Observation of Solar Wind Charge Exchange Emission from Exospheric Material in Earth's Magnetosheath

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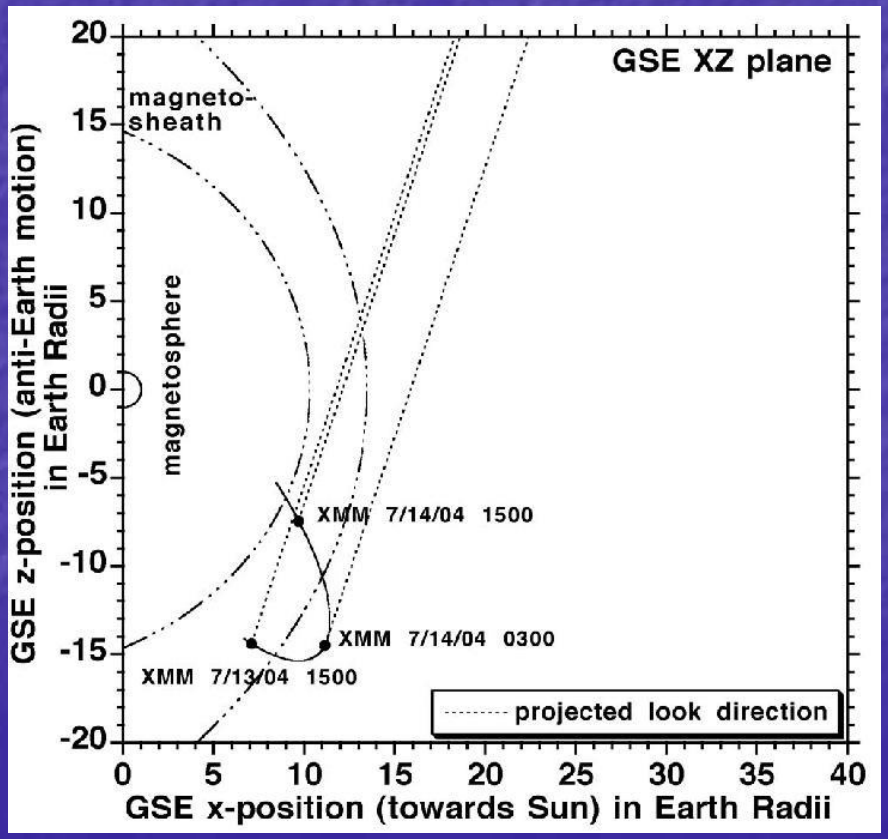
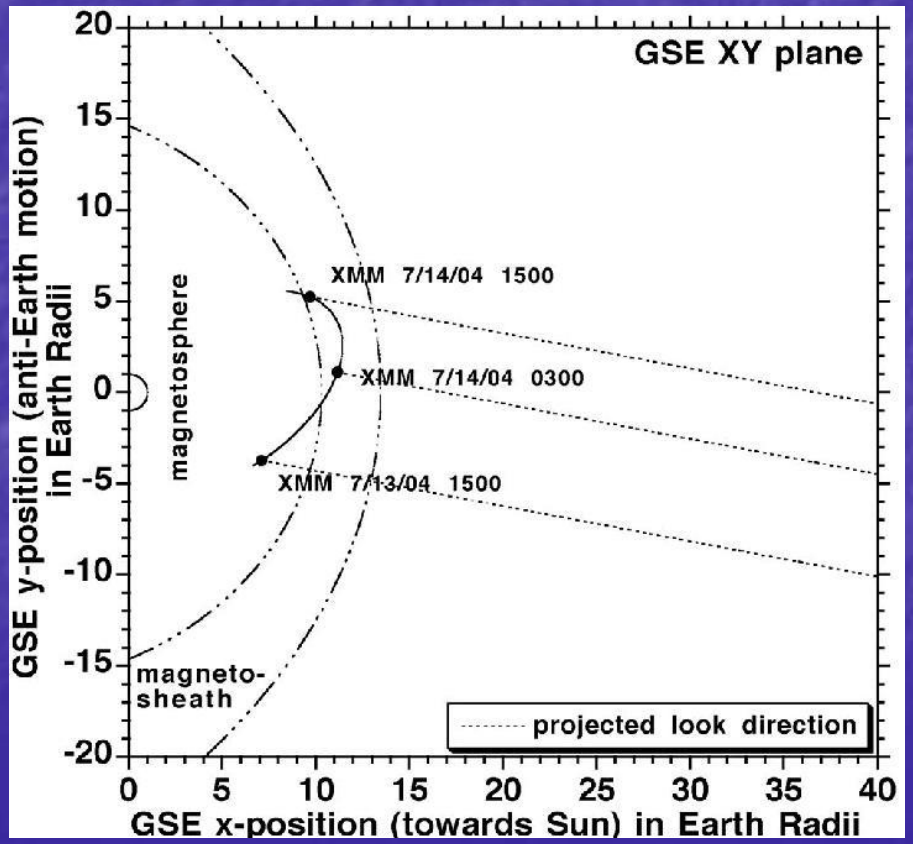
- Specifically planned XMM-Newton proposal to observe magnetosheath SWCX emission
- Long (100 ks) observation at a dim part of the sky
- Designed to test Robertson & Cravens magnetosheath emission model
- SWCX emission observed in spite of lower solar wind flux

