Geophysical Research Abstracts,
Vol. 11, EGU2009-11760, 2009
EGU General Assembly 2009

Hot Solar-Wind Helium: Direct Evidence for Local Heating by Alfven-Cyclotron Dissipation

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The distribution of the ratio of the temperatures of solar wind helium and hydrogen is bimodal, with peaks at equal temperature and equal thermal speed but a long tail with helium up to eight times hotter. We use solar wind measurements with the SWE and MFI instruments on the Wind spacecraft to investigate the mechanism responsible for the hottest helium. In this talk we will present compelling evidence of heating by an Alfven-cyclotron dissipation mechanism by sorting the data as a function the rate of Coulomb interactions, or collisional age, and the differential flow between the two species. We show that helium is preferentially heated perpendicular to the magnetic field direction by more than a factor of 6 when the flow between the species is small relative to the Alfven wave speed and collisions are infrequent. These signatures are consistent with predictions of dissipation in the presence of multiple ion species. We also report an unexpected result: observations of efficient heating of helium parallel to the magnetic field for large differential flow relative to the sound speed.