RHESSI Results on Diffuse Radioactivity Lines

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INTRODUCTION: THE 1809 keV LINE FROM ^{26}Al

- Observed from the Galactic plane since HEAO-3 in 1979 (Mahoney et al. 1984)
- Thought to be ejected in SNII, novae, Wolf-Rayet and AGB star winds
- Million-year halflife: gives average of current Galactic nucleosynthesis rate
- Maps from COMPTEL on CGRO correlate best with early stellar populations:

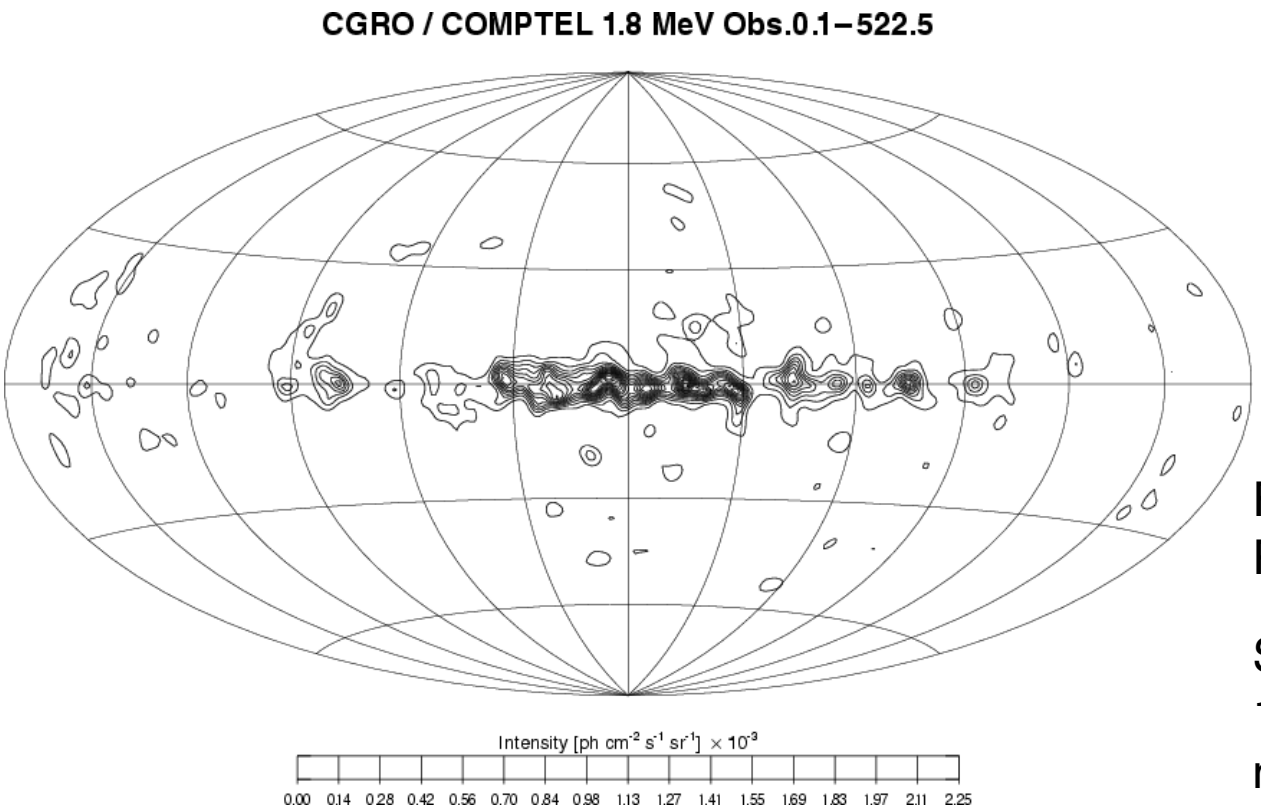


Figure from U. Oberlack 1997, PhD dissertation.

See also J. Knoedlseder et al. 1999, A&A 345, 813 for newer maps

WIDTH OF THE 1809 keV LINE

- The GRIS balloon (Naya et al. 1996, Nature, 384, 44)
  found the 1809 keV line to be broad: 5.4 (+1.4, -1.3) keV.

