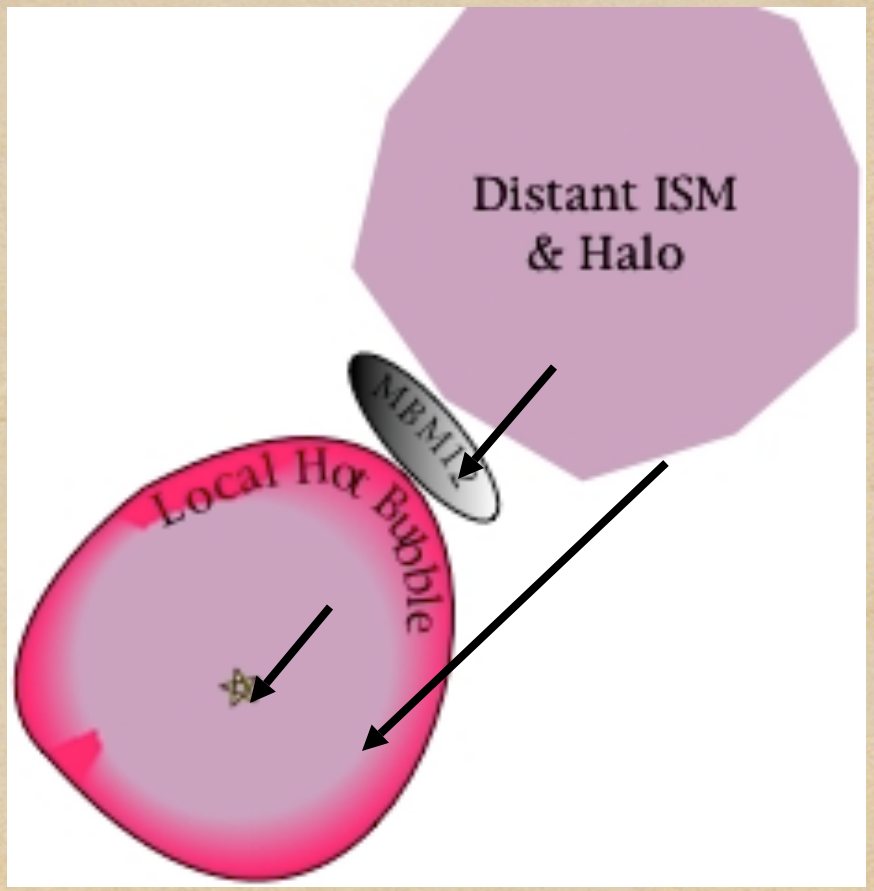
Diffuse Soft X-rays: From the Local Hot Bubble or the Solar Wind?

Randall Smith

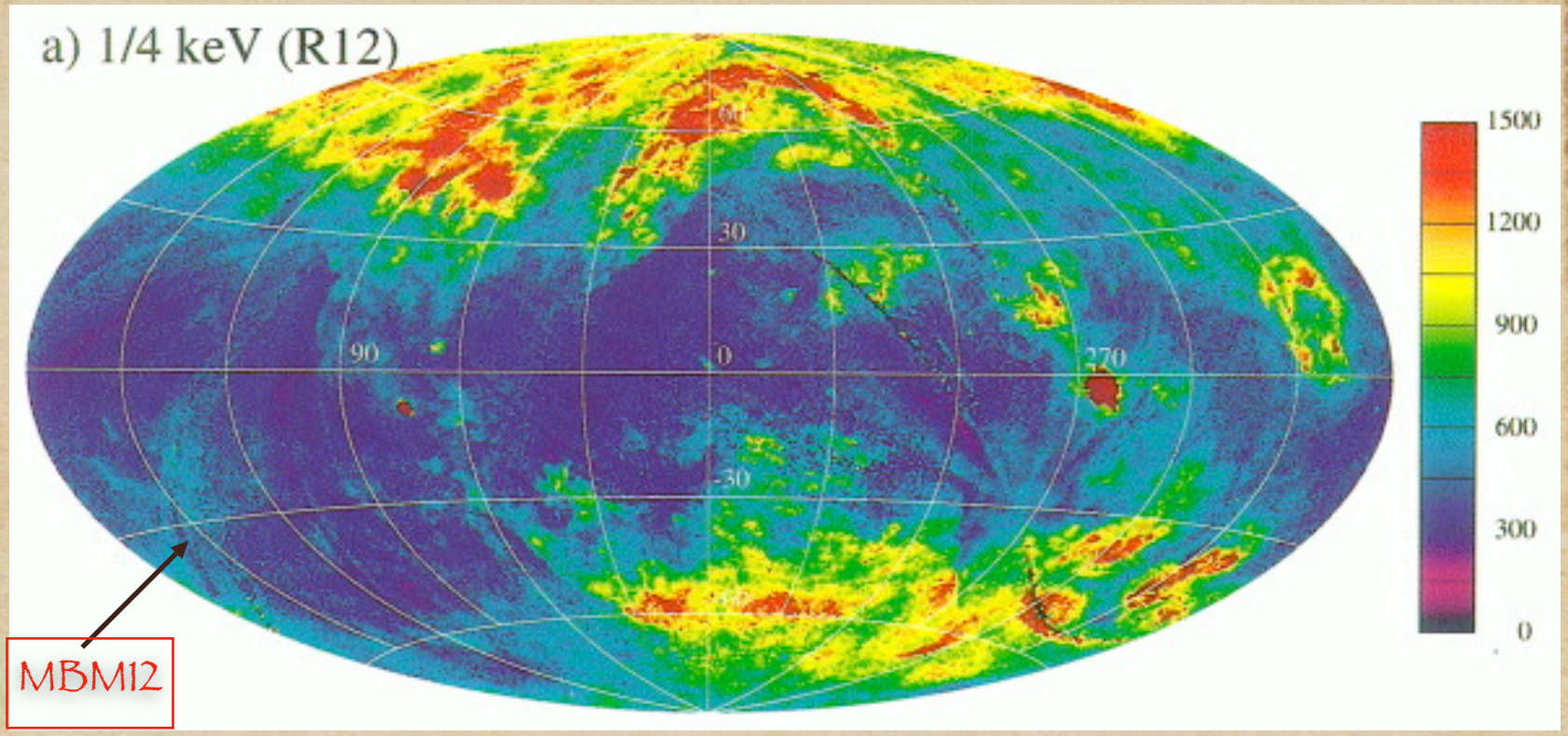
Goal

Determine the temperature and emission measure of the local and distant components of the soft X-ray background emission.

