven instabilities