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

Source: NASA Goddard Space Flight Center

Handout Page 1

What Do We Want To Learn?

- What is the physical state of the plasma in the Local Bubble (or shell)?
- What is the origin of this plasma?
- Where are the abundances of the elements?
- What is the evolutionary history of the Local Bubble?
- What is the origin of SWCX?
- What is the spin-up level of SWCX expansion?

Partial Answer

- Nearly nothing of everything, it all depends on:
  - Spectral resolution: Can individual interstellar elements be resolved?
  - Instrumental group: How many photons can be acquired in a reasonable exposure?
  - Instrumental energy band: In the sampled spectrum covering a useful energy range?
  - Signal-to-noise: How much of the sky can reasonably be observed in a useful manner?
  - Angular resolution: What angular scale can be studied? Can those tiny point sources be resolved?
- Observational focus: What is the view geometry of the local SWCX evolution?

Ancient History

- ROSAT
  - Spectral Resolution: Proportional Counter with E/R = 0.75
  - Field of View: ~25 degrees
  - Angular Resolution: ~10°
  - Sky Coverage: Entire sky (~13° useful points)
  - Good Response at 5 keV

Modern History 1

- DXS
  - Diffuse X-ray Spectrometer
  - Spectral Resolution: Bragg Crystal Spectrometer with E/R = 0.75
  - Field of View: ~15 degrees
  - Angular Resolution: ~15°
  - Sky Coverage: Few percent of the sky
  - Response at 5 keV

Modern History 2

- XMM-Newton
  - Spectral Resolution: CCDs with E/R = 10
  - Field of View: ~25 degrees
  - Angular Resolution: ~1°
  - Sky Coverage: Few percent of the sky
  - Little Response at 5 keV

https://ntrs.nasa.gov/search.jsp?R=20080000771 2019-12-01T08:46:59+00:00Z
Future continued

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Future continued

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What can be Learned? The LHB

The Cosmic Background at 1 keV
Considering how little we really know, let's
the emission is at least, high resolution X-ray
spectroscopy will tell us a lot which can be
determined in no other way:
1) Thermal equilibrium versus non
2) Relative abundances of the plasma
3) Temperature, ionization state, local conditions
4) Is there really a LHB
See many similarities at 1 keV

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What can be Learned? SWCX

Solar Wind Charge Exchange
High resolution X-ray spectroscopy will tell
us more about the condition of solar wind.
Temporal variations provide information
concerning the distribution between
magnetosheath, heliosheath, and helsphere
emissions (within the clocking)
Is there really a LHB

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What can be Learned? Geospheric SWCX

SWCX From Earth's Magnetosphere

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Handout Page 3
What can be Learned? Geospheric SWCX

Remove scattering of the solar wind and magnetosheath.

What can be Learned? Heliospheric SWCX

SWCX may provide a mechanism to remotely observe solar CMEs moving outward from the Sun. Again, a high resolution X-ray spectrometer could determine luminosity states and abundance ratios.

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Random Thoughts

The SWCX measured by Chandra, XMM, and Swift is significantly different from the SWCX contributing to the radiation belts. In addition to whether there is a hot spot in the LHB, not everything is the same. The contributions are from different elements.

SUMMARY

- High resolution soft X-ray spectroscopy of diffuse emissions can provide a routine tool for understanding the relative contributions of the Local Hot Bubble and SWCX.
- What's the LID? "Hot"?
- Is there evidence for the LHB? "Yes"?
- What are the abundances in the LHB?
- What is a good method to measure the abundance of SWCX? A high resolution X-ray spectrometer could determine luminosity states and abundance ratios.
- What is the ionization level of SWCX? Heliospheric versus geospheric (magnetosheath)?
- Dominated at 1.5 keV by the Loop I, the Galactic Breeze, and sporadic remnants and superbubbles.
- Dominated at 1.5 keV by the ionized extragalactic background.
- New missions: Spectrum Recovery Gamma, Pipeline System studies, Members for the magnetosheath and CMEs.

References
