LETGS: A look at the plus and minus orders

Martin C. Weisskopf

NASA/MSFC

Introduction

- Observation of the Crab Pulsar
    - ObsID 759
    - hrcf00759N003_evt2.fits
- Detailed analysis of the continuum spectrum with plus and minus orders combined completed and documented in paper accepted for publication in ApJ - see astroph/0310332
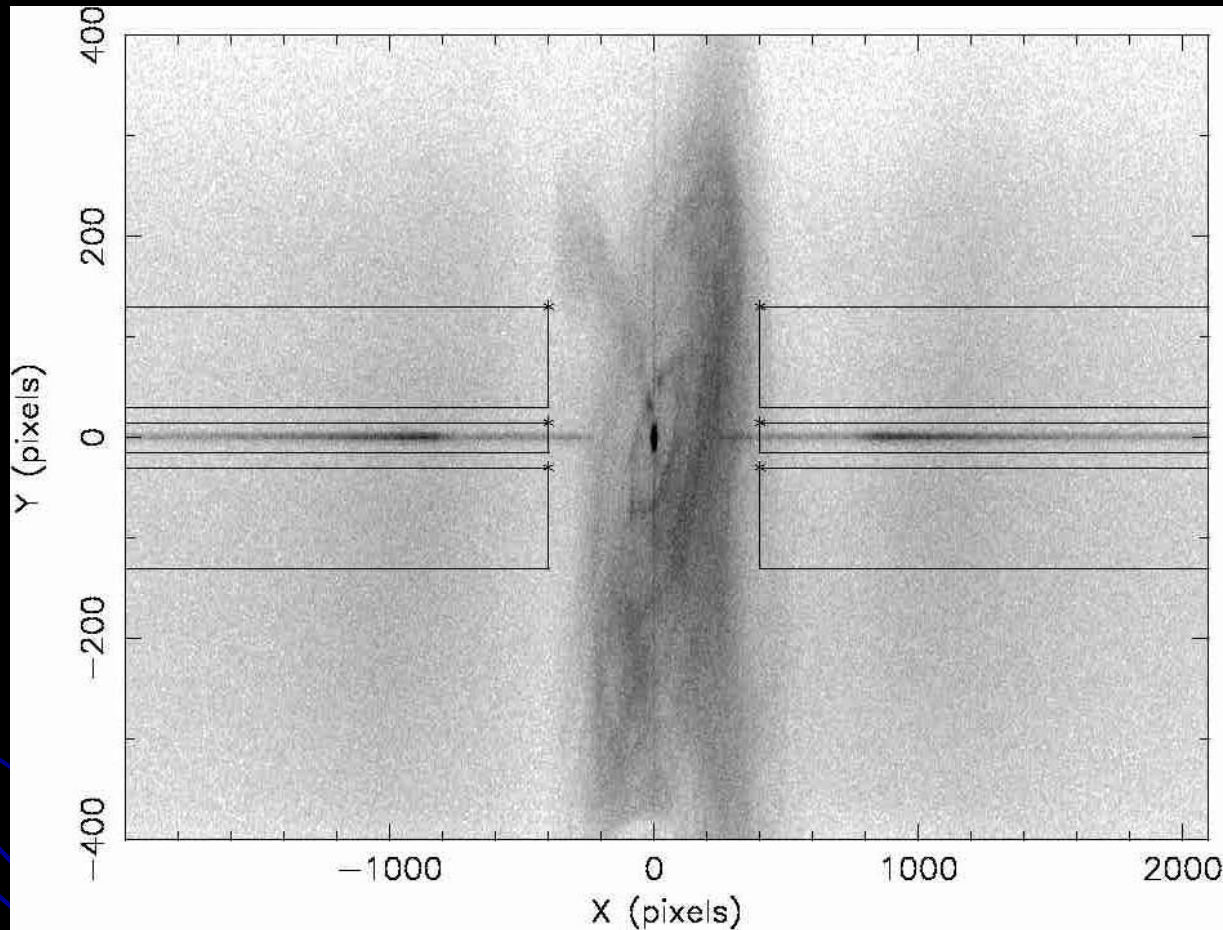
Notes

