Geophysical Research Abstracts
Vol. 14, EGU2012-3249, 2012
EGU General Assembly 2012

Multi-coordinate System (Ecliptic, Galactic, ISMF) Spectral Analysis of Heliospheric ENA Emissions Using Cassini/INCA Measurements

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Energetic Neutral Atom (ENA) images have led to a number of unexpected heliospheric signatures such as the "Belt" and the "Ribbon" (Krimigis et al, McComas et al, 2009) and to new aspects of the physics of the heliosphere that were substantially at variance with theoretical models (e.g. the relative symmetry between the "nose" and "tail" directions, and the need for a stronger interstellar magnetic field than assumed before in order to balance the non-thermal pickup-ion pressure in the heliosheath). With this study we use all-sky energy-resolved ENA maps obtained by the INCA instrument onboard Cassini over the time period 2003 to 2009, in 4 discrete energy passbands ($\sim$5.4 to $\sim$55 keV). We investigate the geometrical characteristics of the Belt, and spectral analyses are performed to further examine its possible energy dependence and possible variability with time. We conclude that: (a) The high flux ENA Belt is identified in the energy range of 5 to 55 keV and is moderately well organized in galactic coordinates, because the ENA minima appear in the vicinity of the North and South Galactic poles, (b) using standard criteria ($\boldsymbol{B}\cdot\boldsymbol{R}\sim 0$), the deviation of the ENA emissions from the equator is effectively minimized in a rotated frame (that we interpret as ISMF) where its North Pole points towards 190^o Ecliptic Longitude and 15^o Ecliptic Latitude, (c) ENA spectra show a power law form in energy, that can be fitted with a single function presenting higher spectral slopes in the Belt region and lower outside ($3.4< \gamma <4.4$), (d) the spectra are almost indistinguishable between the tail and the nose regions, i.e. no noticeable asymmetry is observed, (e) the consistency of the ENA distributions as a function of latitude among the different INCA channels indicates that the morphology of the Belt (peak, width and structure) is almost energy-independent from 5 keV to 35 keV (minor deviations start to appear at $>$35 keV), (f) in the low intensity regions INCA ENA count rate profiles as a function of time do not match the measured cosmic ray profiles, indicating that the ENA emissions detected by INCA are foreground ENA's.