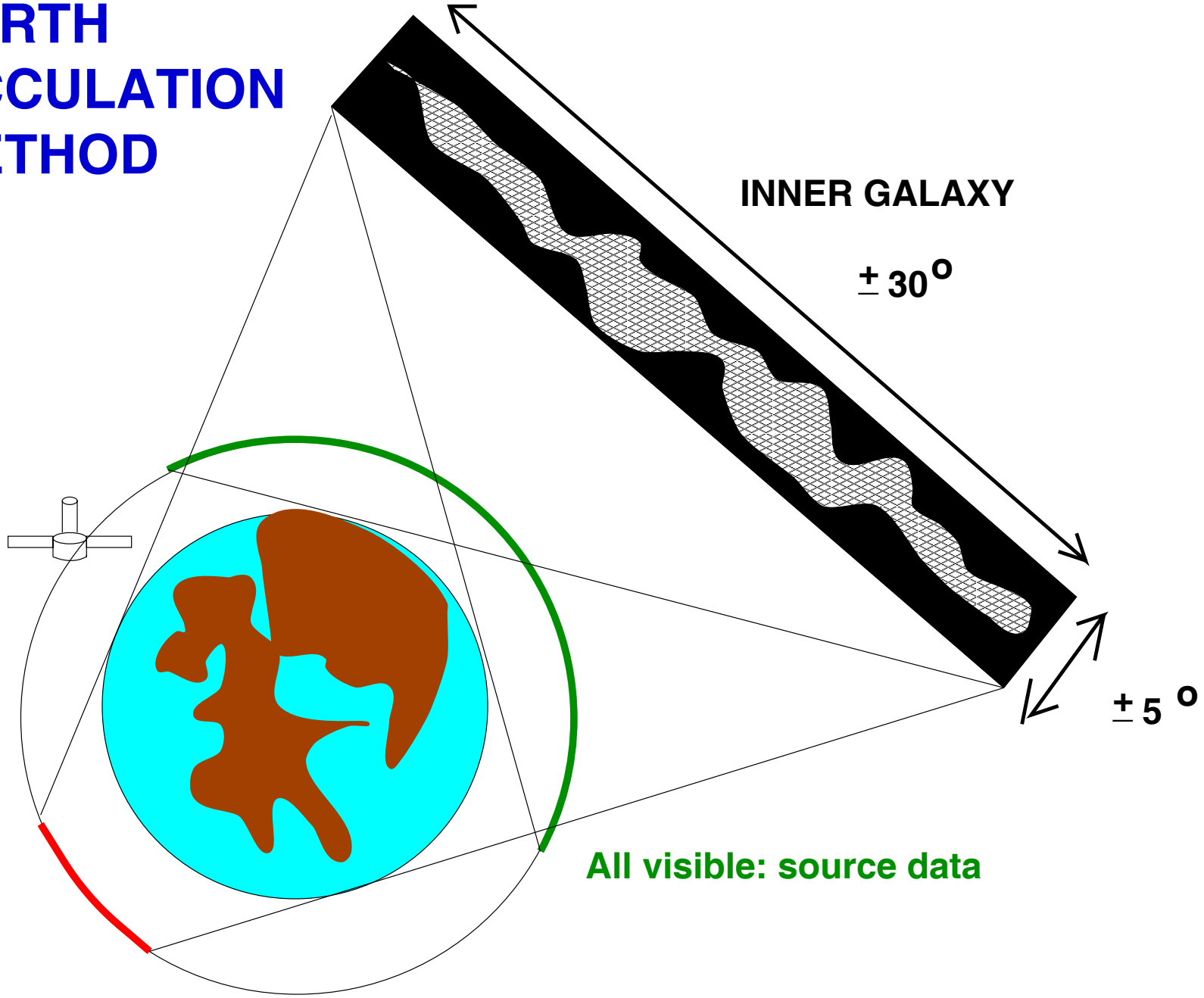
- How does it stay fast for such a long time?

- Grains can stay fast longer, and can also be re-accelerated
  in supernova shocks

  (Chen et al. 1997, Proc. 2nd INTEGRAL workshop;
  Ellison, Drury & Meyer 1997, ApJ 487, 197;
  Lingenfelter, Ramaty & Kozlovsky 1998, ApJL 500, L153
  Sturner & Naya 1999, ApJ 526, 200) .