- Analysis restricted to the energy range 0.3-4.2 keV

- The upper energy limit chosen to limit contamination from the zeroth-order nebular image (Fig 1)

- The lower energy limit chosen to minimize the degree of contamination from higher orders (Fig 2)
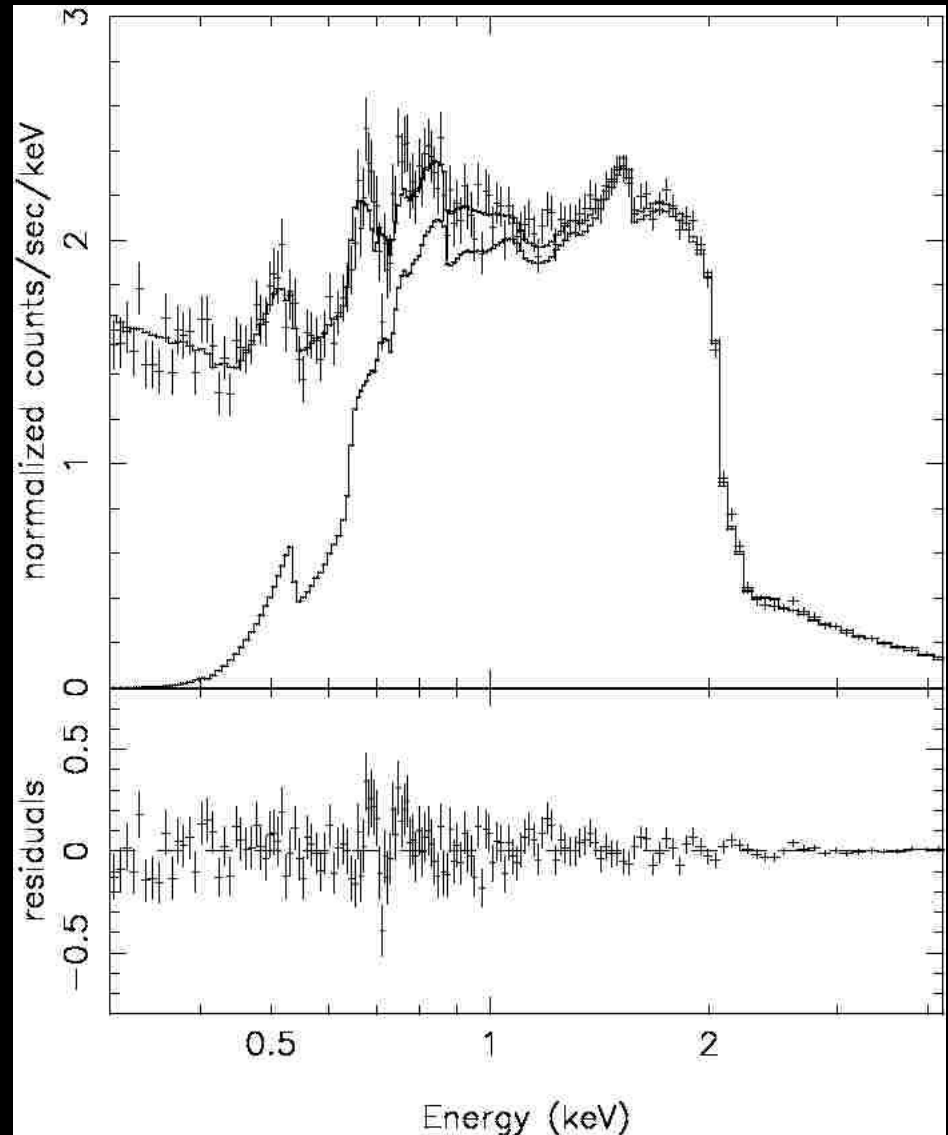
Figure 1

