A Possible Point Source of 2.2 MeV Gamma-Rays

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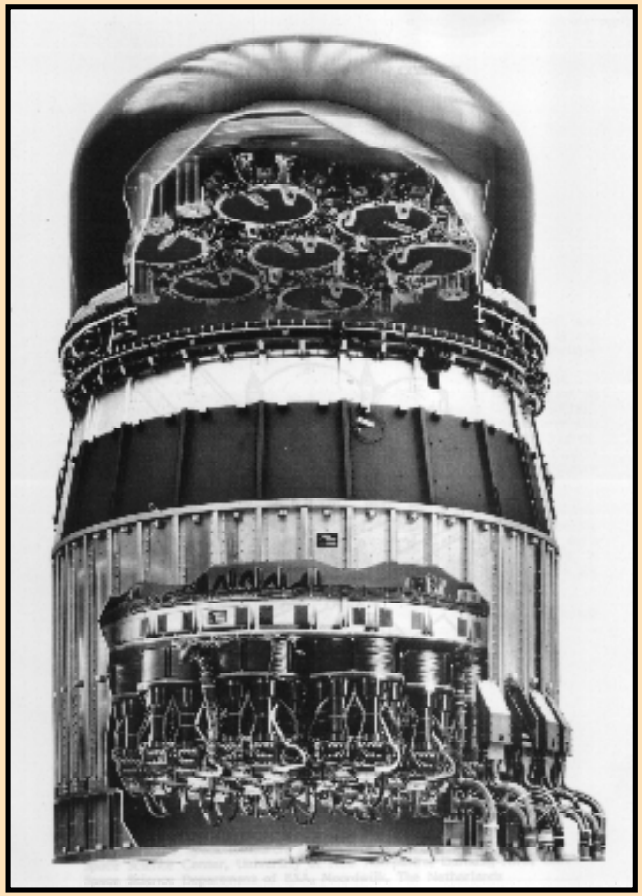


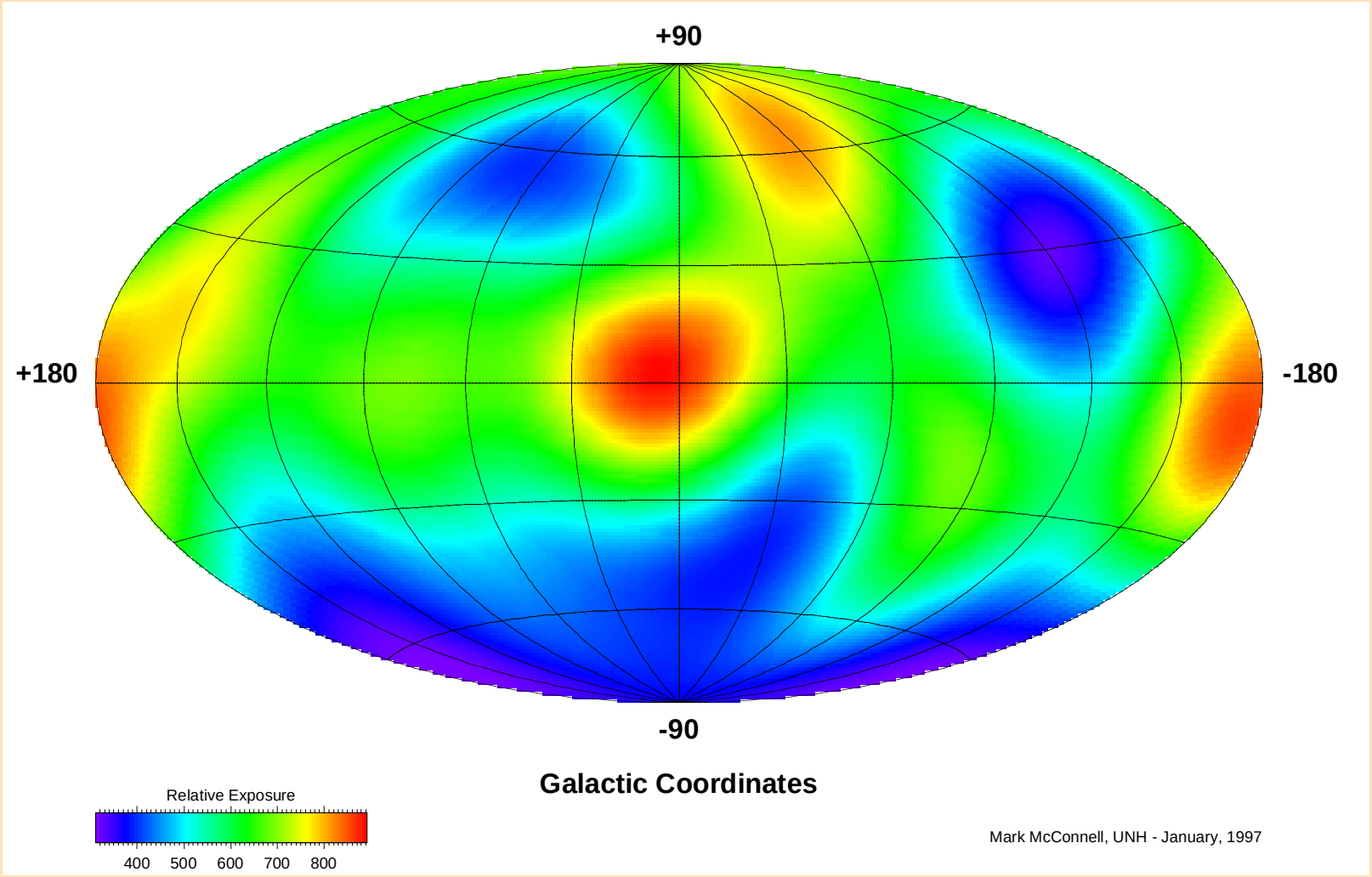
the COMPTEL experiment
on the Compton Gamma-Ray observatory

