

# The High Energy Spectrum of NGC 4151

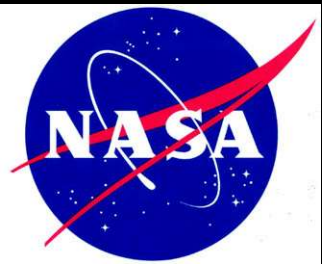
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JCA, University of Maryland, Baltimore County

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Graphic:  
NASA/CXC/SAO



ESTEC INTEGRAL workshop, January 21, 2005

JCA

# Overview

- INTEGRAL and AGN
- NGC 4151
- high energy spectrum: comptonisation of soft photons in hot gas
- cut-off powerlaw, compTT, pexrav...

# AGN seen by INTEGRAL



- Blazars fall in the “gap” between synchrotron and inverse Compton branch
- AGN seen so far: 3C273 (Courvoisier et al. 2003), 3C279 (Collmar et al. 2004), NGC 4388 (Beckmann et al. 2004), NGC 4151 (Beckmann et al. 2005), MCG -05-16-23, Cen A, NGC 4695... (see previous presentation by S. Soldi)
- Seyfert 2 dominant at 20-100 keV

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**Main Search Form** > Search Results > Choose Data Products

**1. Do you want to search around a position ... ?**  
 (If you want to search on parameters other than object name or coordinates, select "More Options".)

**Object Name Or Coordinates:**  **and/or** [Select Local File:](#)

(e.g. Cyg X-1 or '12 00 00, 4 12 8') Use semi-colons (;) to separate multiple object names or coordinate pairs (e.g. Cyg X-2; 12.235, 15.345).  
 File should contain targets one per line or separated by semi-colons.

**Coordinate System:**

**Search Radius:**

Default uses the optimum radius for each catalog searched.

**... and/or search by date?**

**Observation Dates:**  YYYY-MM-DD hh:mm:ss or MJD: DDDDD.ddd

The time portion of the date is optional. Separate multiple dates/ranges with semicolons (;).  
 Range operator is '..' (e.g. 1992-12-31; 48980.5; 1995-01-15 12:00:00; 1997-03-20 .. 2000-10-18)

**2. What missions and catalogs do you want to search?**

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<http://heasarc.gsfc.nasa.gov>

### INTEGRAL Public Data Results Catalog (intpublic)

Search radius used: 600.00'

Select	Related Links	Services	rev	start time	end time	exposure	name	ra	dec	dither pattern	pi lname	pno	Search Offset
<input type="checkbox"/> All			↕↕	↕↕	↕↕	↕↕ [s]	↕↕	↕↕	↕↕	↕↕	↕↕	↕↕	[']
<input type="checkbox"/>	<a href="#">AD</a>	<a href="#">Q</a> <a href="#">R</a> <a href="#">N</a> <a href="#">S</a> <a href="#">D</a>	75	2003-05-25 21:03:01	2003-05-28 11:31:36	222657	NGC 4151	12 10 32.60	+39 24 20.6	Staring	Amalgamated	0120050	0.030
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<input type="checkbox"/>	<a href="#">AD</a>	<a href="#">Q</a> <a href="#">R</a> <a href="#">N</a> <a href="#">S</a> <a href="#">D</a>	74	2003-05-24 01:32:42	2003-05-25 11:43:29	121378	NGC 4151	12 10 32.60	+39 24 20.6	Staring	Amalgamated	0120259	0.030
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11 rows retrieved from intpublic

#### Are you interested in data products?

- Select the checkboxes for the rows of interest above,
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#### Data Products available for intpublic

- All
- FITS Results Maps (fits)
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- SPI Analysis Results (results)

#### Further Actions:

- Do you want to  Plot your intpublic results? ([help](#))
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Services:

### INTEGRAL Bright Source Catalog (intbsc)

Search radius used: 15.00'