Local Bubble and Beyond II – Philadelphia, PA – 21-24 April

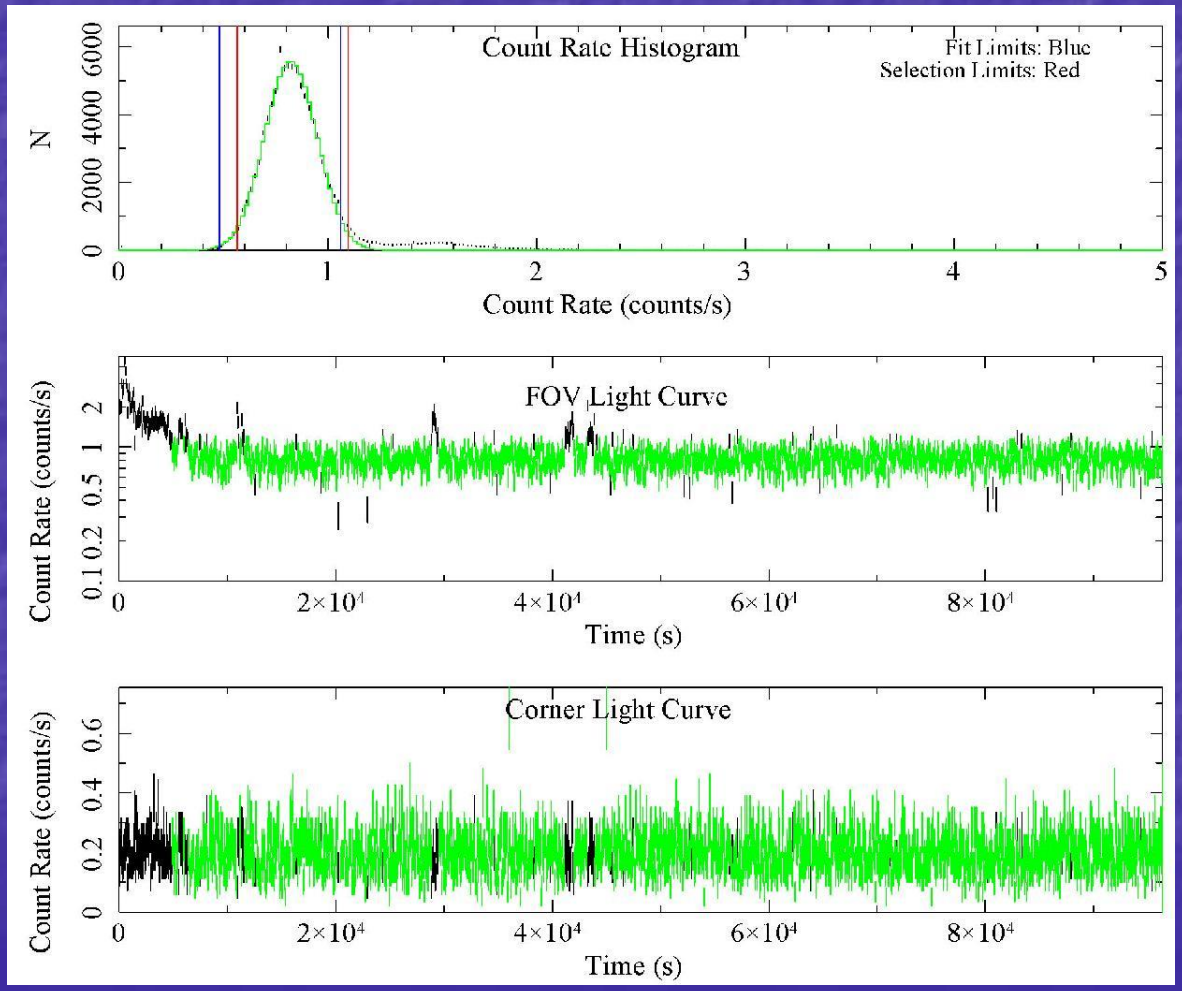
XMM_Newton Observation Geometry

- Maximum elongation of orbit towards Sun
- Look direction north through the magnetosheath close to the subsolar point.
- Tricky to combine low cosmic background and best scan through the magnetosheath