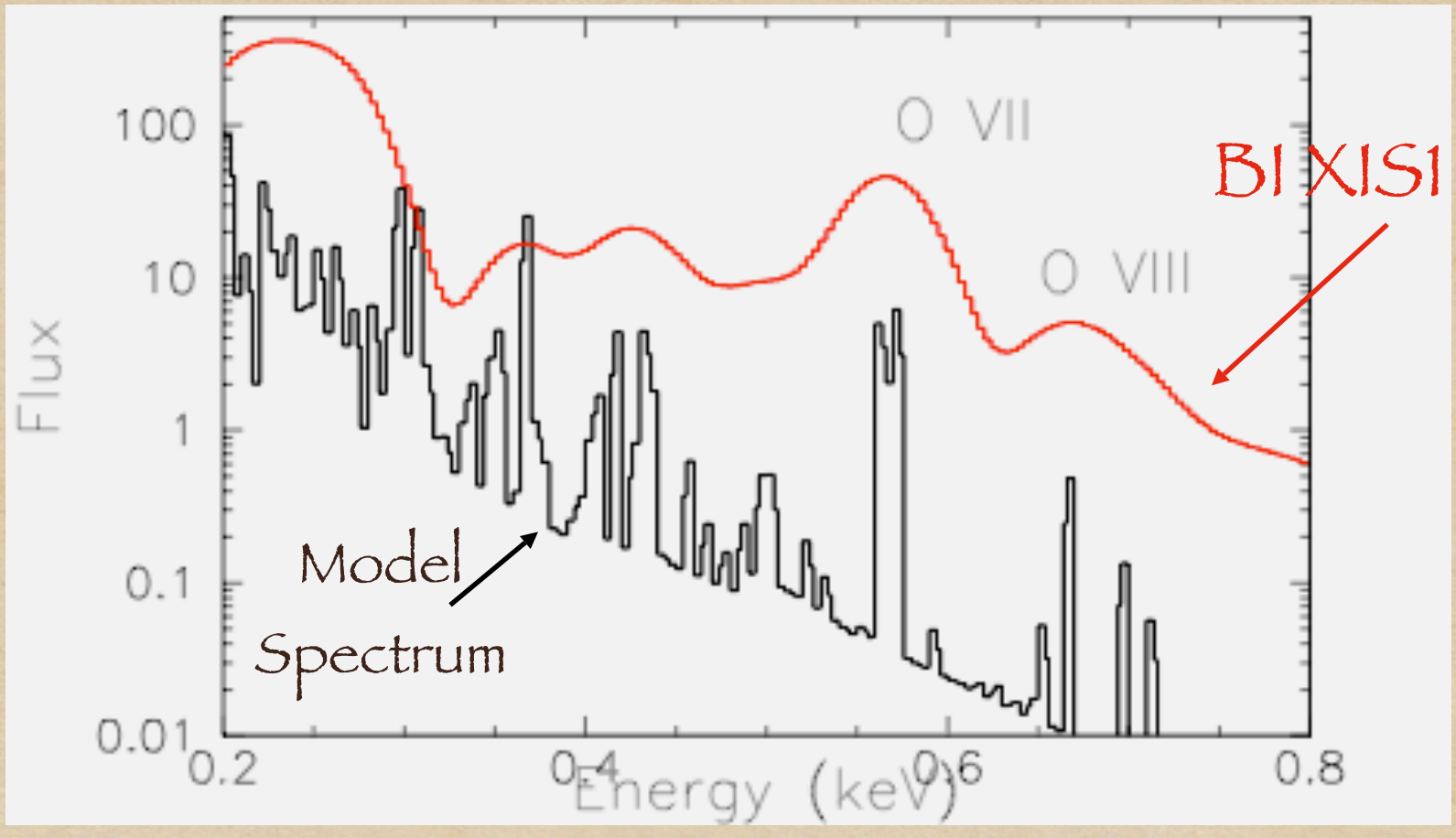
MBM12 is a nearby molecular cloud that serves as an excellent "curtain" for separating local and distant soft X-ray emission. We observed MBM12 for ~100 ksec and an off-cloud position for ~70 ksec immediately thereafter.



The Local Bubble

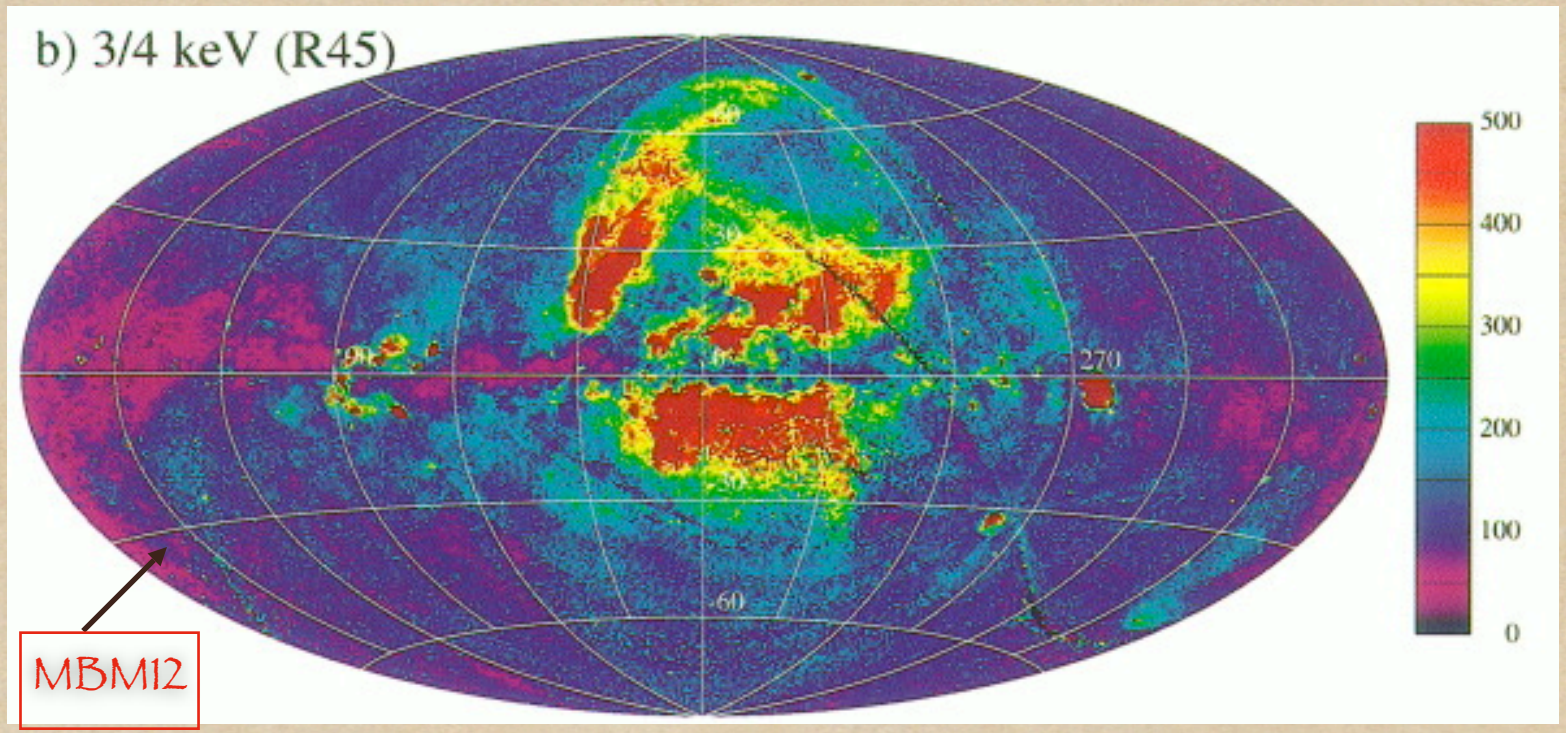


The ROSAT All-sky 1/4 keV image. Some of the emission at high latitudes is from the Galactic halo, although not all. Various SNR can be seen in the plane, but the emission is largely featureless.



The 1/4 keV emission is the signature of the soft X-ray emission. But at CCD resolution, the O VII and O VIII are the sharpest features.

