So you think the Crab is described by a powerlaw spectrum and other considerations: a presentation in two parts

I. Matteo Guianari, Keith Jahoda, Nikolai Shaposhnikov, Steve O’Dell, Slava Zavlin, Colleen Wilson-Hodge & Ron Elsner
II. Allyn Tennant, Steve O’Dell & Ron Elsner

Martin C. Weisskopf

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I have invested all of my self-esteem in this PowerPoint presentation.

It is all that I am and all that I will be. It is a digital reckoning of my value.

DID THEY CATCH THE CHIMP WHO MADE YOUR SLIDES?

Ow. Ow. Ow.
I. So you think the Crab is described by a powerlaw spectrum!
We examine the consequences for three observatories under two hypotheses:

- Rosat/PSPC (0.1-2.4 keV)
- RXTE/PCA (3-60 keV)
- XMM-Newton/EPIC-pn in burst mode (0.3-10.0 keV)

- The X-ray spectrum is described by a powerlaw
- The X-ray spectrum is not a powerlaw
What is the spectrum anyway?

Zhang, Chen, Feng (2008)
There is also Volpi et al. 2008

Model V

Model Z
ROSAT/PSPC (0.1–2.4 keV) – the fit to a powerlaw is terrible!

$\chi^2/\nu = 3343/227$
\( \chi^2 / \nu = 331 / 116 \)
ROSAT/PSPC – simulations indicate that the bad fits are **not** a consequence of hypothesis 1

<table>
<thead>
<tr>
<th>Z</th>
<th>Counts/106</th>
<th>$\chi^2/\nu$</th>
<th>$\Gamma$</th>
<th>$N_H/10^{22}$</th>
<th>[O]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.16</td>
<td>(228±21)/227</td>
<td>2.1921 ±0.0063</td>
<td>0.4210 ±0.0020</td>
<td>0.678 ±0.016</td>
</tr>
<tr>
<td></td>
<td>6.16</td>
<td>(229±22)/227</td>
<td>2.0701 ±0.0057</td>
<td>0.4214 ±0.0021</td>
<td>0.670 ±0.013</td>
</tr>
</tbody>
</table>
The simulations indicate that the Crab ought to appear as a powerlaw to the instrument over the 0.1 to 2.4 keV band.

The response function is inaccurate at the 20% level over the full band.

The response function is inaccurate at the 1% level over the reduced (0.5-1.7 keV) band.

Rosat/PSPC data should **not** be used to establish powerlaw parameters.
XMM-Newton Epic-pn (bm)–analysis covering 0.3–10.0 keV yields poor fit

\[ \chi^2/\nu = 2386/1860 \]

\[ (\chi^2-\nu)/(2\nu)^{1/2} = 8.6 \]
$\chi^2/\nu = 1568/1200$

$(\chi^2 - \nu)/(2\nu)^{1/2} = 9.2$
### XMM/EPIC-pn (bm) – What do the models say?

<table>
<thead>
<tr>
<th>Counts/10⁶</th>
<th>$\chi^2/\nu$</th>
<th>$\Gamma$</th>
<th>$N_H/10^{22}$</th>
<th>[O]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>2.44</td>
<td>(1877 ±62)/1860</td>
<td>2.1991 ±0.0026</td>
<td>0.440 ±0.019</td>
</tr>
<tr>
<td>V</td>
<td>2.44</td>
<td>(2038 ±74)/1860</td>
<td>2.1143 ±0.0023</td>
<td>0.524 ±0.020</td>
</tr>
</tbody>
</table>

**V:** \( \frac{(\chi^2 - \nu)}{(2 \nu)^{1/2}} = 2.9 \)
The 1.0-7.0 keV response does not yield an acceptable fit of a powerlaw to the Crab data.

The Z and V models for the Crab spectrum would imply that both fits should be acceptable.

There are problems with the response function at the few percent level at the instrument edges.

Full-band data should not be used to establish powerlaw parameters.
RXTE/PCA – Latest version of response gives good fit!

\( \chi^2/\nu = 166/86 \)

\( N_H \equiv 0.42 \times 10^{22} \text{ cm}^2 \)

[O] \equiv 0.676
### RXTE/PSPC - What do the models say?

<table>
<thead>
<tr>
<th>Counts/10^6</th>
<th>( \chi^2 / \nu )</th>
<th>( \Gamma )</th>
<th>( N_H / 10^{22} )</th>
<th>[O]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>6.66</td>
<td>(89\pm13)/86</td>
<td>2.1958 \pm0.0007</td>
<td>0.42 (fixed)</td>
</tr>
<tr>
<td>V</td>
<td>6.66</td>
<td>(3084\pm112)/86</td>
<td>2.22</td>
<td>0.42 (fixed)</td>
</tr>
</tbody>
</table>
The 3-60 keV response yields an acceptable fit of a powerlaw to the Crab data.

The Z model for the Crab spectrum would imply that the fit should be acceptable, but the V model the opposite.

Hmmmm
II. The Crab Pulsar and the LETG

- Project to perform pulse-phased spectroscopy of the pulsar
- Acquired new data (blade in)
- CIAO responses have evolved
- Using updated HRC-QE maps
- Something(s) is (are) peculiar
The contribution of the higher orders simply cannot be correct (arf="try")

\[ \chi^2/\nu = 1883/1810 \]
Comparison with SRON’s arfs
Comparison with SRON’s arfs
Fifth Order
Comparison with SRON’s arfs
Fifth Order