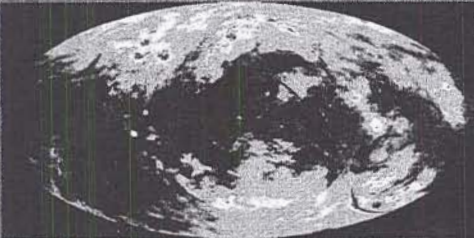


### What can be Learned from X-ray Spectroscopy Concerning Hot Gas in the Local Bubble and Charge Exchange Processes?



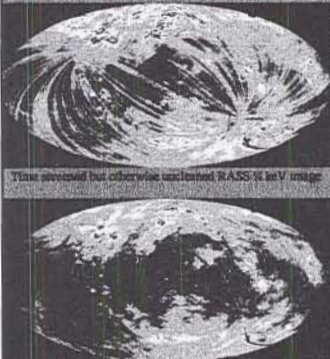
Steve Snowden  
NASA/GSFC

### Partial Answer

Nearly nothing or everything, it all depends on:

- Spectral resolution – Can individual lines be resolved?
- Instrumental grasp – How many photons can be acquired in a reasonable exposure?
- Instrumental energy band – Is the sampled spectrum covering a useful energy range?
- Signal-to-noise – How much other crud is in the way?
- Field of view – How much of the sky can reasonably be observed in a useful mission?
- Angular resolution – What angular scales can be studied? Can those pesky point sources be removed?
- Observatory location – What is the viewing geometry of the local SWCX emission?

### What Do We Want To Learn?



How much of the observed  $\frac{1}{2}$  keV background, after cleaning, originates beyond the solar system?

What is the physical state of the plasma in the Local Bubble (if there is any, of course)?

Is the plasma in equilibrium?

What are the abundances of the plasma?

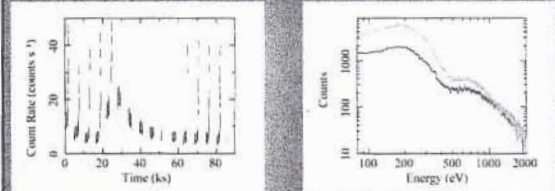
What is the evolutionary history of the Local Bubble?

What is the division of SWCX emission between heliospheric and geocoronal?

What is the zero level of SWCX emission?

Snowden, S. L. et al. 1997

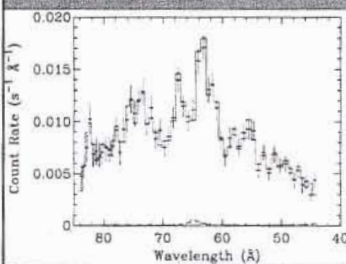
### Ancient History ROSAT



ROSAT

- Spectral Resolution: Proportional Counter with  $E/\Delta E \sim 1$
- Field of View:  $\sim 2$  degrees
- Angular Resolution:  $\sim 10''$
- Sky Coverage: Entire Sky ( $\sim 12'$  useful pixels)
- Good Response at  $\frac{1}{2}$  keV

### Modern History 1 DXS

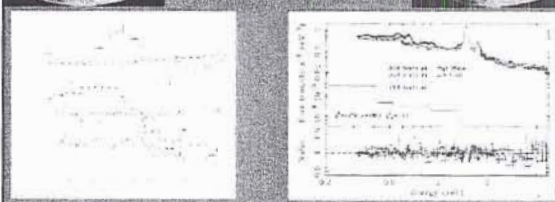


DXS – Diffuse X-ray Spectrometer

- Spectral Resolution: Bragg Crystal Spectrometer with  $E/\Delta E \sim 30$
- Field of View:  $\sim 15$  degrees
- Angular Resolution:  $\sim 15$  deg
- Sky Coverage: Few Percent of the Sky
- Response Only at  $\frac{1}{2}$  keV
- Data fit by 22 Gaussians

