TWINS Energy Spectrum at Peak of Equatorial Pressure

The energy spectrum of the deconvolved ion distribution at the location of the peak of the flux is shown in green as a function of energy from 2.5 to 97.5 keV. The location of the peak is shown at the top of the plot.

In order to obtain sufficient counts to construct a meaningful image, the TWINS ENA images are integrated over energy bands whose width is equal to the central energy, e.g., the 40.0 keV images are integrated from 20.0-60.0 keV. To account for the overlap of the measured energy bands, particularly at higher energy, the physically meaningful energy spectra are obtained using a method described in Appendix B of *Perez, et al.* [2012]. For the spectrum shown here, TWINS ENA images at 5.0 - 65.0 keV in 5.0 keV steps were deconvoled to obtain the ion fluxes.

The technique used to extract the equatorial ion pitch angle distributions from the ENA images is described in Appendix A of *Perez, et al.* [2012]. In this method, the ion equatorial pitch angle distribution is expanded in a linear combination of tri-cubic splines [*deBoor,* 1978]. The expansion coefficients are then obtained by minimizing a combination of normalized chi-squared and a penalty function derived by *Wahba* [1990]. Requiring that normalized chi-squared is near unity ensures that the resulting distribution fits the data. Including the penalty function in the minimization ensures that the result is as smooth (in the sense of a minimum second derivative) as is consistent with fitting the data. In this procedure, spatial structure is minimized and appears in the result only to the extent that it is necessary. Thus, while there may be more and smaller scale structure that is not resolved, the structure that is found is statistically required to fit the data, i.e., match the ENA images.

The uncertainties in each pixel of the ENA image are a statistical measure of the information content of the data. The second moment of the 15-16 individual sweeps is used to estimate the uncertainties in each pixel of the time-integrated image.

In order to deconvolve the ion distributions, magnetic field mapping is required. For this study the *Tsyganenko and Sitnov* [2005] magnetic field model was used. The density of neutral hydrogen, i.e., the geocorona, is also needed. The TWINS exospheric neutral hydrogen density model was used *[Zoennchen, et al.* 2013]. To include the LAEs (Low Altitude Emissions), the thick target approximation of *Bazell et al.* [2010] was used.

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