Scientific Motivation

- 2.223 MeV γ-ray emission from neutron capture on hydrogen.
- Requires a supply of free neutrons and a hydrogen target.
- In a solar flare:
  - a supply of neutrons results from interactions of accelerated ions
  - hydrogen target is supplied by the photosphere
- In an X-ray binary system:
  - a supply of neutrons can be generated within the accretion disk or perhaps as a result of particle acceleration processes.
  - hydrogen target can be provided by companion star or the outer regions of an accretion disk (for *unshifted* 2.2 MeV emission).
  - hydrogen target can alternatively be provided by neutron star surface or inner accretion disk (for *redshifted* 2.2 MeV emission)

COMPTEL Exposure at 2.2 MeV

VPs 1.0 - 523.0 (April, 1991 - July, 1996)

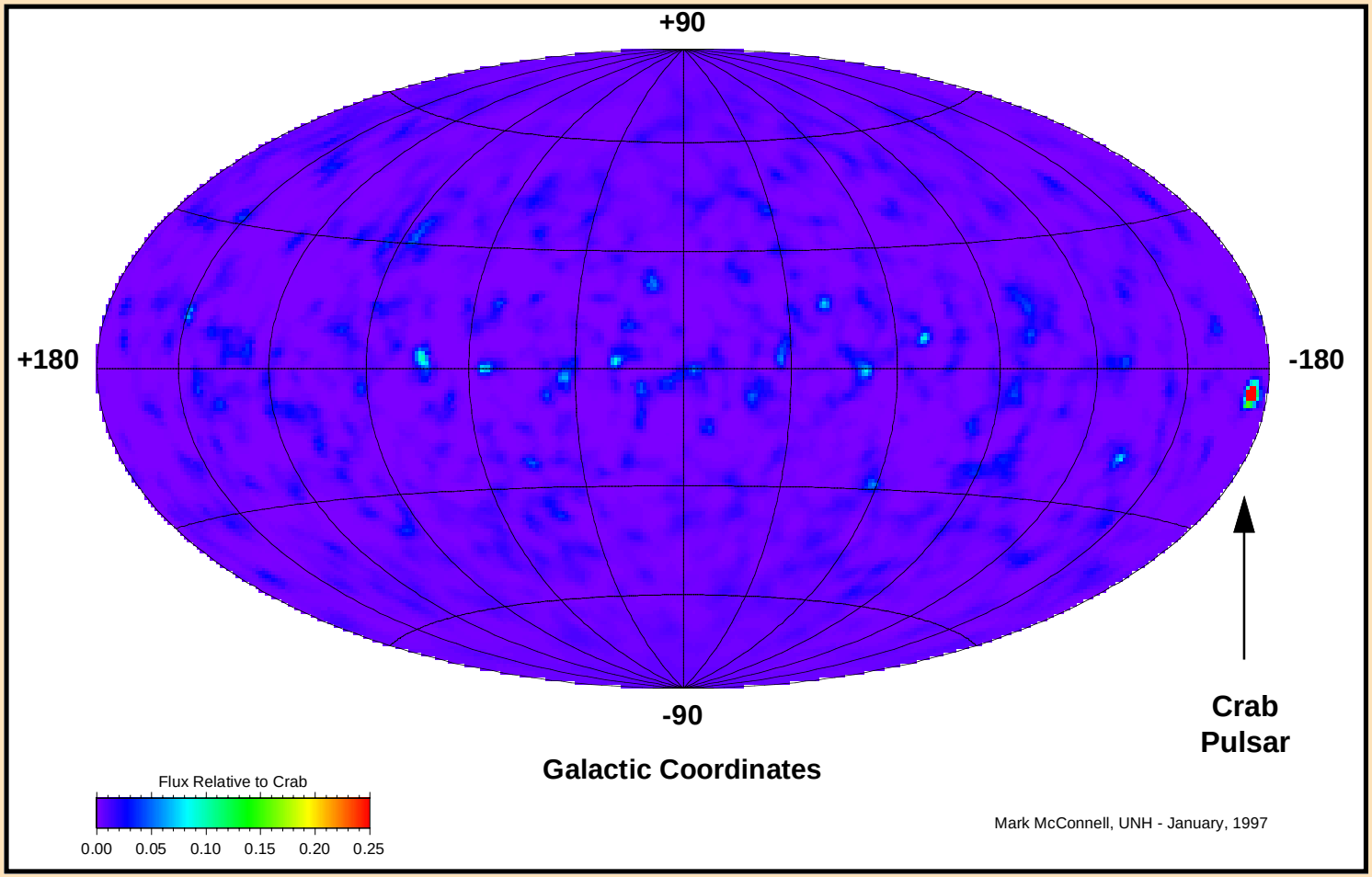


Methodology

- COMPTEL imaging depends critically on background estimation.
- Present approach follows that used in the analysis of 1.8 MeV data (^{26}Al).
- Background is modeled using data from adjacent energy bands.
- The background model incorporates continuum emissions, so that only sources of line emission will be evident in the images.
- Images generated using both maximum entropy and maximum likelihood methods.
- Validation of this approach at 2.2 MeV using:
  - ① Imaging of the Crab pulsar (no emission expected).
  - ② Imaging of the solar flare of June11, 1991 (prominent 2.2 MeV line emission).