- Galactic rotation probably produces a Doppler broadening of < 1 keV
  (Gehrels & Chen 1996, A&AS 120, 331)

EARTH OCCULATION METHOD



BACKGROUND-SUBTRACTION ALGORITHM

SUM SPECTRA:
1 MINUTE,
8 DETECTORS

SELECT LOW-BACKGROUND PERIODS

CORRECT GAIN FOR EACH SPECTRUM

INNER GALAXY IS VISIBLE

INTERPOLATE BACKGROUND FROM DATABASE

SUM ALL SOURCE

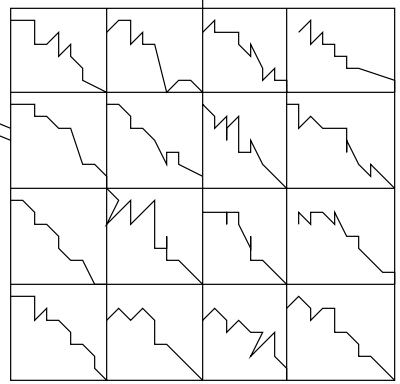
SUM ALL BACKGROUND

MAKE FINAL GAIN CORRECTION USING BACKGROUND LINES IN SUMMED SPECTRA

SUBTRACT BACKGROUND FROM SOURCE

INNER GALAXY IS NOT VISIBLE

SORT SPECTRA INTO BINS BY TWO ORBITAL PARAMETERS



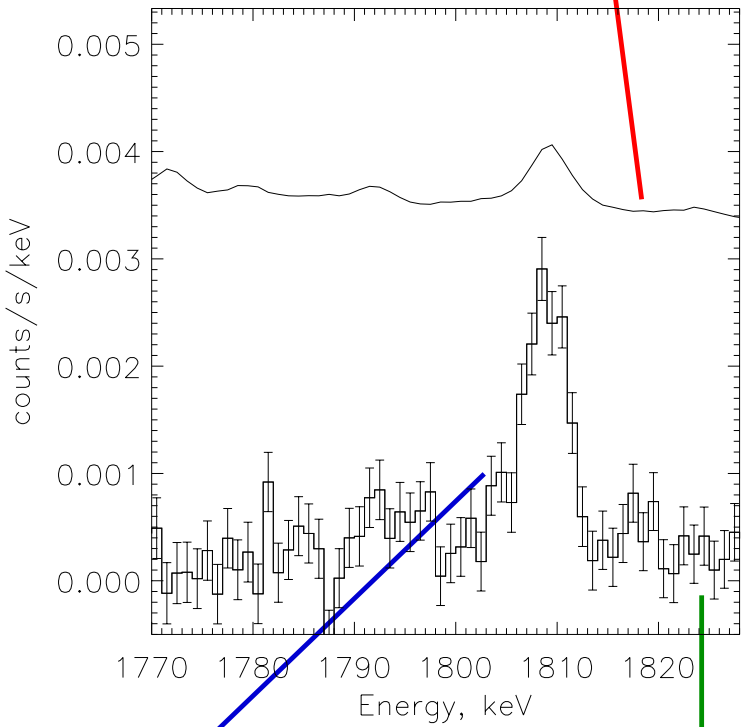
LONGITUDE OF ASCENDING NODE

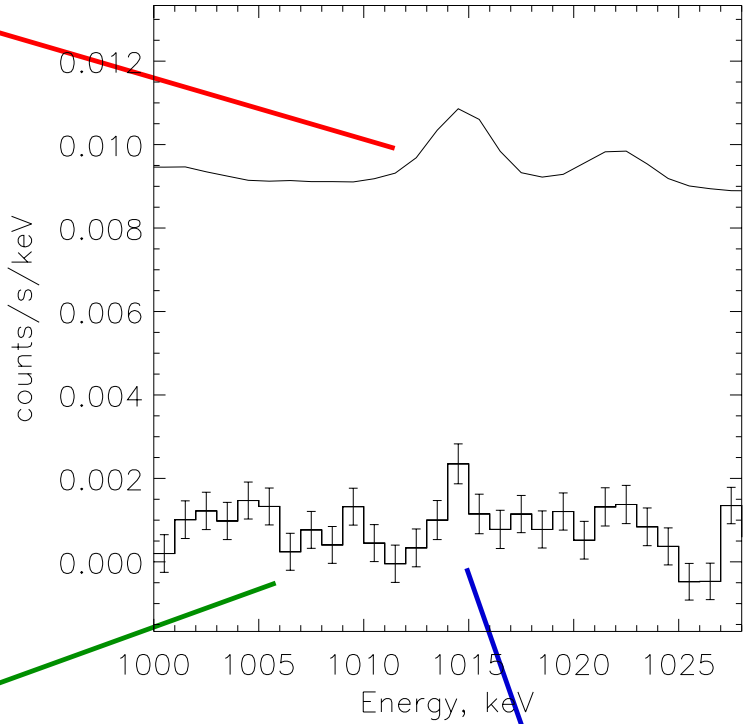
ORBITAL PHASE SINCE ASCENDING NODE

RHESSI SPECTRA: 9 MONTHS OF DATA (3/02-11/02)

The 1014 keV background line, like the background line at 1809 keV, is a prompt line from cosmic-ray activation of aluminum in the spacecraft