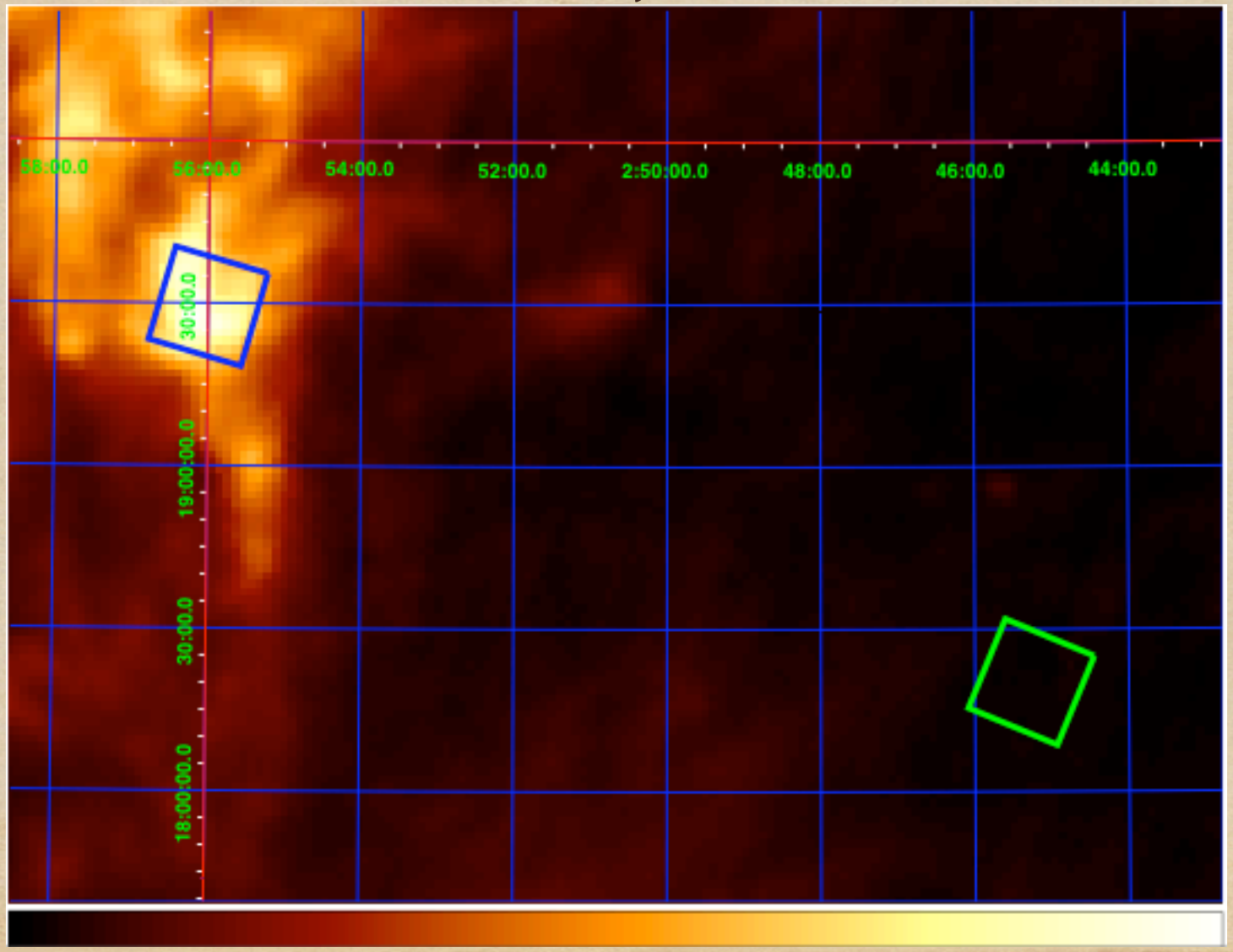
The Local Bubble



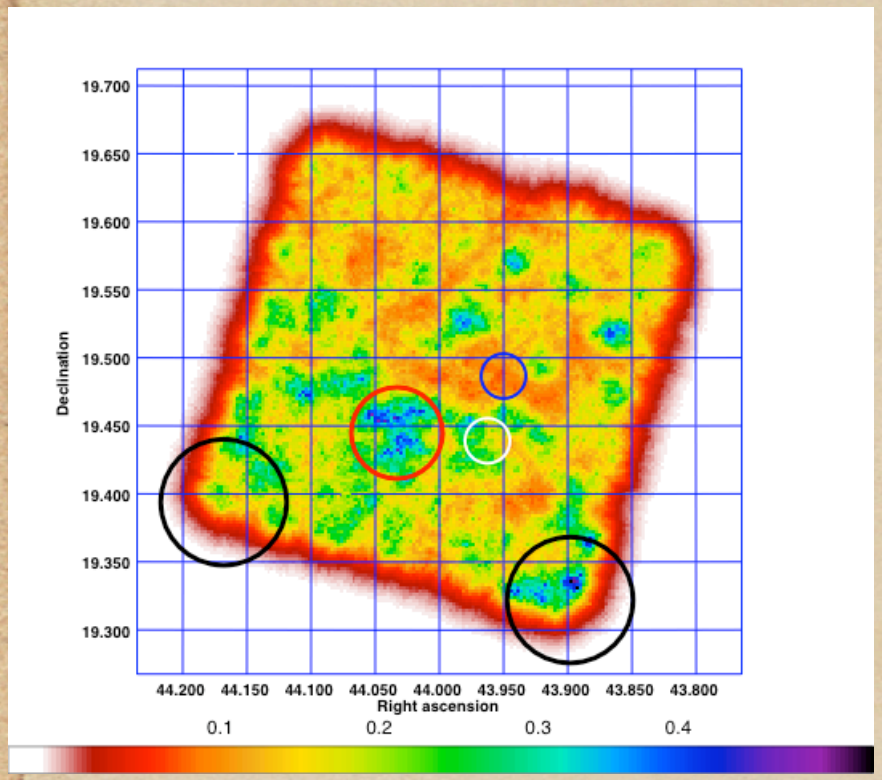
ROSAT All-sky Survey in 3/4 keV

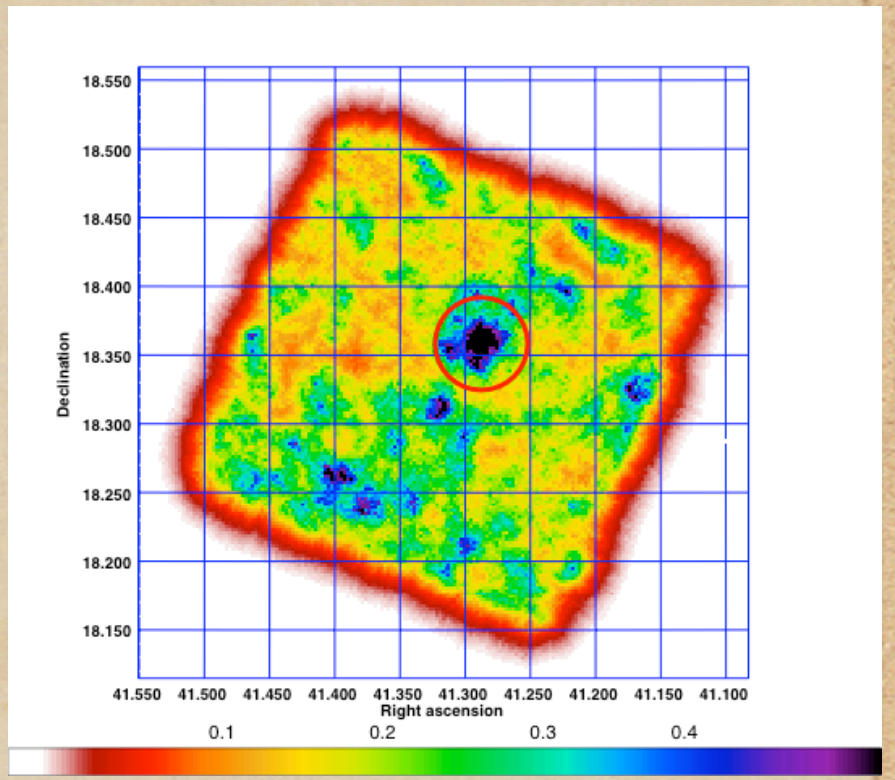
The sky changes relatively little with latitude. The brightest features are from Loop I. (Snowden et al. 1997)