Snowden et al. 2001

### Modern History 2 XMM-Newton



XMM

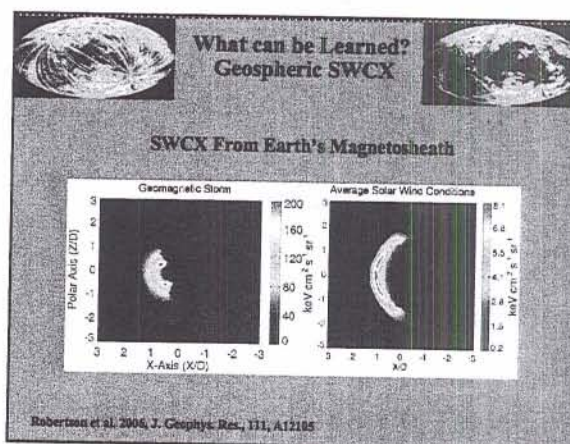
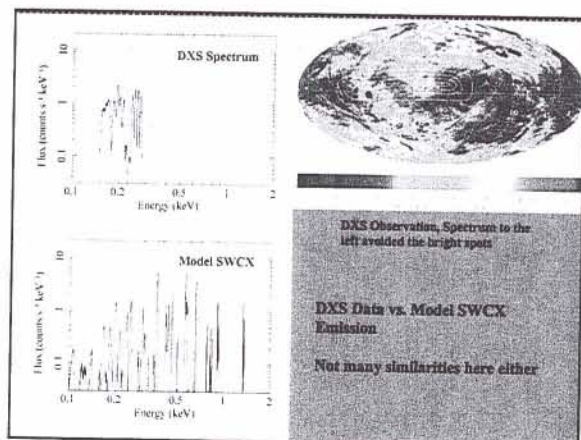
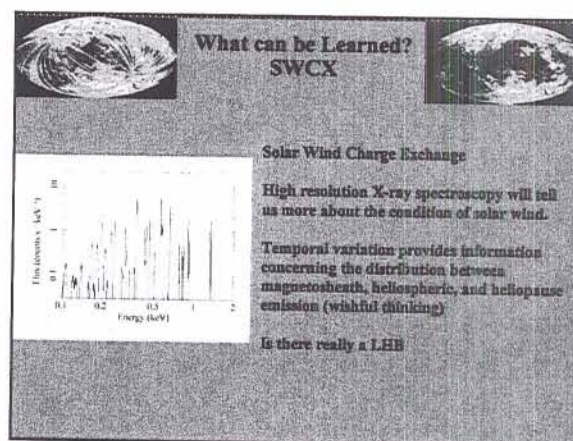
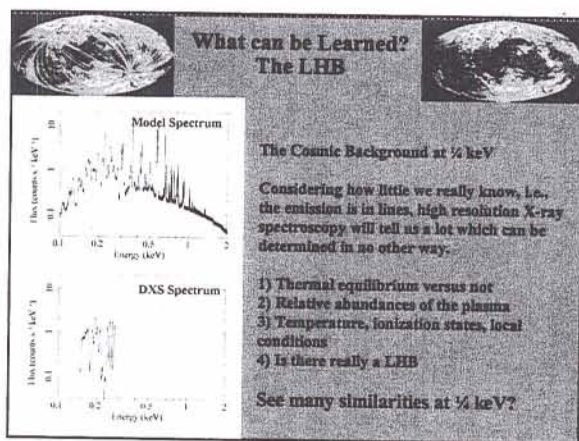
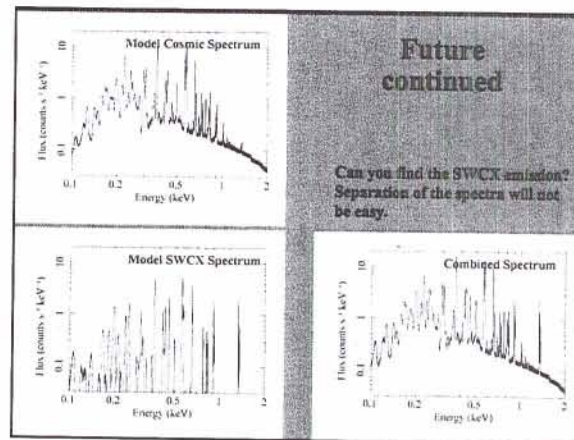
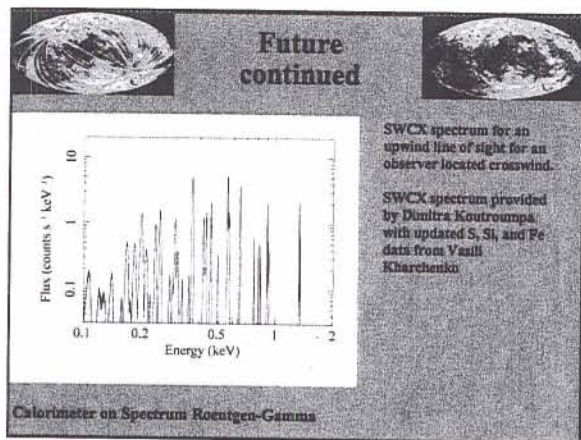
- Spectral Resolution: CCDs with  $E/\Delta E \sim 10$
- Field of View:  $\sim 0.5$  degree
- Angular Resolution:  $\sim 6''$
- Sky Coverage: Few Percent of the Sky
- Little Response at  $\frac{1}{2}$  keV