Stretched for clarity. Boxes show regions selected for signal (narrowest) and background.
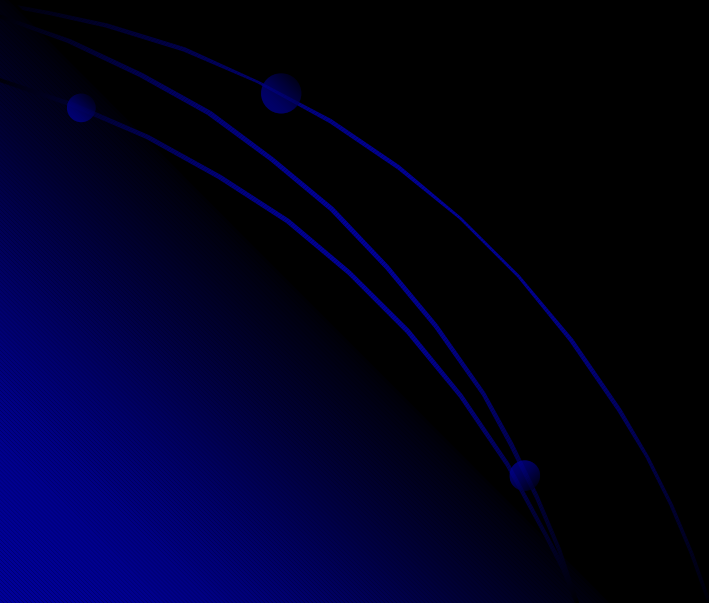
Figure 2

LETGS spectrum of the Crab Pulsar compared to a model (XSPEC: wilm & tbvarabs with thawed oxygen abundance and fixed amount of dust scattering). The lower solid line shows the model including only the first order response.

Plus and Minus Orders Combined

- Power law fit shown in Figure 1 with plus and minus orders added was excellent with χ^2 of 1539 on 1552 degrees of freedom