3% of the background



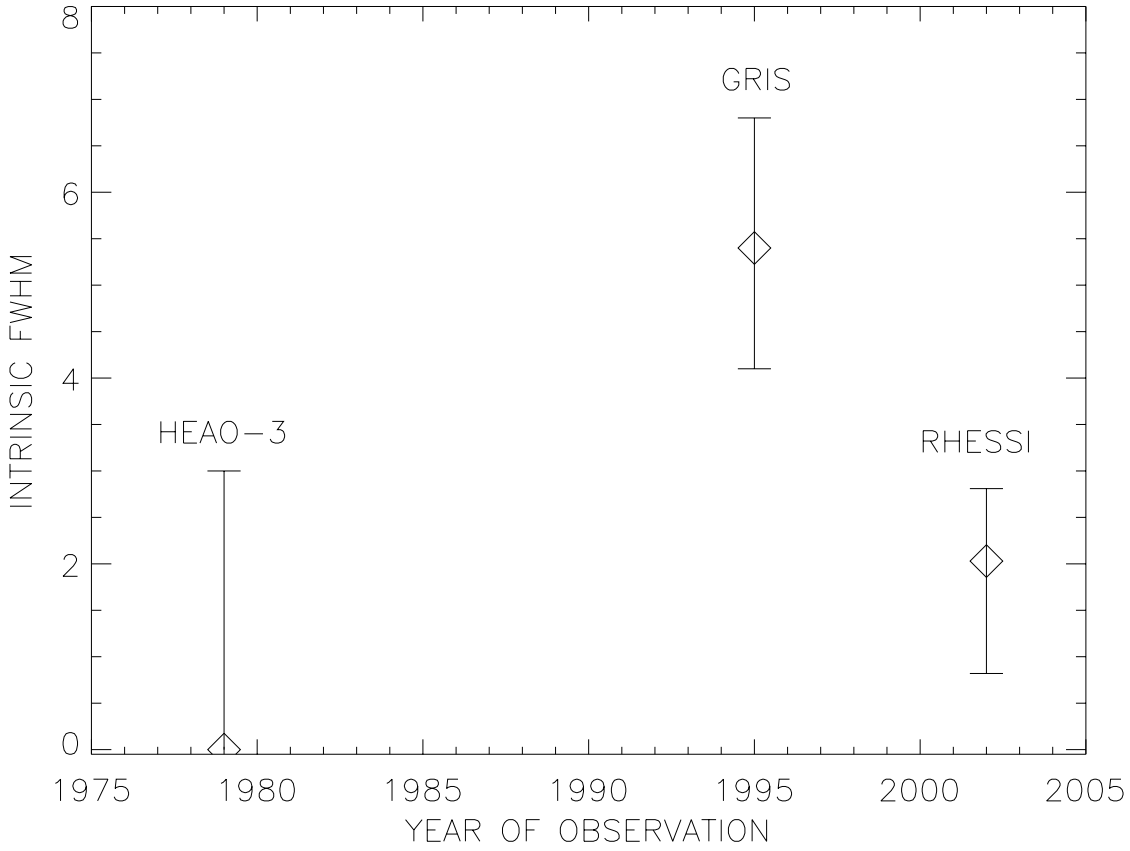


1809 keV line from Galactic 26Al

Background-subtracted spectra for the inner Galaxy

The 1014 keV line subtracts out well

WIDTH OF THE GALACTIC 1809 KEV LINE



HEAO-3:
W. A. Mahoney et al., 1984, ApJ 286, 578

GRIS:
J. E. Naya et al. 1996 Nature, 384, 44