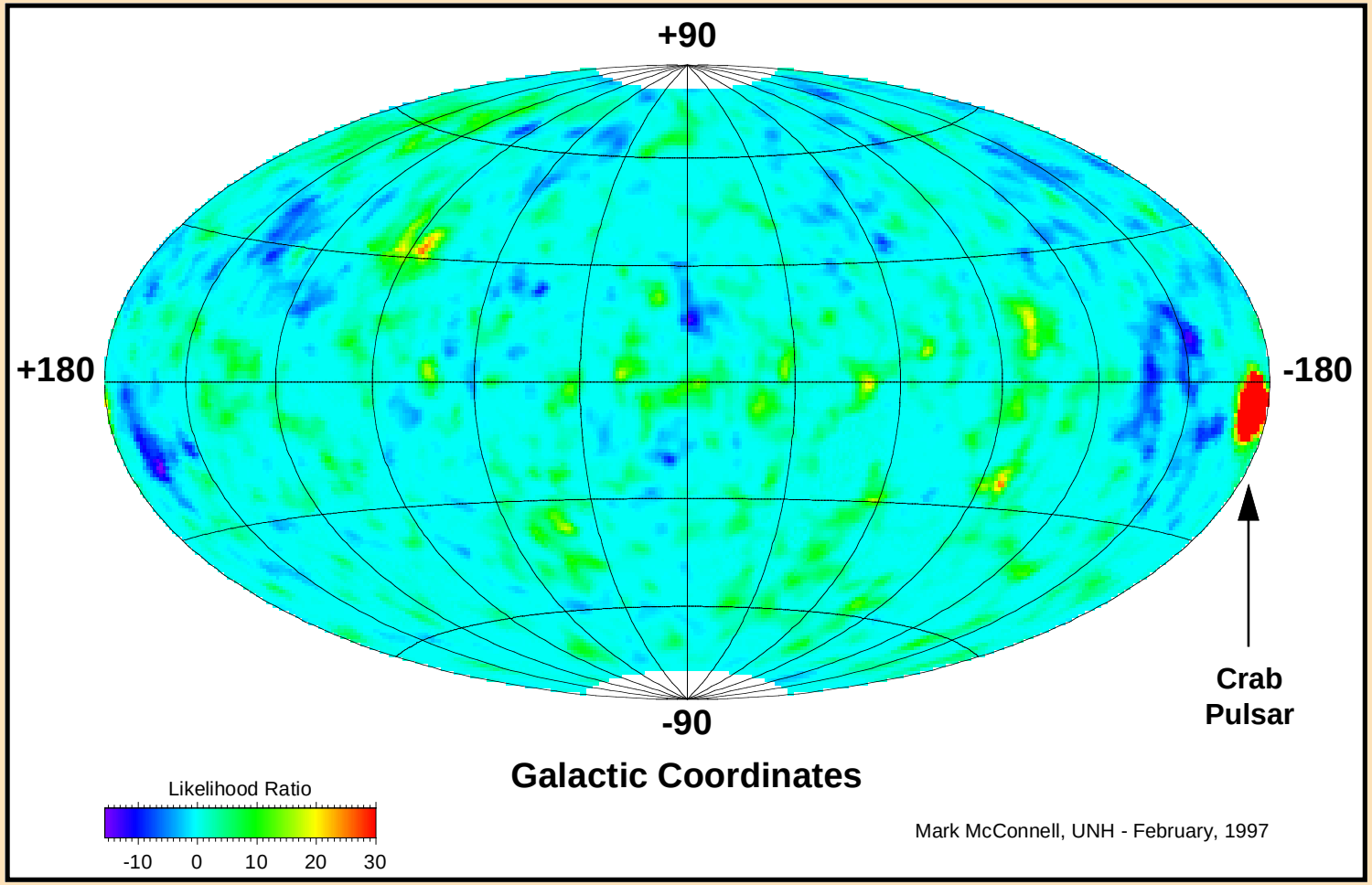
Continuum Emission Map

Maximum Entropy Imaging, 2.110 – 2.336 MeV



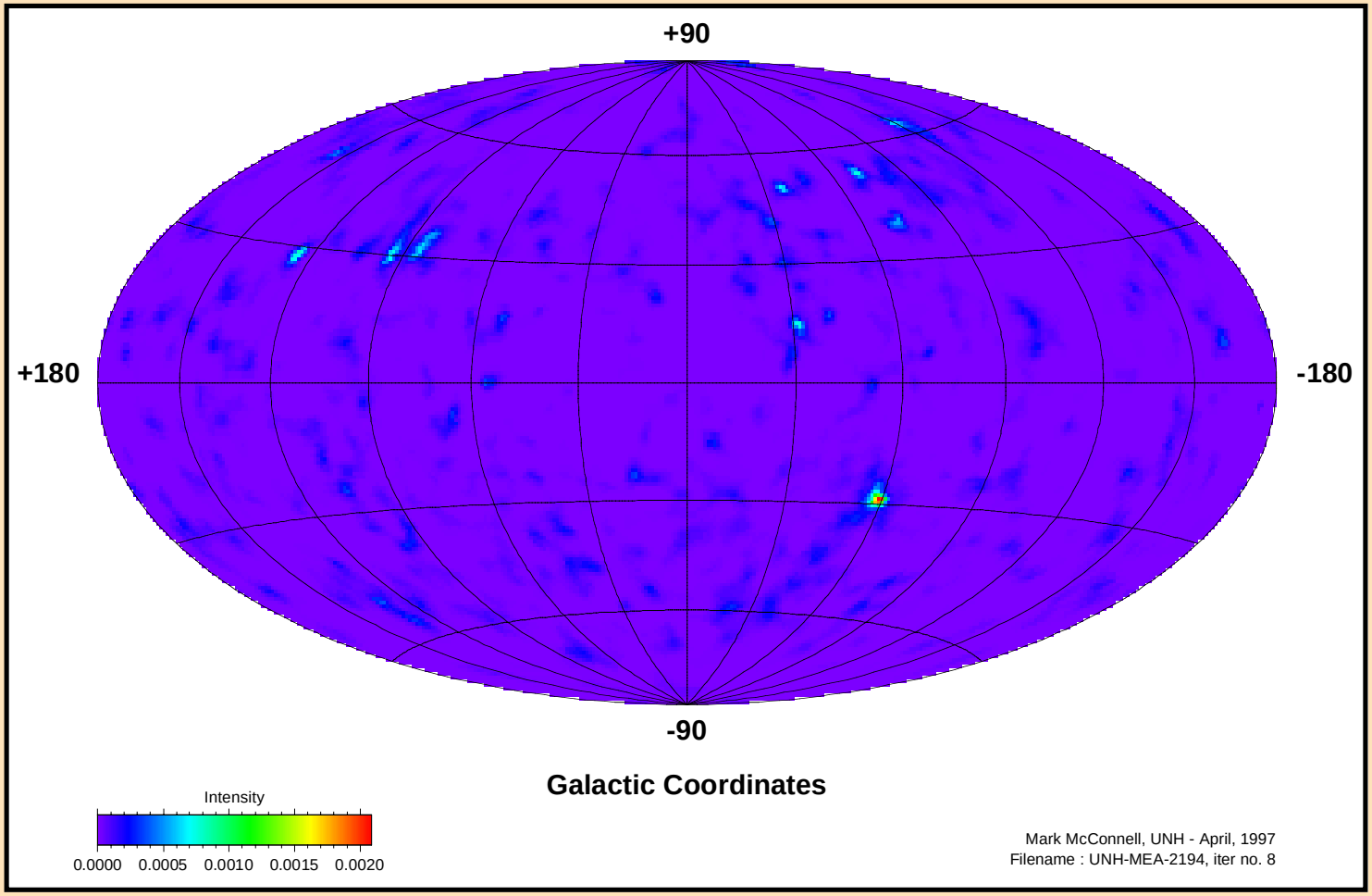
Continuum Emission Map

Maximum Likelihood Imaging, 2.110 – 2.336 MeV