IRAS 100 um map of both fields



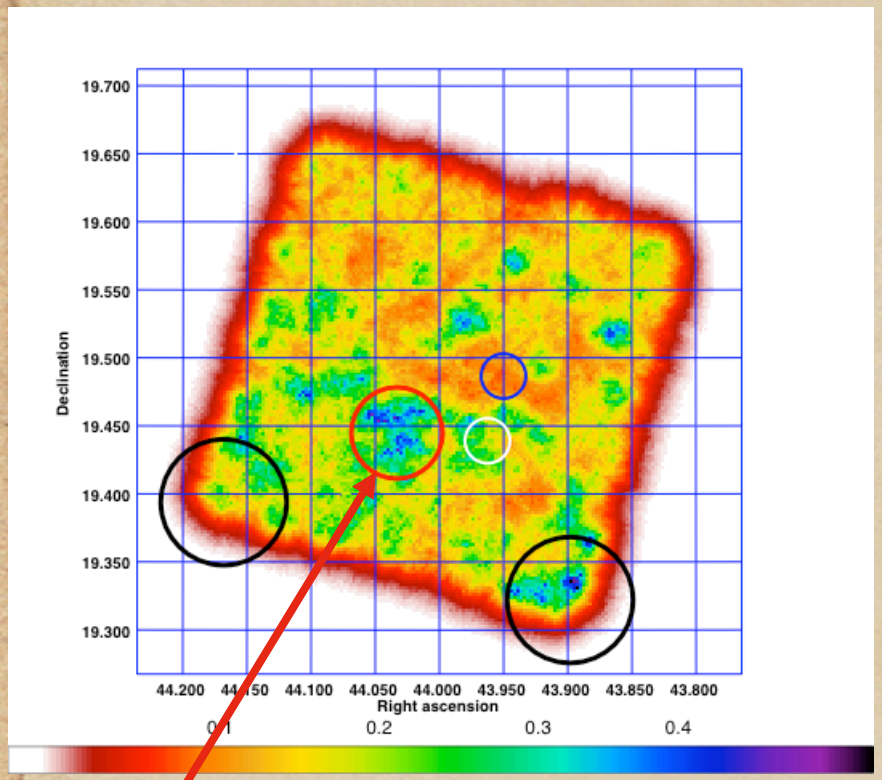
Known Sources, 0.4-1.0 keV

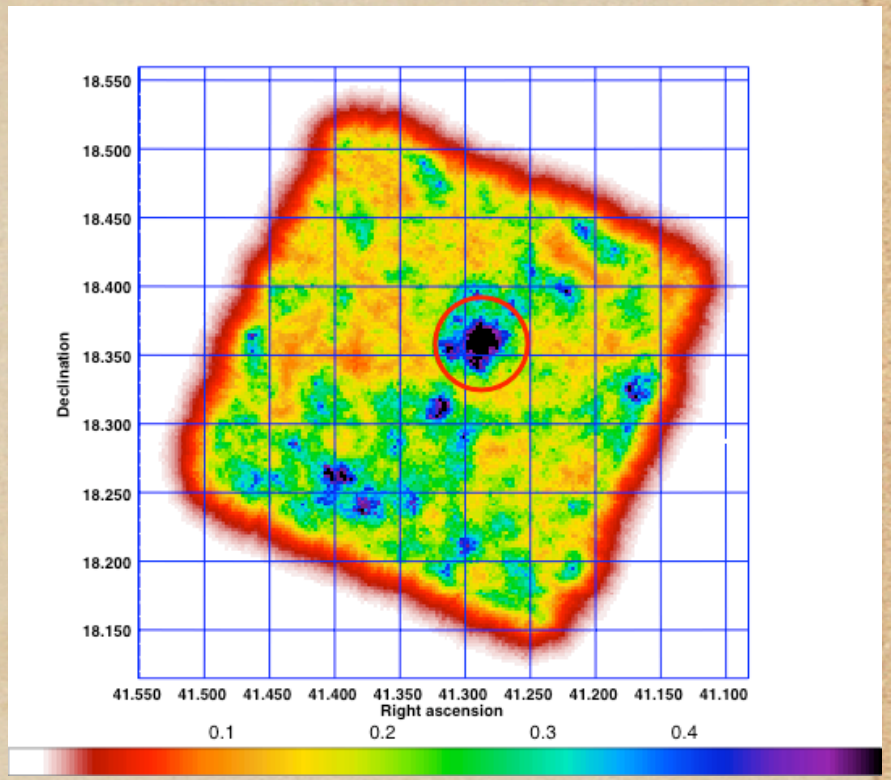




But there are other sources...

Known Sources, 0.4-1.0 keV

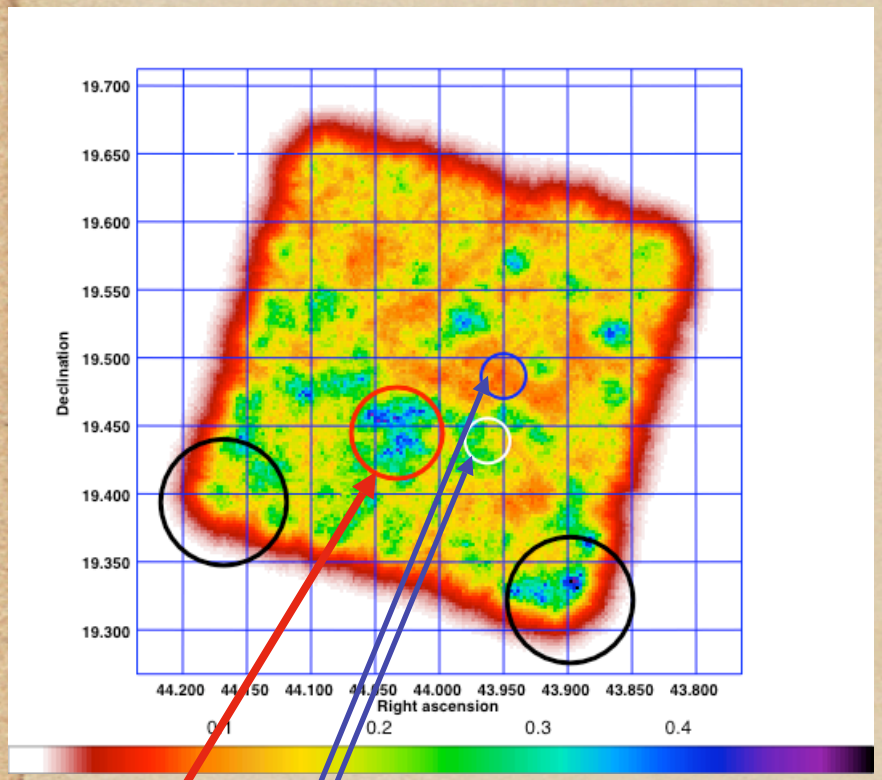


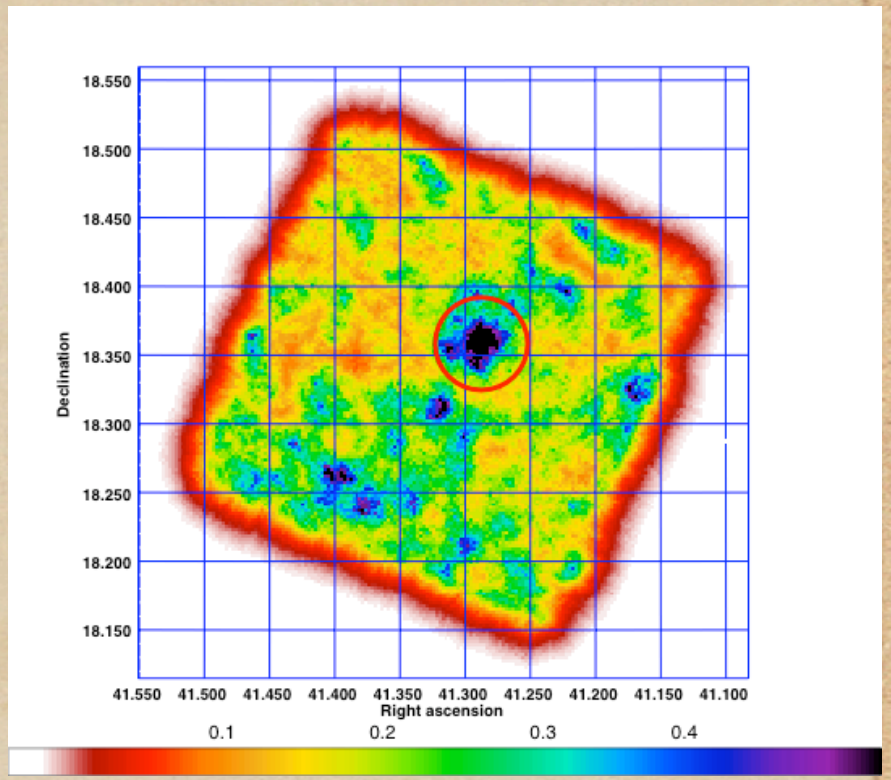


XY Ari

But there are other sources...