Plus and Minus Orders Separated

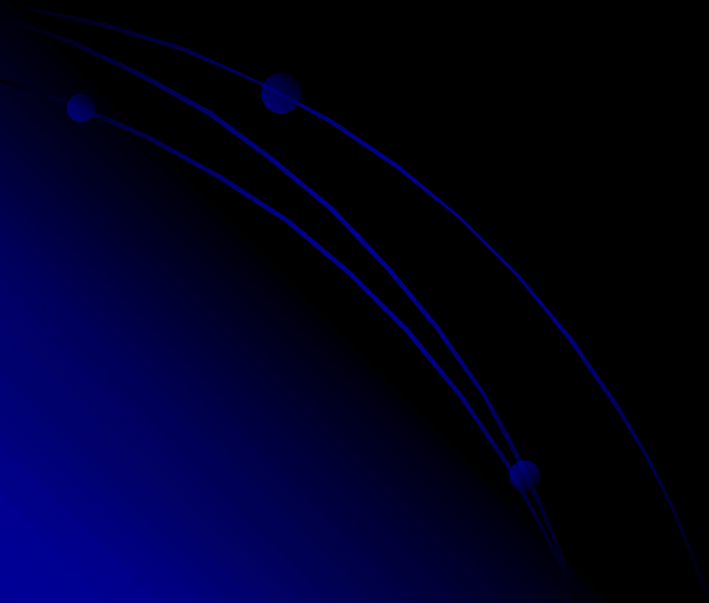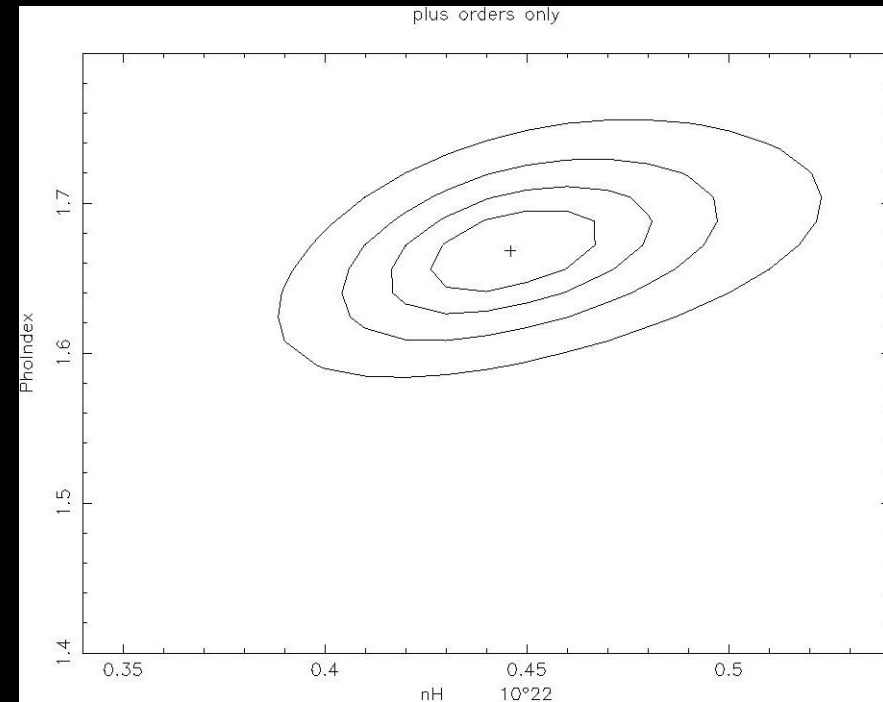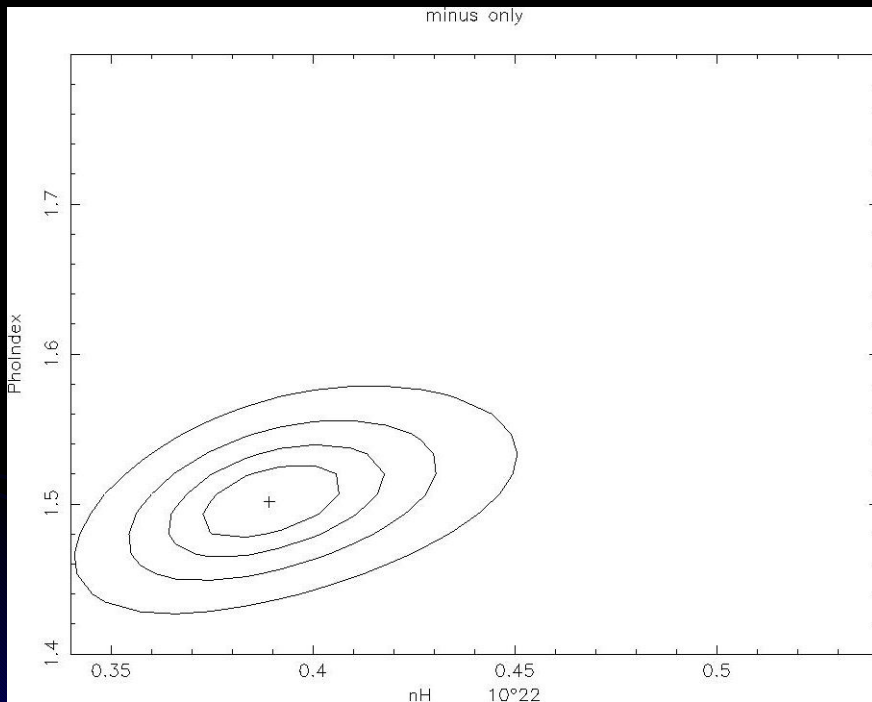- Fits do not give same answers (Fig 3)!?!

Figure 3

Confidence contours for chi-squared minimum plus 1, 2.3, 4.61, 9.21. Left: minus orders (χ^2 = 1215 , ν = 1142). Right: plus orders (χ^2 = 1168 , ν = 1169

Next steps

- Analyze in two energy bands
  - 0.3-1.5 sensitive to higher orders (see Fig 1)
  - 1.5-4.2 sensitive to first order (see Fig 1)
- If, e.g. problem with higher orders then expect higher energy band to give identical results
- Results in Table 1

Table 1
Powerlaw Index

	Plus Order	Minus Order
0.3-1.5 keV	1.54 (0.10)	1.72 (0.09)
1.5-4.2 keV	1.74 (0.11)	1.49 (0.10)

Other Considerations & Conclusion

- Choice of background region
  - No impact
- Offset of zero order position
  - Yes – but requires huge offsets
- Cross-correlation of plus and minus orders
  - Peaked at zero and appears symmetric
- Conclude problem(s) in response functions used