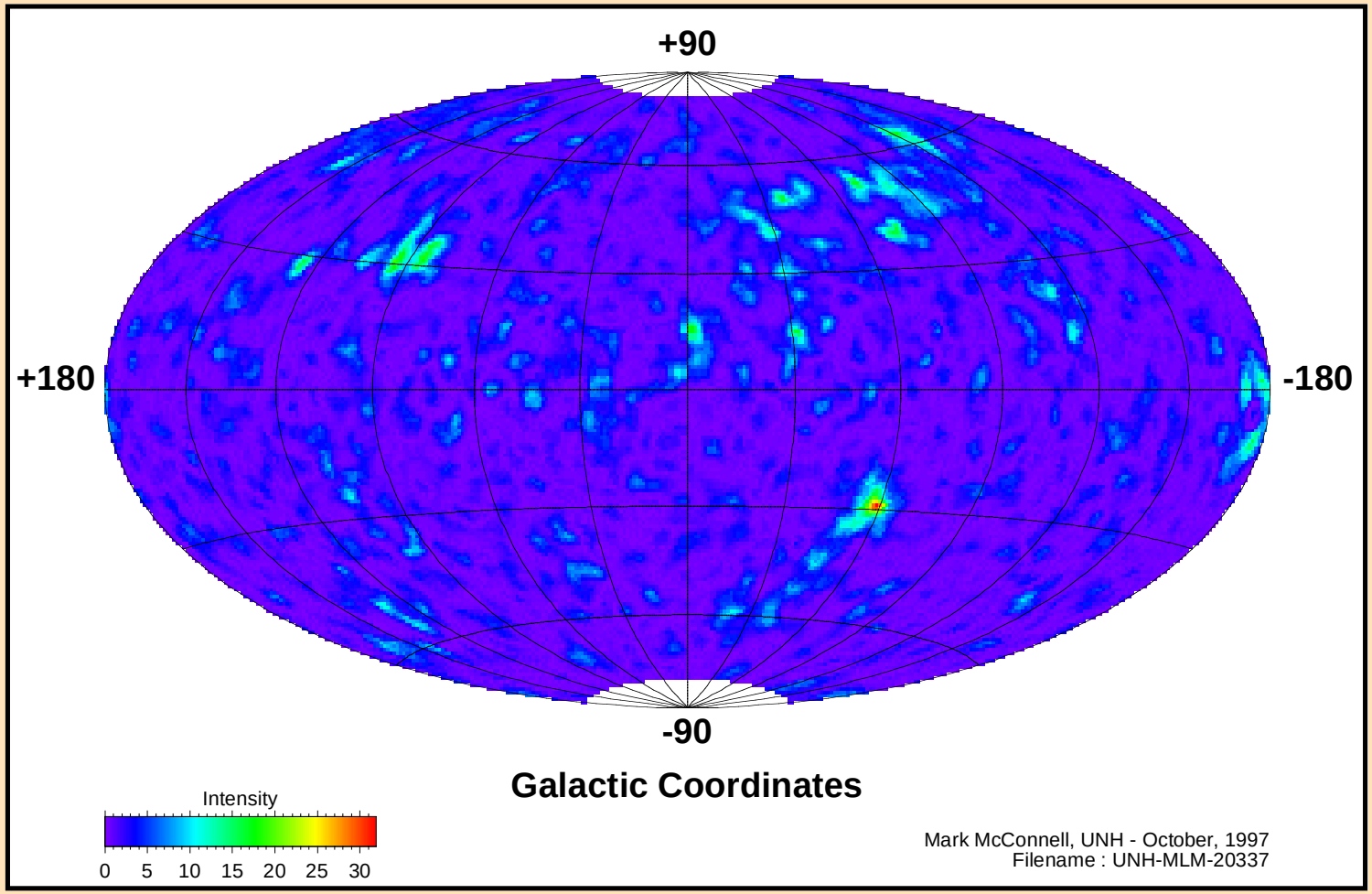
Line Emission Map

Maximum Entropy Imaging, 2.110 – 2.336 MeV



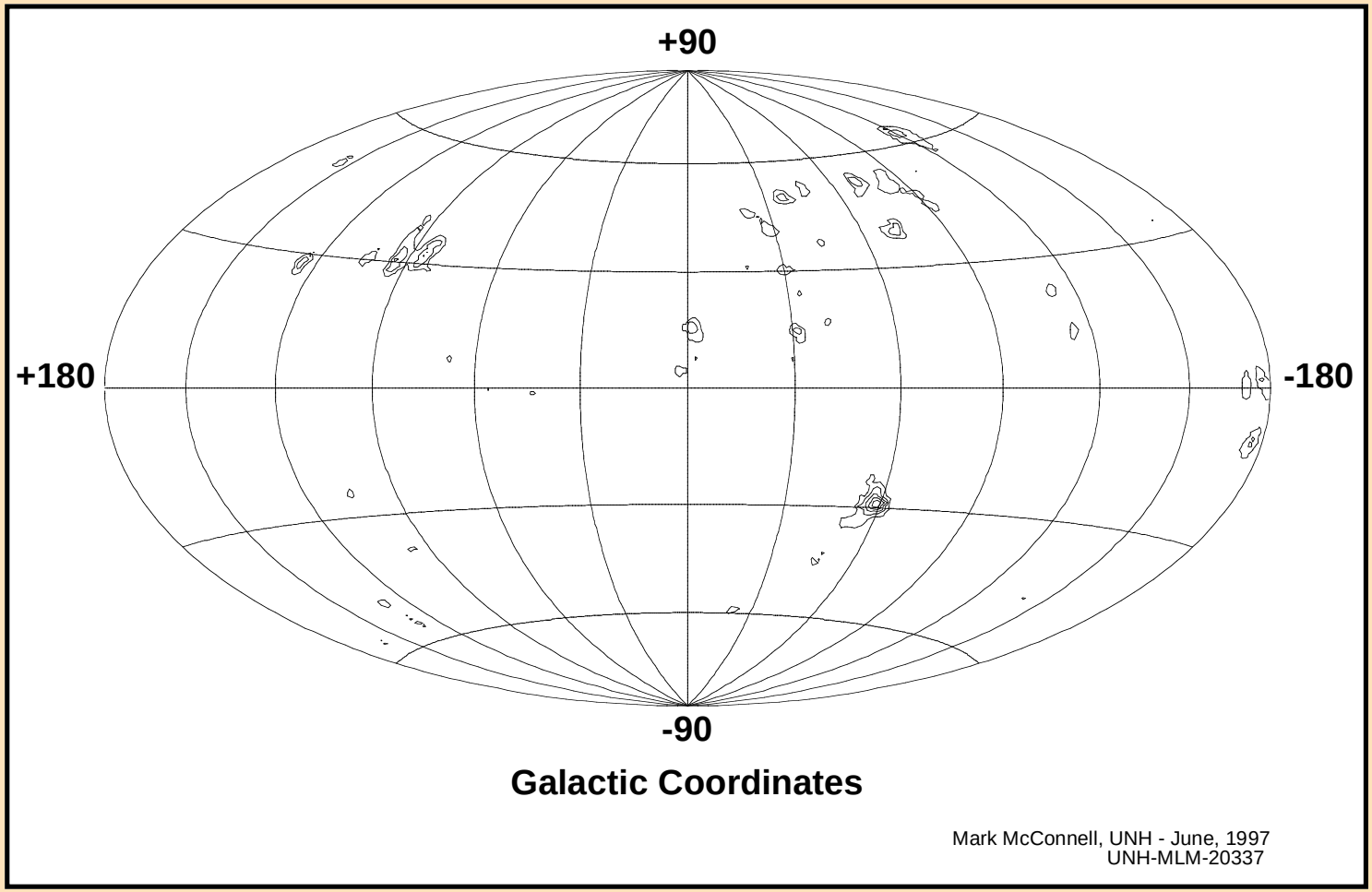
Line Emission Map

Maximum Likelihood Imaging, 2.110 – 2.336 MeV