THE THREE MOST SIGNIFICANT MEASUREMENTS OF THE WIDTH OF THE 1809 KEV LINE WITH HIGH-RESOLUTION INSTRUMENTS

Lines of ^{60}Fe

Expected from supernovae but not nove

Thus constrains production sites of 26Al

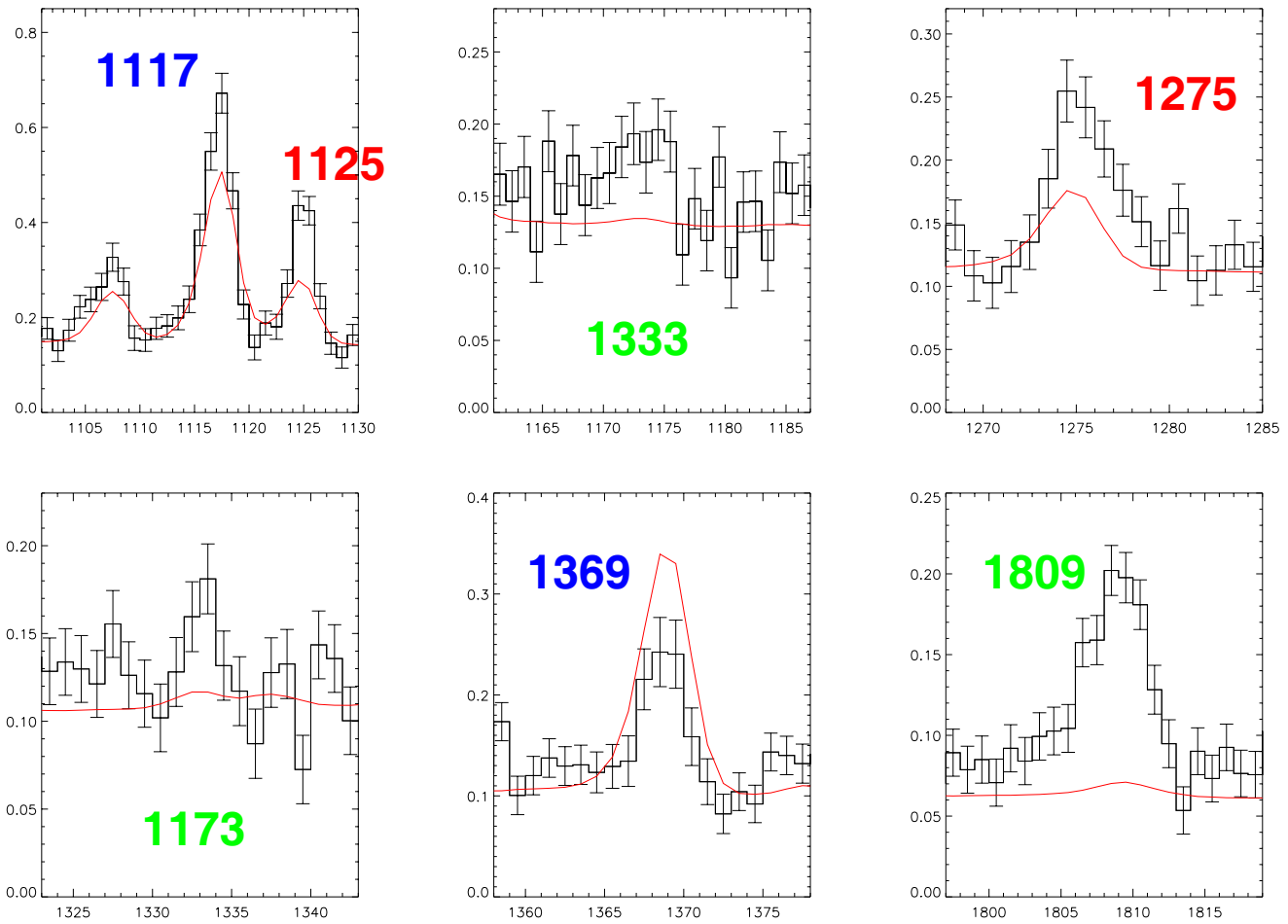
It has yet to be detected from the Galaxy