Known Sources, 0.4-1.0 keV



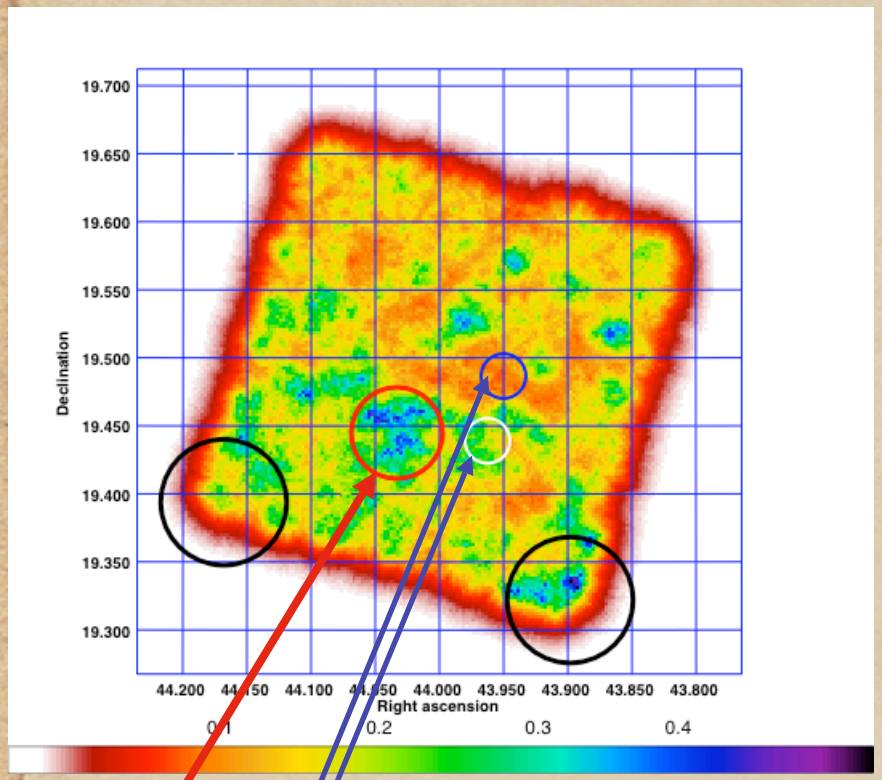


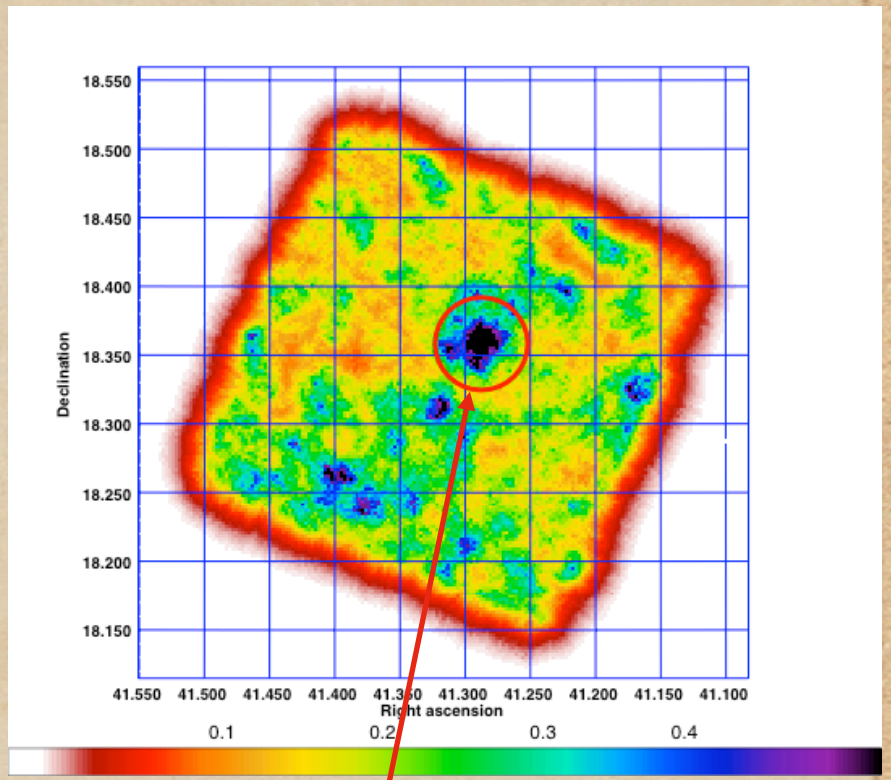
XY Ari

Chandra sources

But there are other sources...