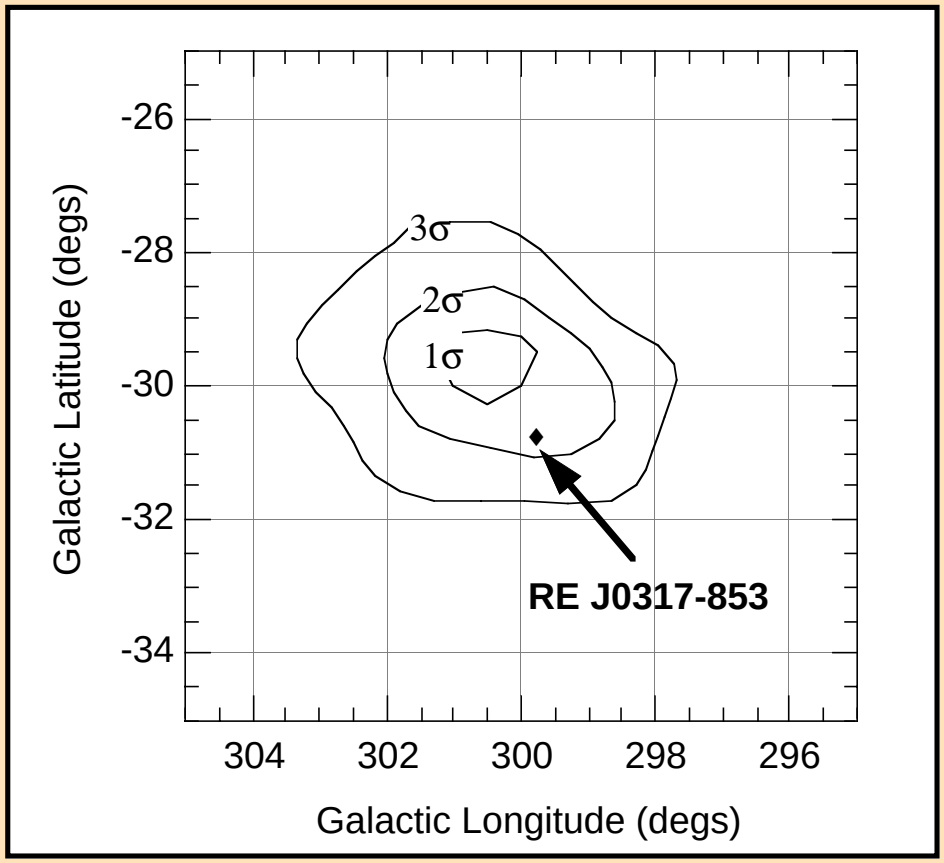


Line Emission Map

Maximum Likelihood Imaging, 2.110 – 2.336 MeV
likelihood contour threshold = 9.0



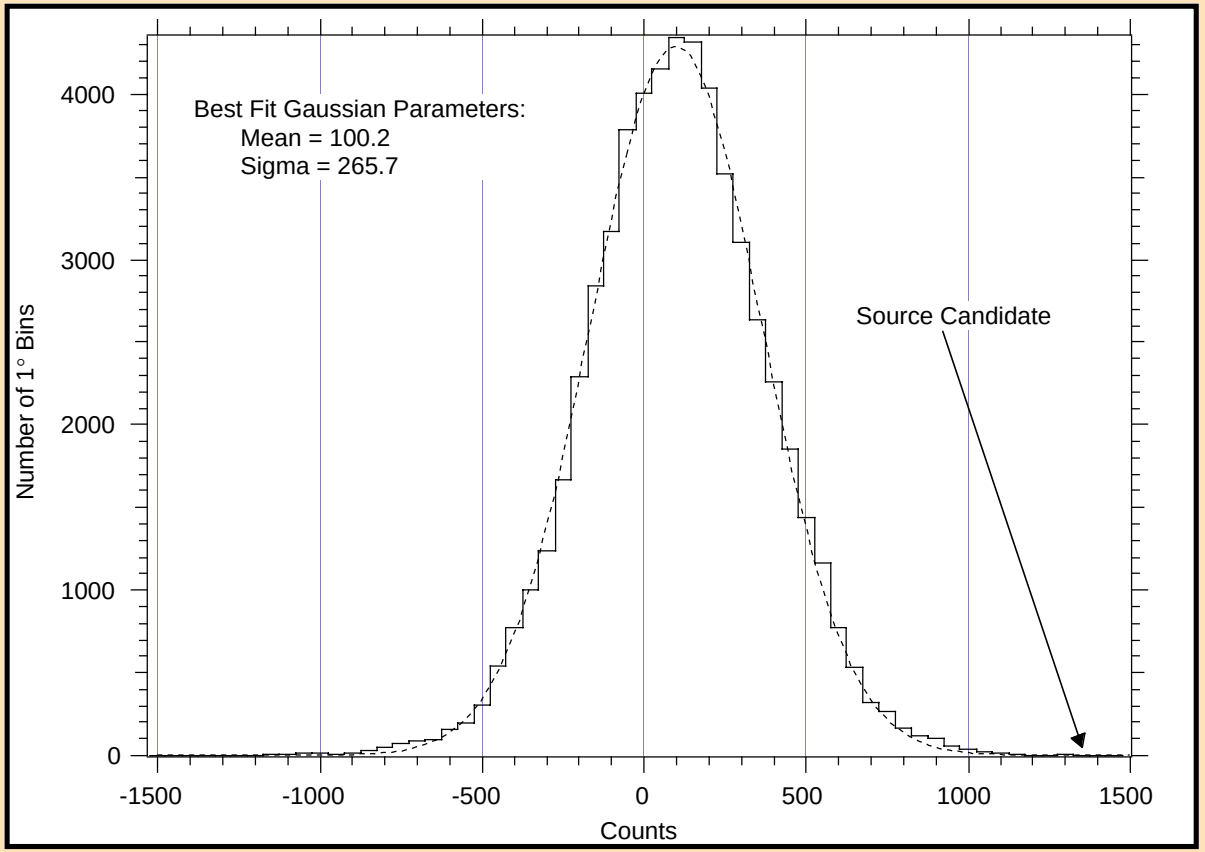
2.2 MeV Source Candidate