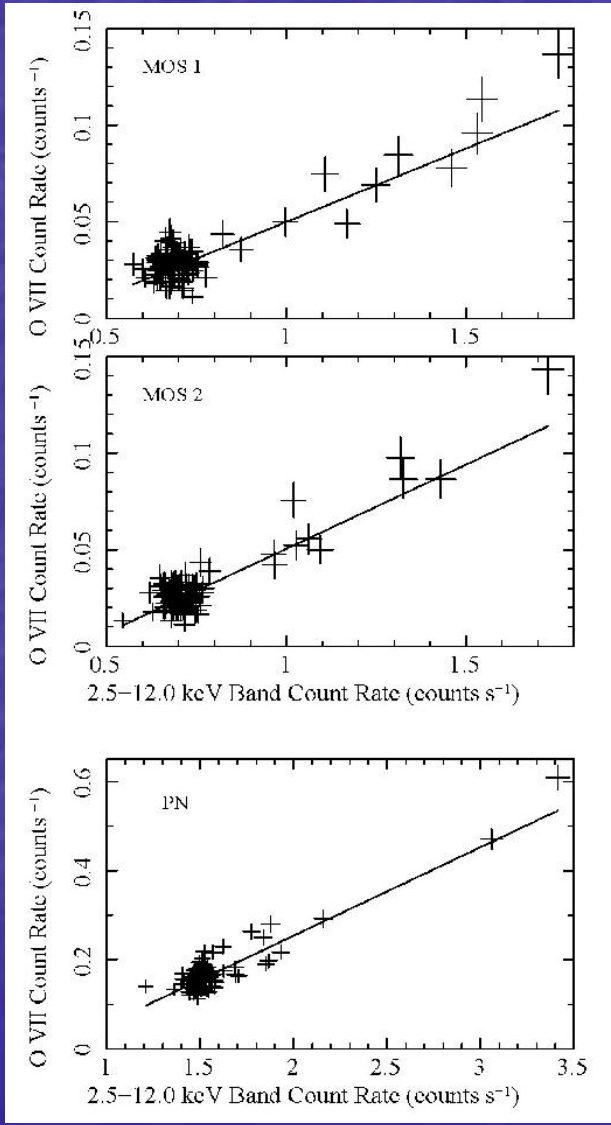


X-ray Observation



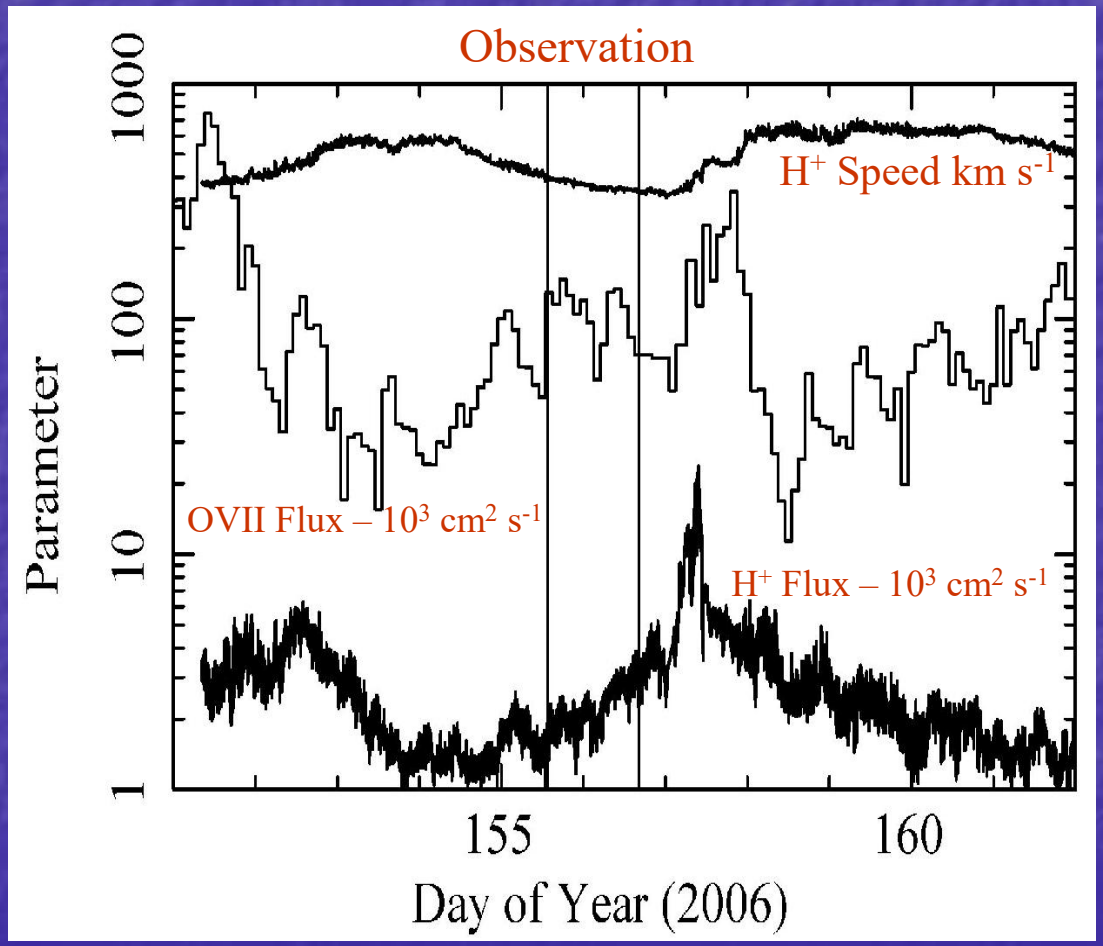
- The observation was relatively free from soft-proton contamination