Known Sources, 0.4-1.0 keV





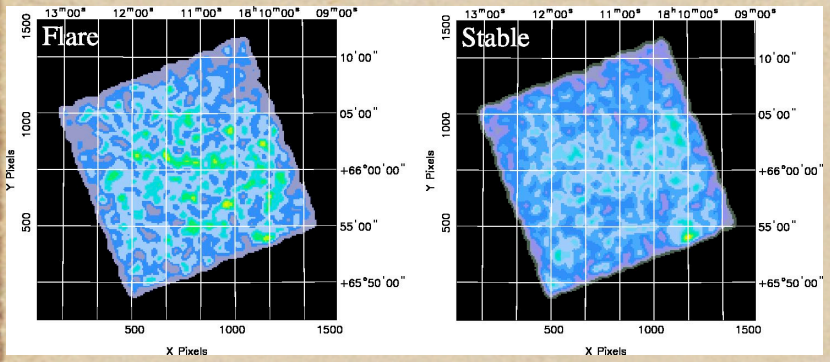
XY Ari

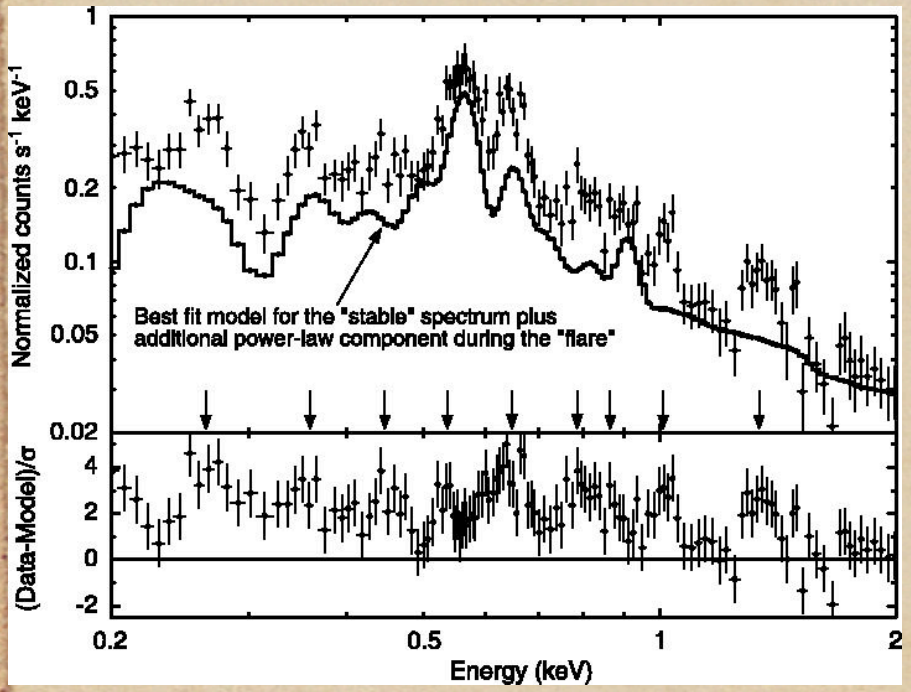
Chandra sources

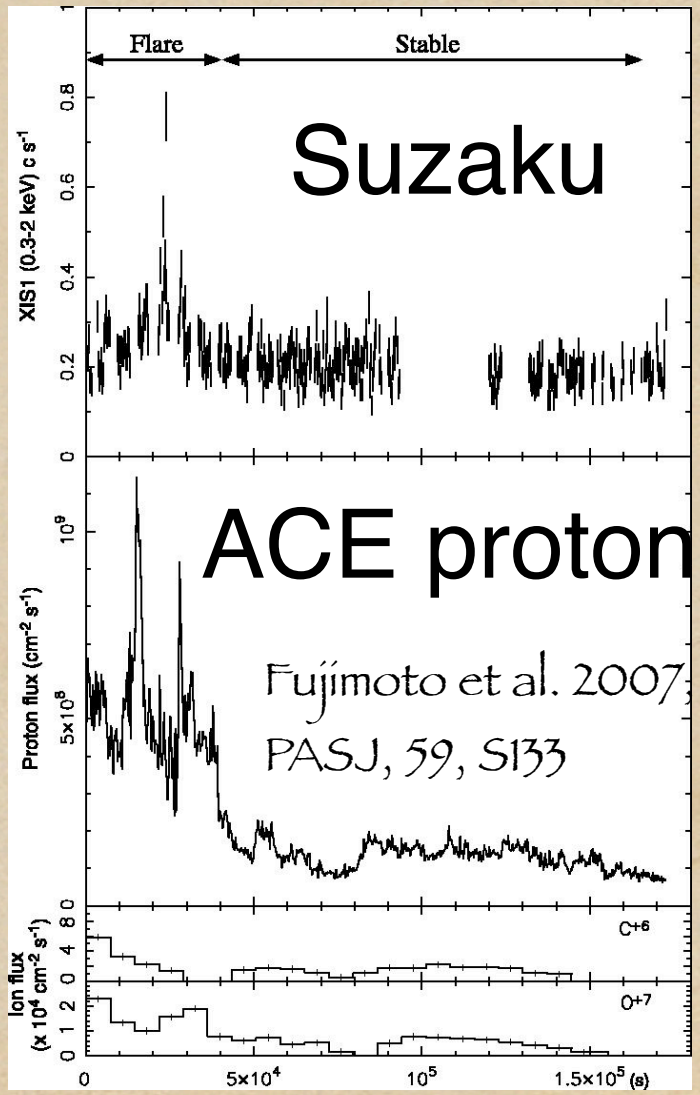
Unidentified source

But there are other sources...

SWCX emission found in NEP

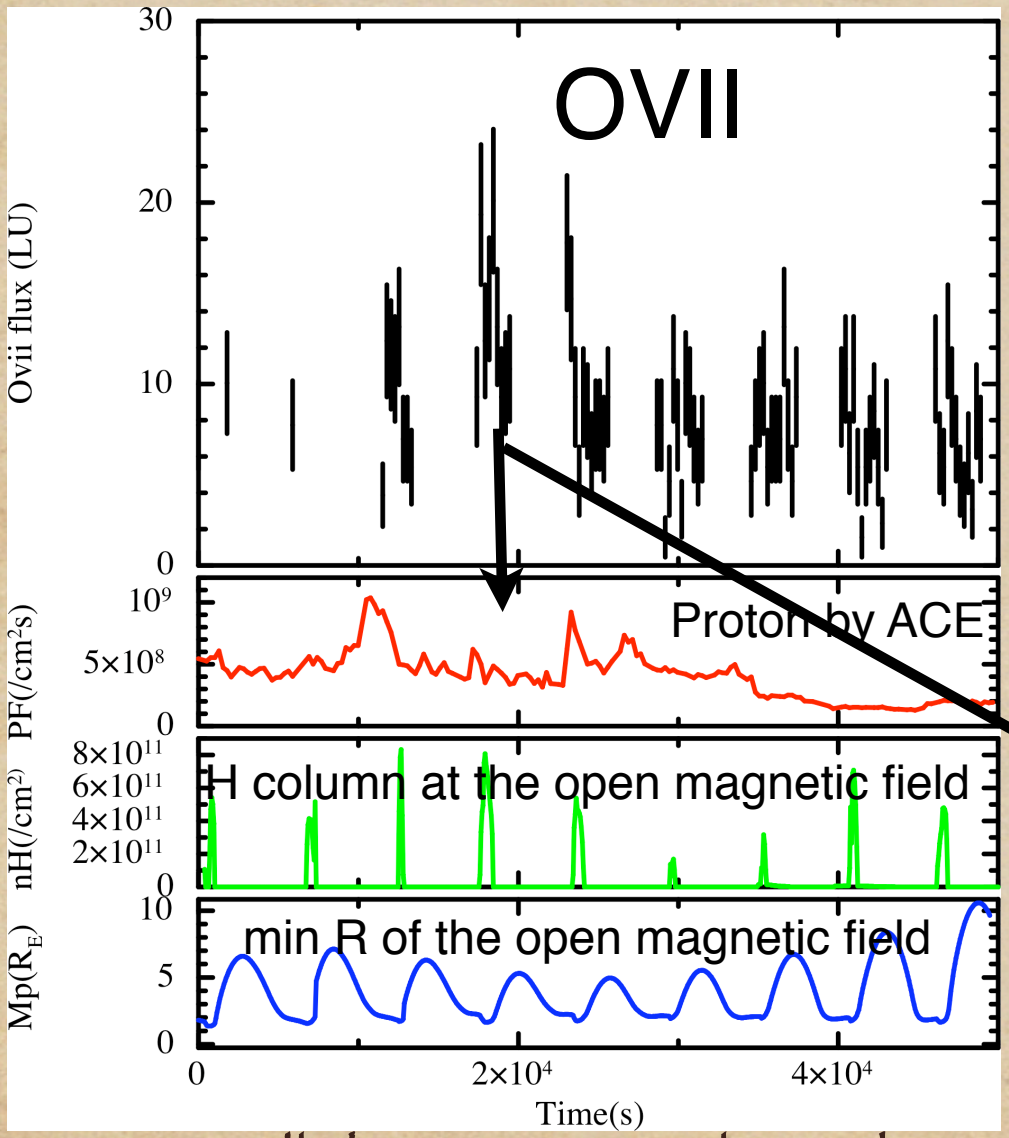


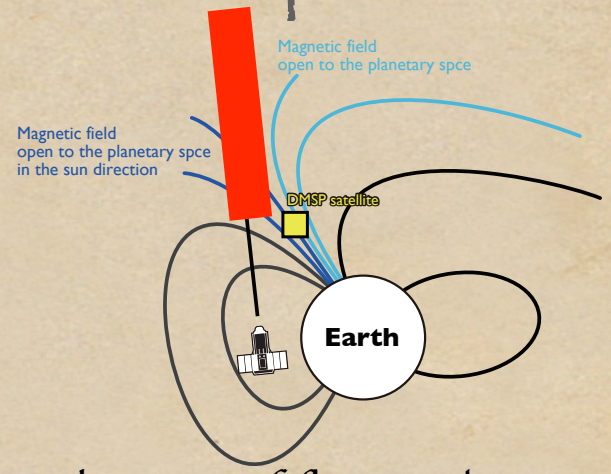




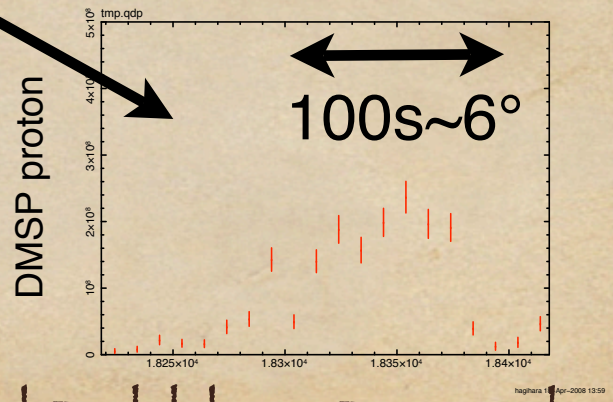
From a talk by N. Yamasaki at the Local Bubble & Beyond II

Solar wind came from "Cusp"?





At the time of flux peak, SW through the "CUSP" was detected by a DMSP crossed the same line of field.