- **Only significant feature is a point source near (l,b) = (300.5°, -29.6°).**
- **Peak likelihood value = 31.9.**
- **For a single trial => 5.7σ.**
- **All-sky survey (500 trials) => 3.7σ.**
- **Line flux = 1.7 ($\pm$0.4) $\times$ 10^{-4} cm^{-2} s^{-1}.**
- **Consistent with constant flux.**

Statistics of All-Sky Map

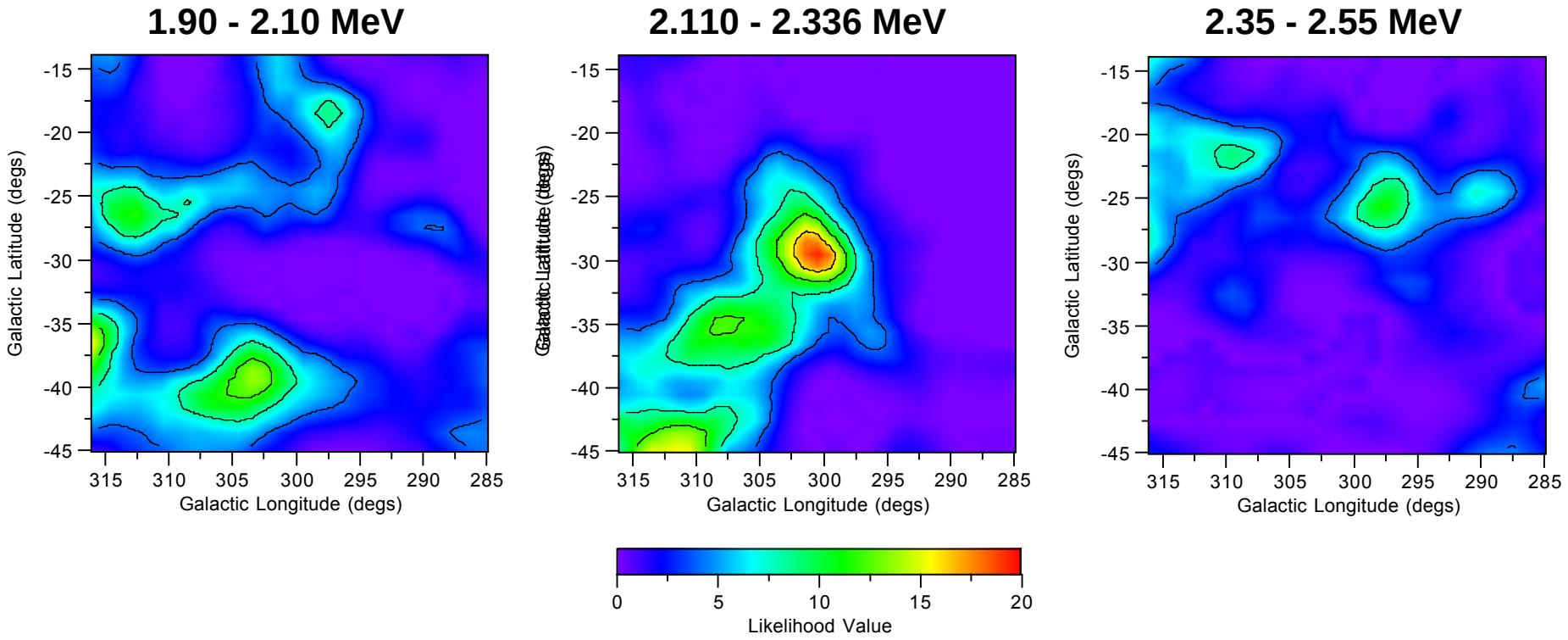
Source candidate (1308 counts) lies well out in the tail of the distribution, 4.5σ from the peak of the distribution.