Extract Light Curves



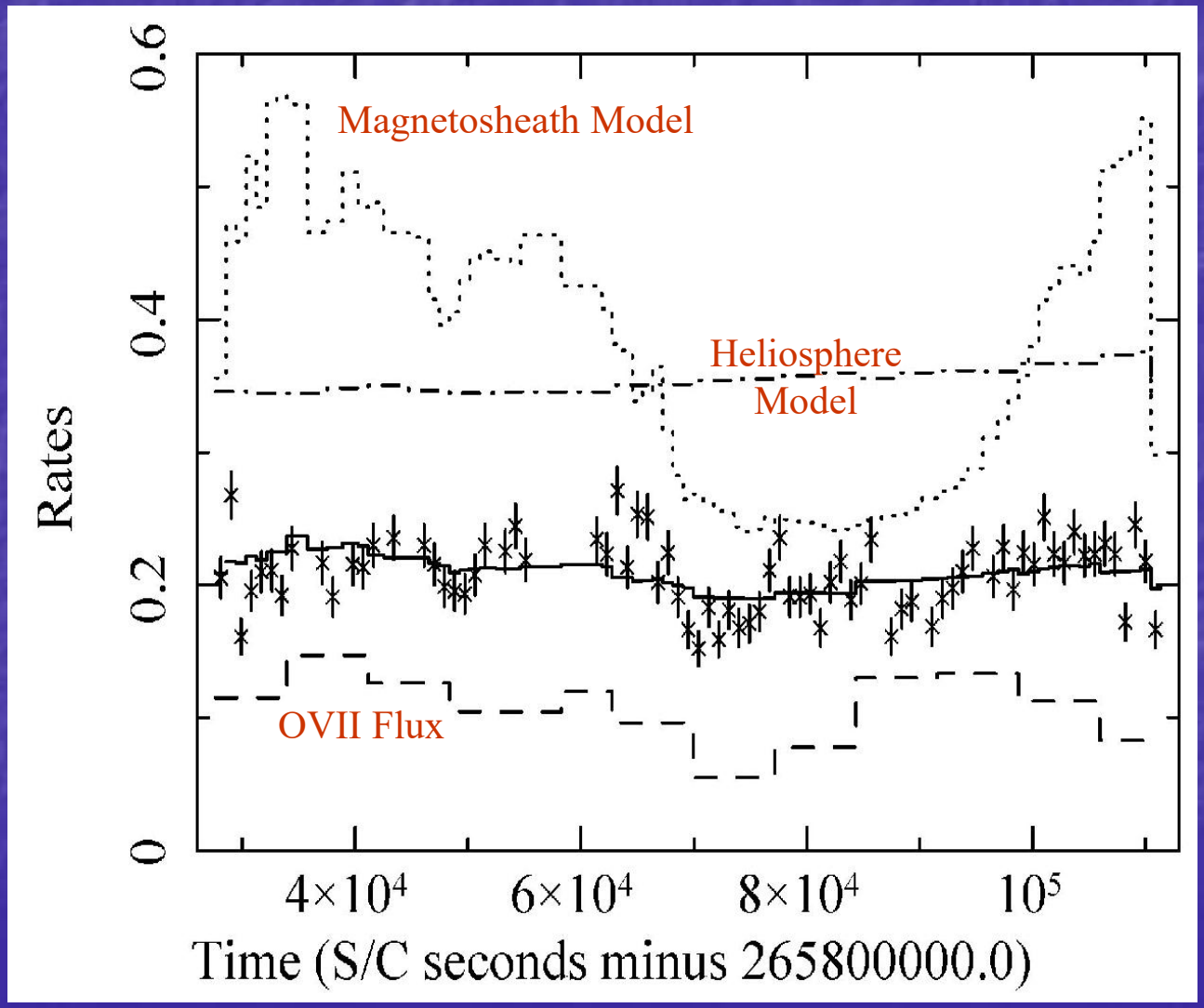
- OVII and Hard Band (2.5-12.0 keV)
- Scatter plot of OVII count rate versus hard count rate to identify soft proton contamination
- Correlation indicates contamination => exclude outliers
- Add MOS1, MOS2 and PN count rates, uncertainties added in quadrature
- Include only data where all three instruments are accepted