Snowden et al. 2004

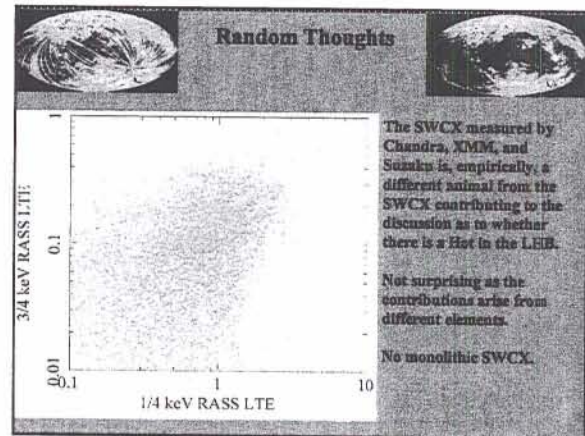
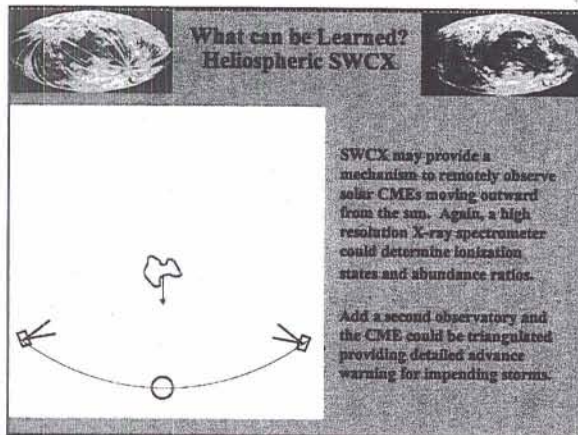
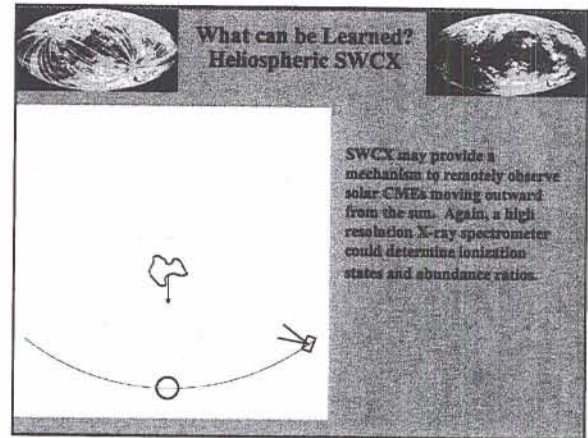
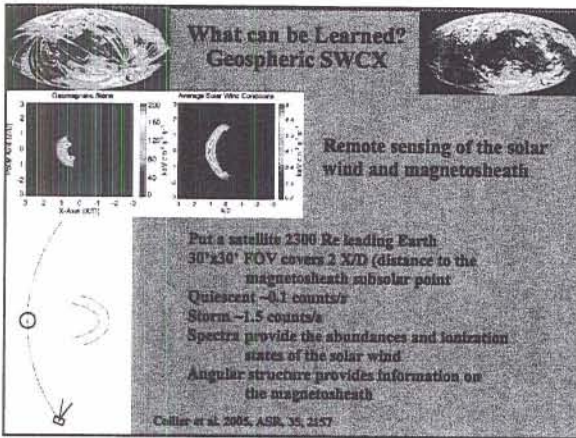












### SUMMARY

- High resolution soft X-ray spectroscopy of diffuse emission can provide a Rosetta stone for understanding the relative contributions of the Local Hot Bubble and SWCX
- Is there hot in the LHB? If so:
  - Is the LHB in thermal equilibrium?
  - What are the abundances in the LHB?
  - What are the ionization states?
- What is the nominal quiescent level of SWCX?
  - Heliospheric versus geospheric (magnetosheath) SWCX
  - dominated at 3/4 keV by the Loop I, the Galactic Bulge and supernova remnants and superbubbles
  - dominated at 1.5 keV by the unresolved extragalactic background
- New mission - Spectrum Roentgen Gamma
- Pipe dream missions - Monitors for the magnetosheath and CME
- Local Bubble and Beyond II
  - Philadelphia, USA, 2008 April 21-24
  - <http://lhb.gsfc.nasa.gov/>

### References

Collier et al. 2005, ASR, 35, 2157, One-up on L1: Can X-rays provide longer advanced warning of solar wind flux enhancements than upstream monitors?

McCauley et al. 2002, ApJ, 576, 188

Gardner, W. T. et al. 2001, 554, 694, Spectra of the keV X-Ray Diffuse Background from the Diffuse X-Ray Spectrometer Experiment

Robertson, I. P. et al. 2006, J. Geophys. Res., 111, A12103, X-ray emission from the terrestrial magnetosheath including the cusp

Strohmaier, S. L. et al. 1997, ApJ, 485, 125, ROSAT Survey Diffuse X-Ray Background Maps. II

Jurveten, S. L., Collier, M. R., & Kuntz, K. D. 2004, ApJ, 610, 1182, XMM-Newton Observation of Solar Wind Charge Exchange Emission

Thanks to:  
 Dimitra Rezzonutti for providing a model SWCX spectrum  
 Randall Smith for providing Spectrum Roentgen Gamma Calorimeter response file