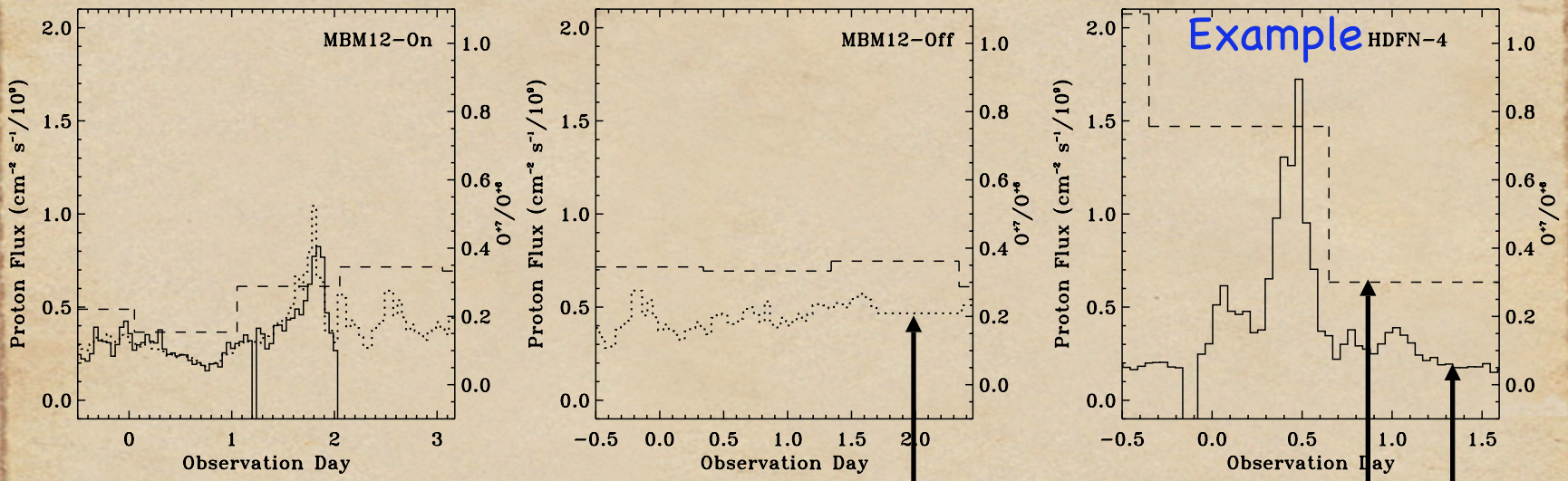
From a talk by N. Yamasaki at the Local Bubble & Beyond II

Back to MBM12 with Suzaku

On-Cloud

Off-Cloud

SWCX Contamination



Proton flux in 10^9 cm^{-2}/s from WIND

The Solar Wind O^{+7}/O^{+6} ratio from ACE.

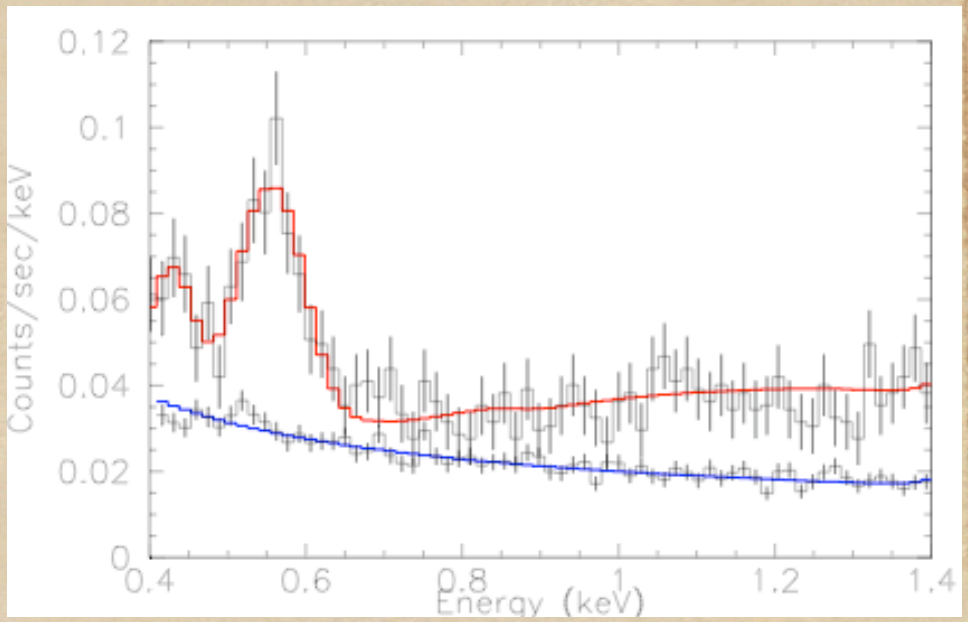
Proton flux in 10^9 cm^{-2}/s from ACE

Physical model

After excluding a 2' radius around XY Ari, a model including an O VII line and a low energy C/N line, as well as the CXRB & background gives:

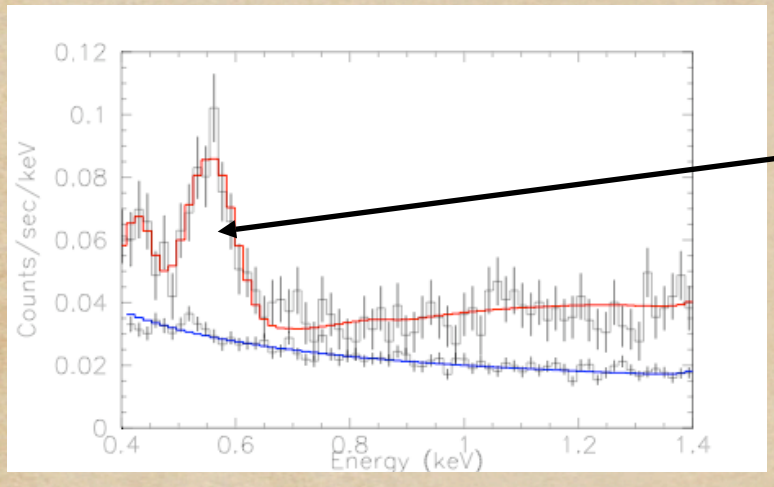
SB(O VII)= **3.53±0.26 LU**
SB(O VIII) = **0.24±0.1 LU**

In equilibrium at 1.2x10^{6}K, this corresponds to an emission measure of **0.0075 cm^{-6}pc**, or with a 100 pc radius, an average density of **0.0087 cm^{-3}**.

