Non-thermal WG summary

Kristin Madsen on behalf of Lorenzo Natalucci
Integral - The Crab

• Integral/SPI is tracking the same source variations as the other observatories

• GRBM Band model is preferred by SPI over broken powerlaw

• The curvature could go all the way down to 20 keV
A(E) = \begin{cases} \frac{A(E)}{E/100}^{a_1} \exp(-E/E_c) & \text{if } E < E_c(a_1 - a_2) \\ \frac{A(E)}{E/100}^{(a_1 - a_2)}(E/100)^{a_3} \exp(-(a_1 - a_2)) & \text{if } E > E_c(a_1 - a_2) \end{cases}

GRBM, Band model

\[ P1 \]

\[ P2 \]

\[ P3 \]

\[ P4 \]

GRBM, Band model

0.5% syst.

Broken PL model

Band model (GRBM)
Simultaneous fit

(model) Flux @ 100 keV

2003
6.50
10^4 ph/cm^2/s/keV

2009-2011
5.42

2012-2014
6.46

2015-2016
6.30

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<th>( \alpha_1 )</th>
<th>( E_c )</th>
<th>( \alpha_2 )</th>
<th>( \chi^2 )</th>
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<td>P1 4.96 ks</td>
<td>2.90</td>
<td>698.6</td>
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<td>77.91 (39)</td>
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<td>P2 1.84 Ms</td>
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<td>P3 1.82 Ms</td>
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<tr>
<td>P4 2.2 Ms</td>
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<td>596.5</td>
<td>2.28</td>
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<tr>
<td>Tot</td>
<td>2.0</td>
<td>572.3</td>
<td>2.27</td>
<td>351.2 (165)</td>
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<td>P4 2.2 Ms</td>
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<td>Tot</td>
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NuSTAR - Crab
Crab “multi-year” data analysis project

- Results exclusively based on the analysis of nearly simultaneous periods
- Emphasis on the hard band (>10 keV)
- Instruments on board: XIS, PIN, GSO, PCA, IBIS/ISGRI, SPI, NuSTAR, (EPIC-pn), GBM, BAT
- Broken power law model, with $E_{br} \sim 100$ keV
- Broad bands spectral fitting
**Action Items - Crab**

- Apply the GBRM model to NuSTAR SL data and determine if NuSTAR can measure the curvature seen in SPI
  - Goal to determine the degree of curvature in the NuSTAR band to evaluate if a curved description of the data is necessary for the calibration below 80 keV.

- Finish up the paper on the "multi-year" Crab
  - Goal: circulate draft
G21.5-0.9 – IACHEC 2018

(2) G21.5 : Application to Hitomi

Energy below the break is not explained. More work is needed.

Presentation by M. Tsujimoto

$E_{\text{break}} = 7.1 \pm 0.3$ keV, $\Gamma_{\text{soft}} = 1.74 \pm 0.02$, $\Gamma_{\text{hard}} = 2.14 \pm 0.01$
Action Items - G21.5-0.9

• XRISM (Athena and eRosita) will be using this as an effective area calibration source, but spectrum is not a simple power-law
• Contact below will send data to Masahiro, who will do joint fit
• Goal: Define the curved spectrum as an IACHEC standard
• Cont(r)acts
  Chandra = Nick
  XMM = Felix
  NuSTAR = Kristin
  Hitomi = Masahiro
  Integral = Volodymyr
  Swift = Jamie/Andy
Summary

1. NuSTAR applies the GRBM model to SL data and evaluates the significance of curvature in the 3-50ish keV spectrum
2. G21.5-0.9 data will be prepared by instrument groups and provided to Masahiro for joint fit to quantify the curved spectrum of G21.5-0.9 at the next meeting.
3. Lorenzo to circulate a draft of the Crab paper