Extract the Solar Wind Fluxes



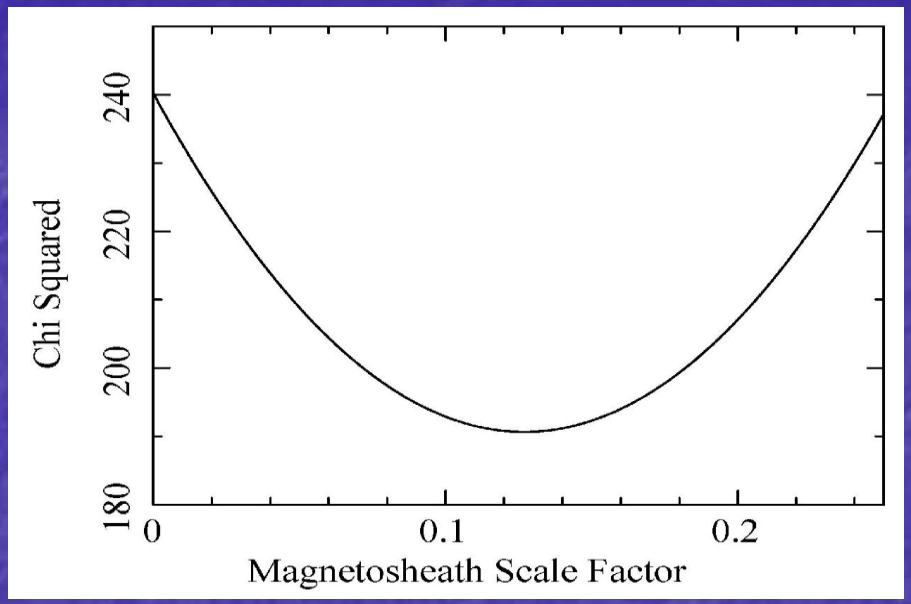
- Solar wind proton speed
- Solar wind OVII flux
- Solar wind proton flux

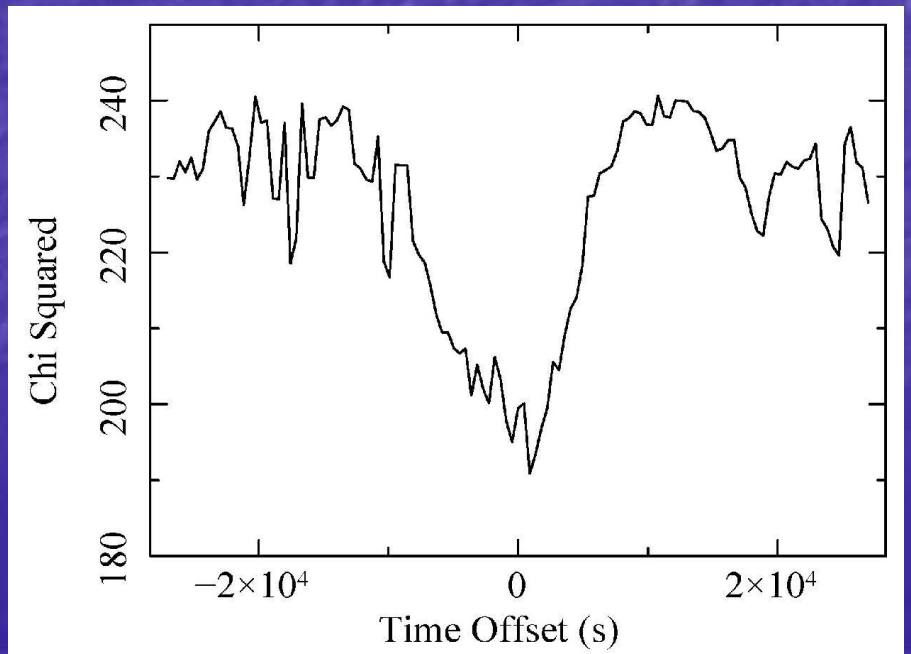
Data and Model



- Fit constant plus scaled magnetosheath model
- Insufficient heliospheric model variation to get a significant fit
- Best fit has a terrible χ^2 value, ~2.6
- Dominated by scatter, undersampling of OVII variation?