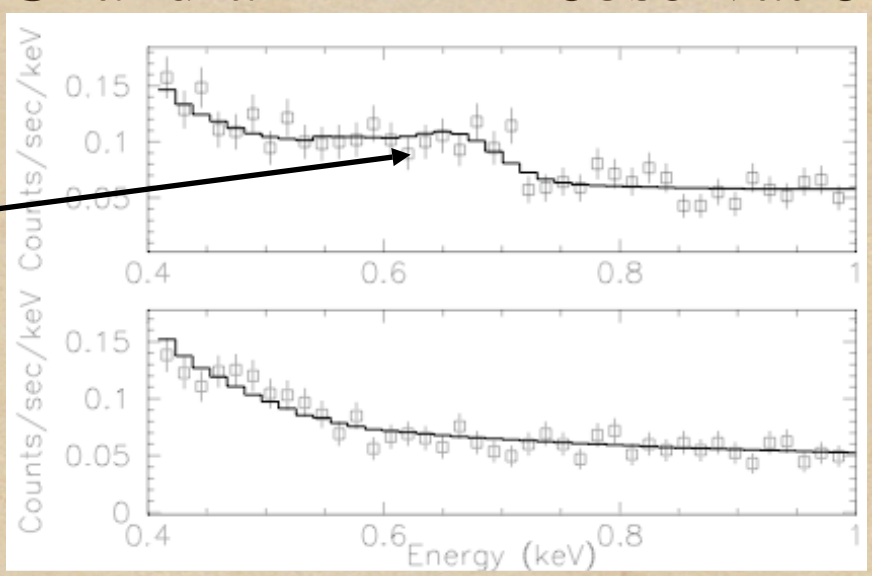


Results

Suzaku MBM12



Chandra MBM12 observation

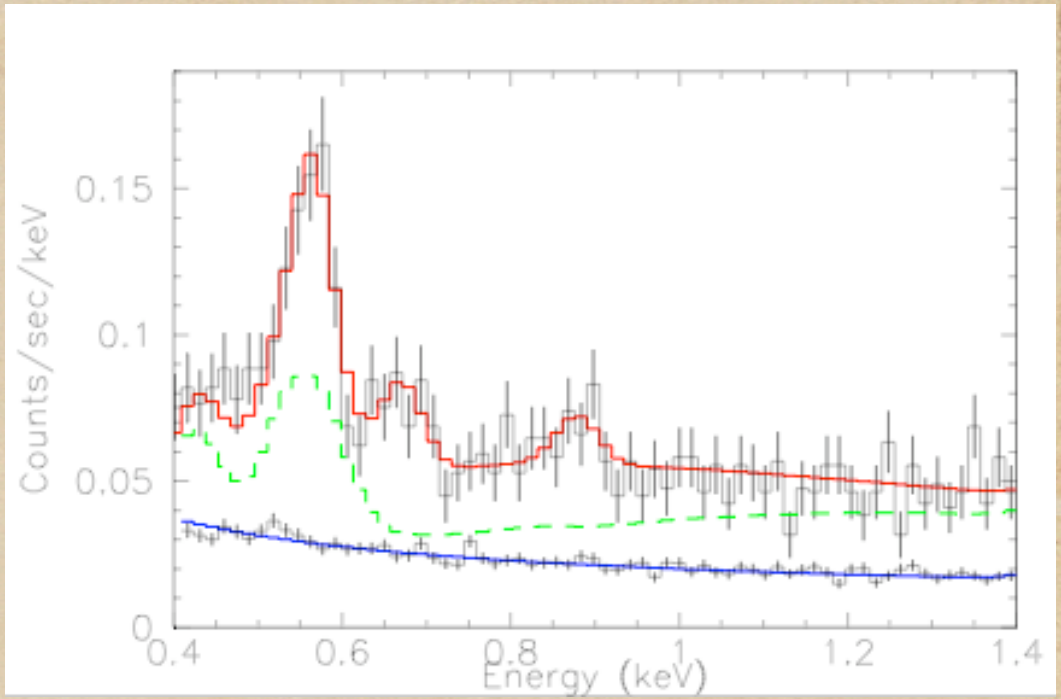


Chandra particle background

Chandra's background at 0.6 keV is ~0.075 cts/s/keV, compared to Suzaku's value of 0.025 cts/s/keV, and the Chandra observation appeared to be impacted by SWCX.

Off-cloud results

The off-cloud spectra show a clear O VIII line as well as a possible line at 0.876 keV.



The ratio of the excess O VIII/O VII seen "off-cloud" is consistent with a T ~ 2×10^6 K plasma. The mystery line is probably not from Ne or Fe, since other features from those ions would be seen in this bandpass (but it is only a 3σ detection).

Conclusions

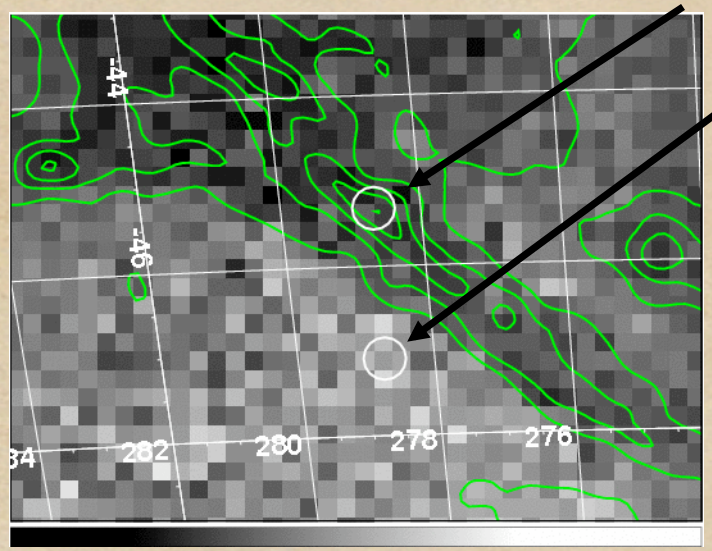
- The O VII is **3x** stronger than expected from the 1/4 keV emission.
  - Could be due to 'quiescent' SWCX
- If the LHB is responsible for both:
  - O VII flux (from Oxygen) *and*
  - the 1/4 keV flux (primarily Si, S, and Fe lines)

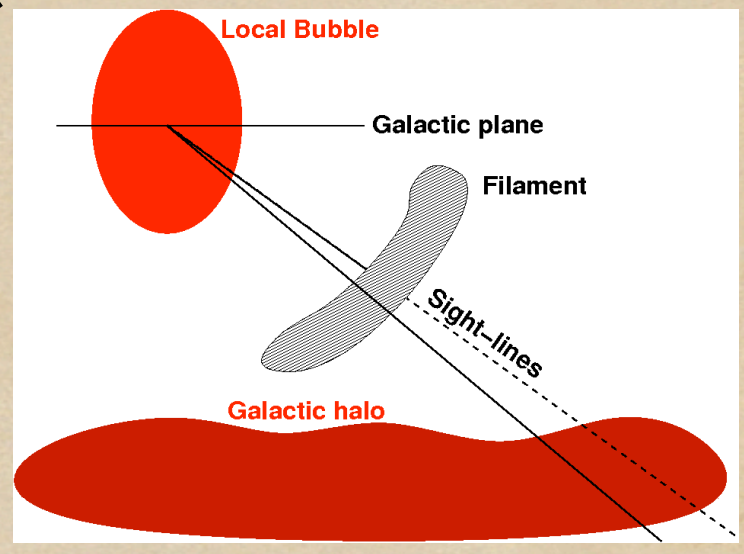
$\Rightarrow$ These elements (Si, S, Fe) must be depleted **relative to Oxygen** in the LHB.

But Beware ! ACE isn't everything...

Henley, Shelton & Kuntz 2007

On Off



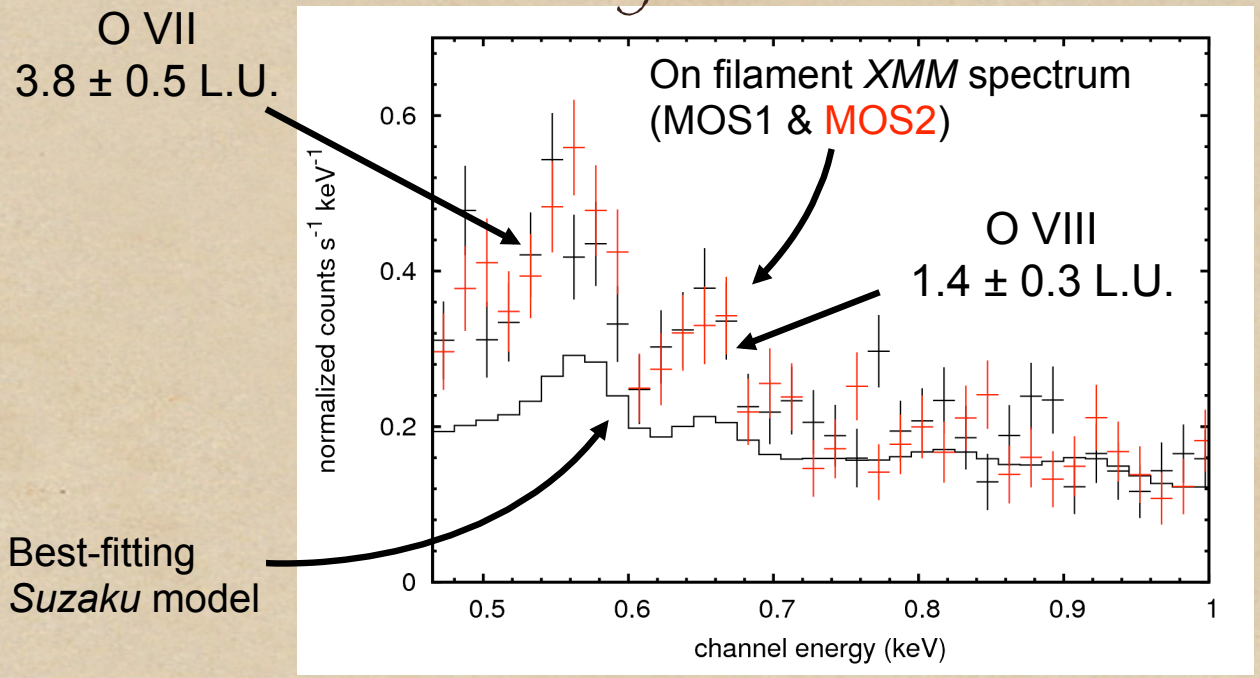


Grayscale: *ROSAT* 1/4 keV
Contours: *IRAS* 100 micron

From a talk by D. Henley at the Local Bubble & Beyond II

SWCX Emission in XMM Spectra

Henley & Shelton 2008



- Extra emission component in *XMM* spectra (in addition to LB, halo, extragalactic background)
  - Solar wind charge exchange emission

From a talk by D. Henley at the Local Bubble & Beyond II