Upper limits (see Diehl and Timmes 1997, Proc. 4th Compton Symposium):

SMM (Leising and Share 1994)
GRIS (Naya et al. 1997)
Comptel (Diehl et al. 1997)
OSSE (Harris 1997)

LINES IN THE BACKGROUND SUBTRACTED SPECTRUM

RED CURVE IS 0.8% OF THE AVERAGE BACKGROUND

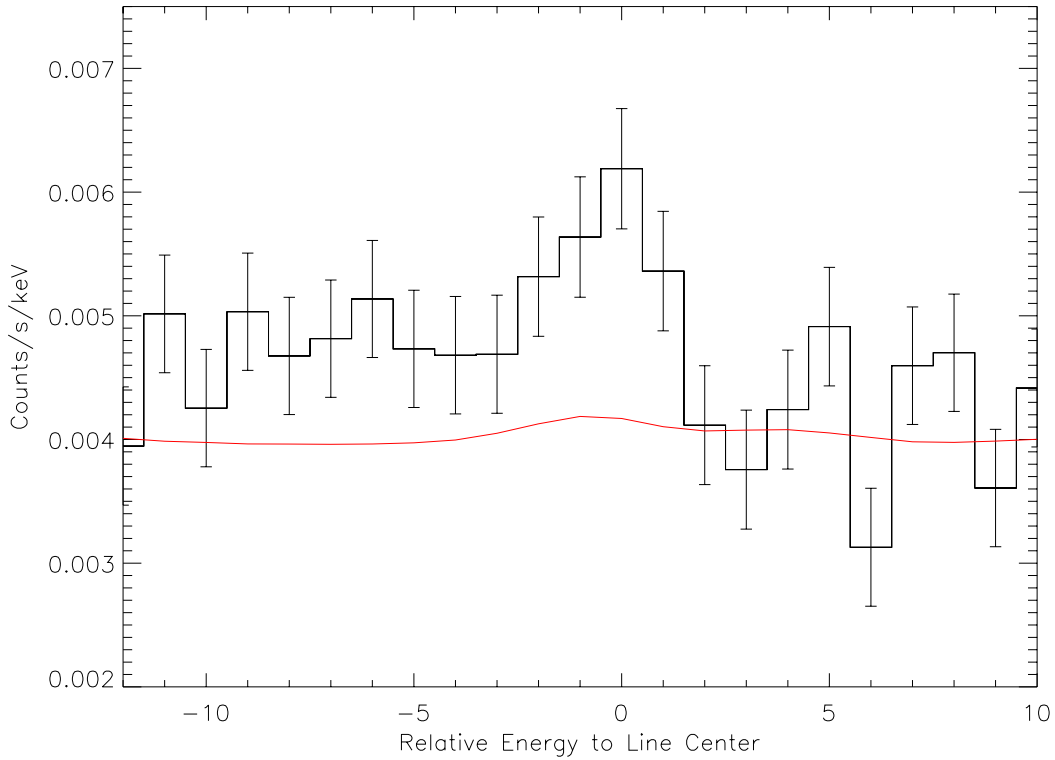


RED: LONG-LIVED BACKGROUND LINES -- KNOWN BUILDUP

BLUE: SHORT-LIVED BACKGROUND LINES: NEAR 0.8% EXCESS

GREEN: GALACTIC LINES (26 Al, 60Fe)

COMBINING THE TWO 60Fe LINES:



Flux per line for a point source:
(1.05 +/- 0.30) x 10-4 ph/cm2/s

Estimated undersubtraction of the background line
(0.8 +/- 0.4) %

Corrected flux and error:
(0.91 +/- 0.31) x 10-4 ph/cm2/s

26Al flux measured with RHESSI (Smith 2003, ApJL): (5.71 +/- 0.54) x 10-4 ph/cm2/s

60Fe/26Al line ratio is (15.9 +/- 5.6) %

This is consistent with 16 +/- 10% predicted by Timmes et al. 1995 (ApJ 449, 204) if most 26Al comes from supernovae!