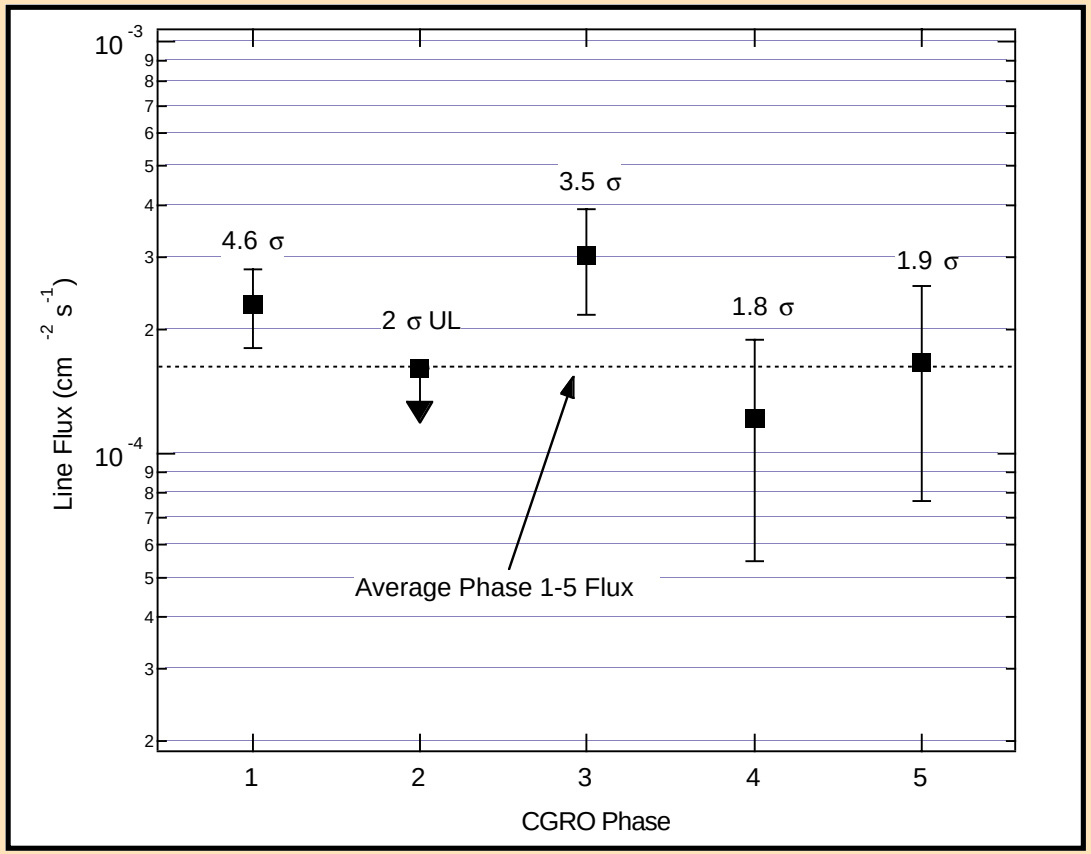
Source Candidate - Continuum Maps

These images were generated using standard COMPTEL methods.
They show all of the emission (line plus continuum) in each energy interval.

The source appears in the line interval, but not in the adjacent energy intervals.



Source Candidate - Flux History



Consistent with constant flux

Phase 1 Exp = 9.87 days
Phase 2 Exp = 2.32 days
Phase 3 Exp = 3.36 days
Phase 4 Exp = 6.56 days
Phase 5 Exp = 3.50 days

A White Dwarf Counterpart???

- Within 3σ contour, there are 11 sources in the ROSAT All-Sky Survey.
- None of these corresponds to any known XRB, CV or AGN.
- The most interesting source is RE J0317-853:
  - ✔ Brightest X-ray source in error box
  - ✔ Only extreme UV source in error box (ROSAT and EUVE)
  - ✔ One of the strongest white dwarf B-fields (340 MG)
  - ✔ One of the hottest known white dwarfs (50,000° K)
  - ✔ Rotation period of 725 sec
  - ✔ Circumstellar cloud of highly ionized heavy elements
  - ✔ Relatively nearby (~35 pc)
- Is this evidence for strong stellar flare activity on a white dwarf?!?
  - ✔ 2.2 MeV emission often dominates solar flare gamma-ray spectra
  - ✔ Observed flux corresponds to L ~ 10^{32} ergs s^{-1}.
  - ✔ Typical solar flare energy release (in a 100 G field) is ~10^{32} ergs.

Future Work

The gamma-ray source is weak in significance.
Further confirmation would be valuable.

- **Continued analysis of COMPTEL data using additional data and alternative (i.e., non-imaging) analysis technqiues.**
- **Additional COMPTEL observation (2 weeks) in June, 1998.**
- **OSSE data will also be collected (for the first time).**
- **RXTE scanning observation is also planned for early 1998.**