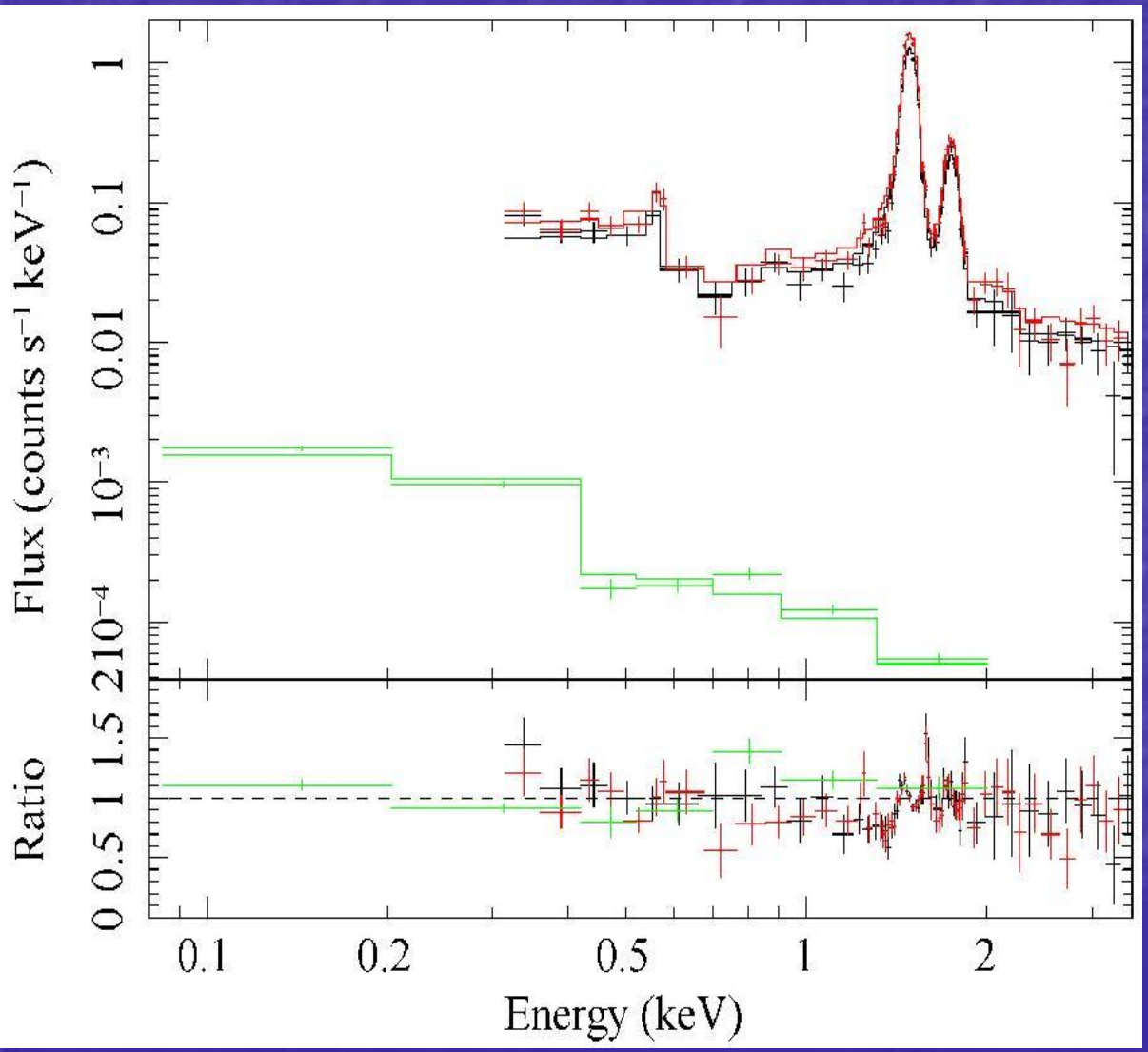
Examine Correlation





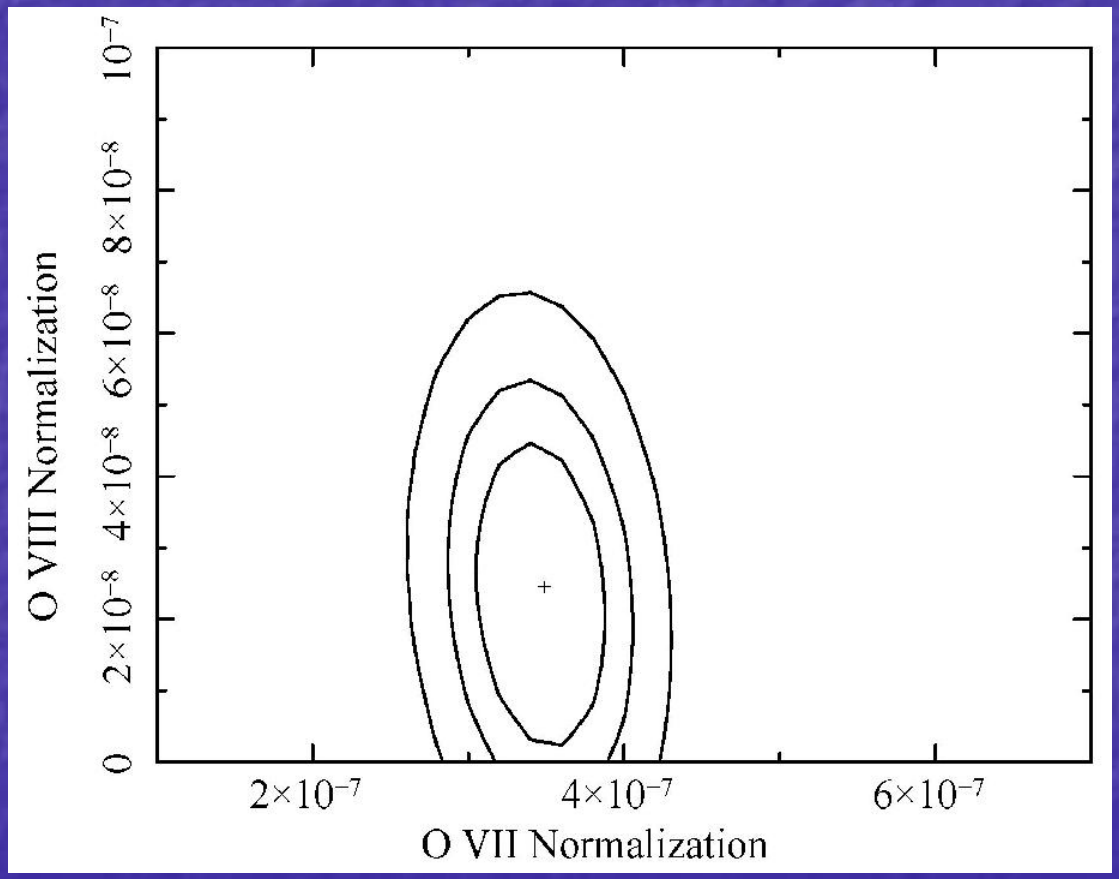
- The correlation coefficient is 0.43 for 77 samples, for a probablility >99%
- While the χ^2 value is bad (~190 for 75 dof), the χ^2 minimum is deep
- If the model is shifted in time, the χ^2 minimum at zero shift is relatively narrow and deep
- These are qualitative arguments but support a significant correlation between the model and the data

Spectral Fit



- Fit for OVII and OVIII – the strongest SWCX lines in the XMM band
- Use XMM-ESAS to model the particle background
- Use RASS spectrum to constrain the fit
- Add a power law for any soft-proton contamination
- OVIII – 0.39(0.17) LU total
- OVII – 4.3(0.3) LU total
  1.6 LU mag.
- OVII measurements agree well with other local values (Smith et al., Kuntz & Snowden)

χ^2 Contours for OVII and OVIII



- The spectral fit is reasonably good so the contours are significant
- OVIII detection marginal
- OVII significant

Conclusions

- Strong correlation found between SWCX magnetosheath emission model

  => First clear verification of SWCX model using X-ray data

  Model agrees to 36% on first cut
- Observing SWCX in X-rays can lead to remote sensing of the magnetosheath.
- Results will form the basis for modeling the contribution of magnetosheath SWCX emission to astrophysical observations
  - Subtraction at this point might be unfeasible but marking observations at risk will be easy.