

The Solar Wind Environment Observed Upstream of Saturn by the MIMI/CHEMS Instrument on Cassini

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Abstract

The solar wind (SW) has a significant influence on the magnetosphere of Saturn, but the extent of this influence lies somewhere between the Jovian and terrestrial cases. Unfortunately, despite the importance of the solar wind conditions near Saturn, direct solar wind plasma measurements made at Cassini have been very scarce owing to technical limitations. In the absence of these measurements, solar wind magnetohydrodynamic simulations—utilizing measurements at 1 AU as the input and following the plasma to Saturn’s orbit—have been used to estimate upstream environmental conditions at Saturn. There are however untapped observational techniques to determine the solar wind speed using pickup ion and suprathermal particle intensity vs. energy spectra. Using measurements from the Charge Energy Mass Spectrometer (CHEMS), one of the three sensors in the Magnetospheric Imaging Instrument (MIMI) suite on the Cassini spacecraft, we apply these techniques to help fill the gap in solar wind measurements by providing solar wind speeds in some cases. We have used the pickup-ion technique, which involves identifying the prominent spectral cut-off at twice the solar wind speed (Figure 1a), to determine solar wind speed and have found good agreement with intervals in which there are solar wind plasma measurements [1]. We now add the technique of transforming the spectral measurements into the solar wind frame by using the nominal solar wind speed and forcing consistency with the resulting spectral form and the expected small anisotropy in the frame of the solar wind (Figure 1b). There are intervals, including the first Saturn orbit, immediately following the Saturn orbit insertion, when Cassini was in the solar wind upstream of Saturn allowing the determined solar wind speed to be utilized as an input to models of Saturn’s magnetosphere.

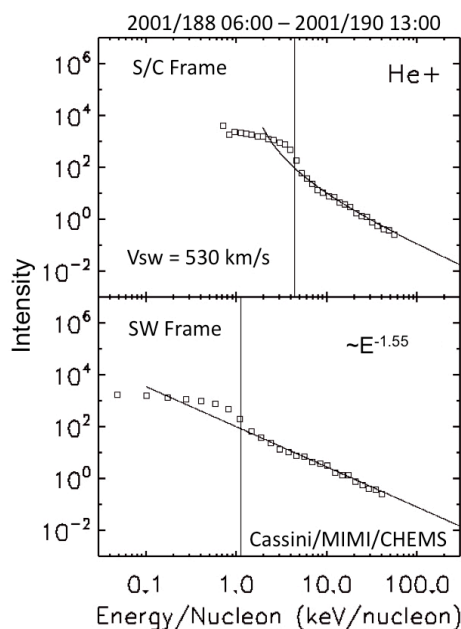


Figure 1: He⁺ spectrum in the (a) spacecraft and (b) solar wind frame (arbitrary units are for intensity). The pickup ion cutoff is shown as a vertical line in both frames of reference and the power law in the SW frame has an index of -1.55. (This is a preliminary analysis. Uncertainties are not shown.)

References

- [1] Hill, M.E et al., Near-Saturn Solar Wind Speeds Determined from MIMI/CHEMS Measurements of Pickup Ion Spectra at the Cassini Spacecraft, Eos Trans. AGU, 85(47), Fall Meet. Suppl., Abstract P51A-1412, San Francisco, 13-17 December, 2004.