Select	Related Links	Services	name	source type	ra	dec	isgri detections	spi avg flux	spi avg flux error	spi high flux	spi high flux error	spi low flux	spi low flux error	spi remarks	Search Offset
<input type="checkbox"/> All			↕↕	↕↕	↕↕	↕↕	↕↕	↕↕ [mCrab]	↕↕ [mCrab]	↕↕ [mCrab]	↕↕ [mCrab]	↕↕ [mCrab]	↕↕ [mCrab]	↕↕	[']
<input type="checkbox"/>	<a href="#">Ref</a>	<a href="#">Q</a> <a href="#">R</a> <a href="#">N</a> <a href="#">S</a> <a href="#">D</a>	NGC 4151	Sy 1.5	12 10 33.0	+39 24 21	157	28	3	35	4	6	2		0.057

1 row retrieved from intbsc

#### Are you interested in data products?

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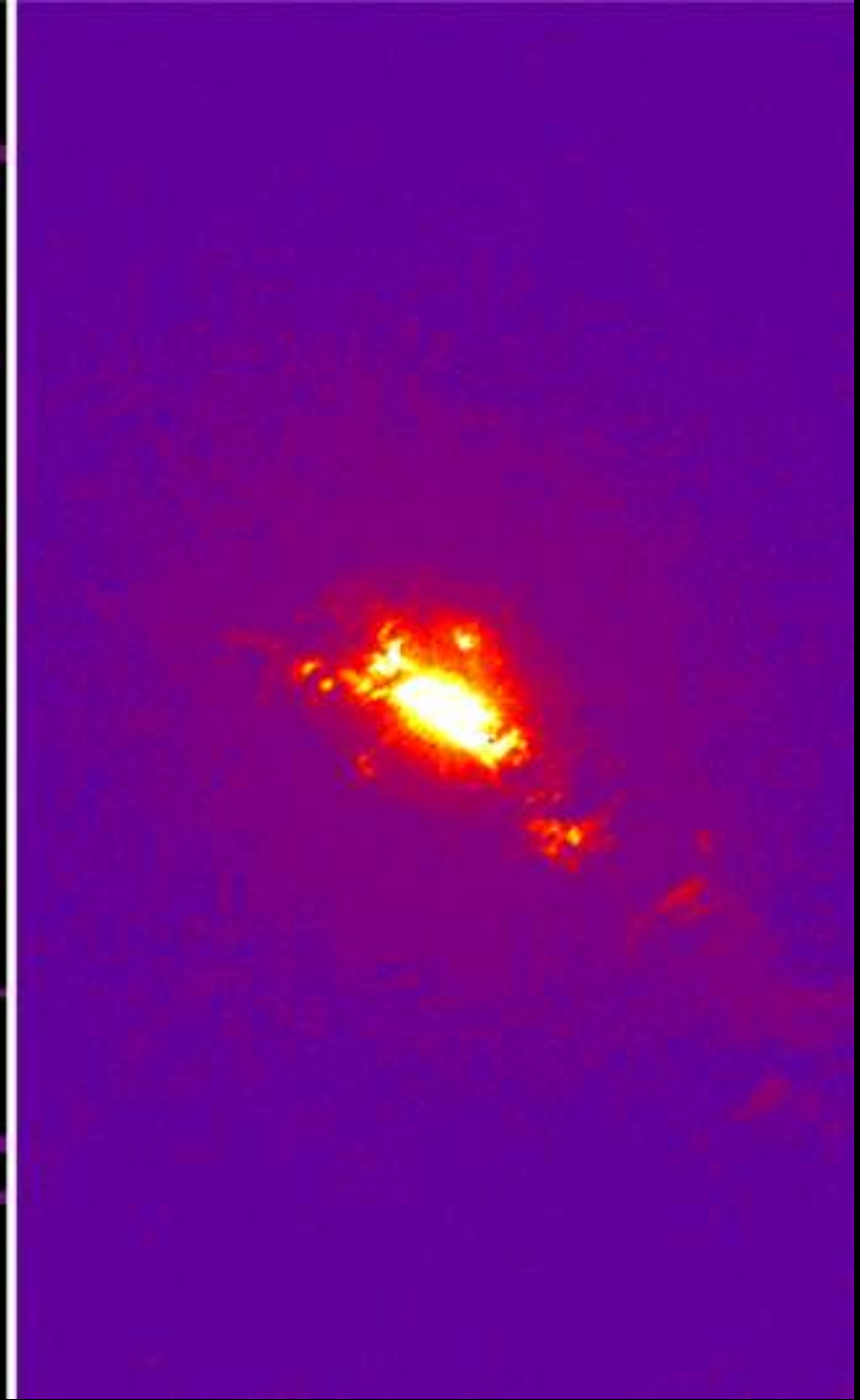
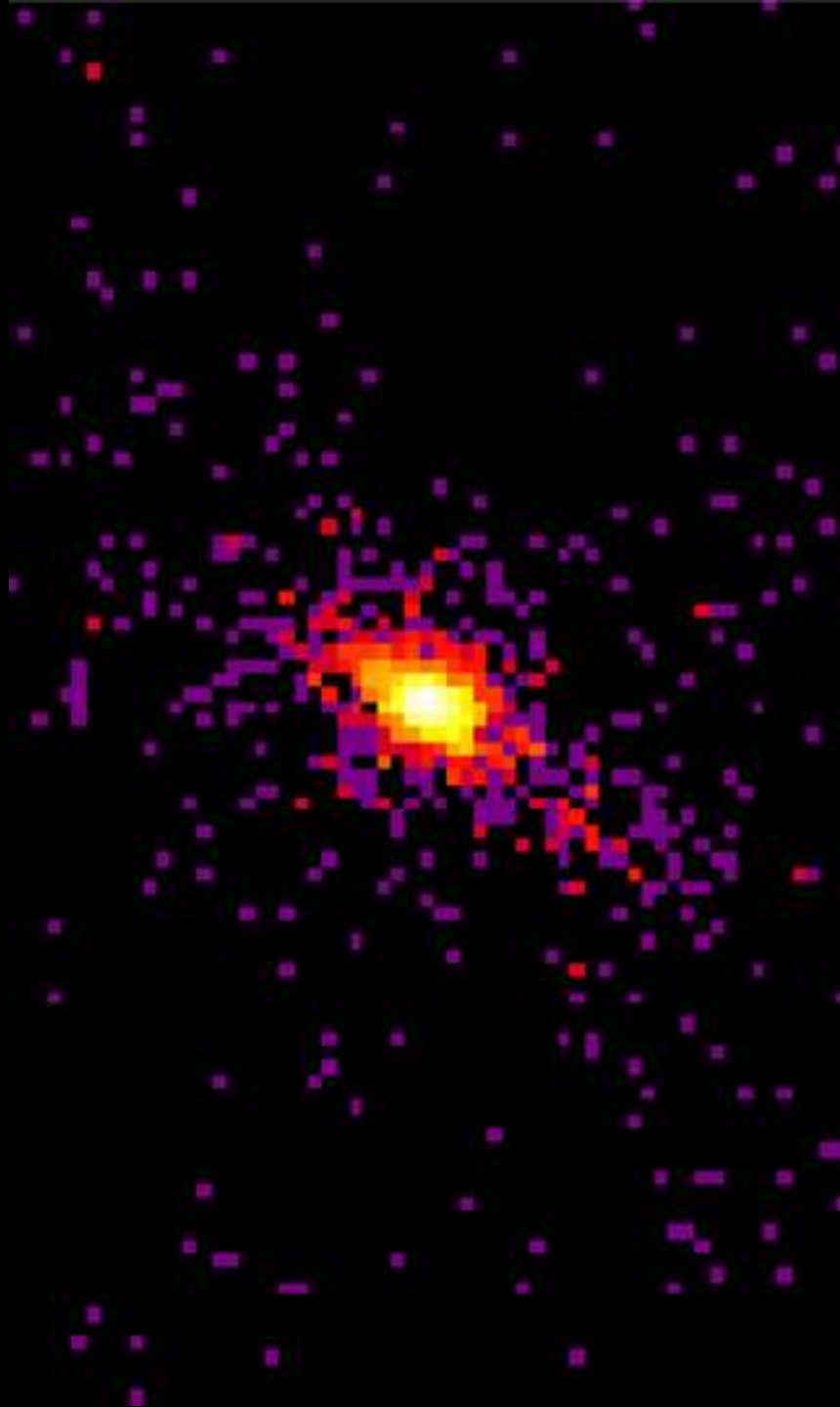
#### Data Products available for intbsc

- All
- ISGRI Results Data (isgri data)
- ISGRI JPEG Lightcurves (isgri jpgs)
- SPI Lightcurve Data (spi lc)

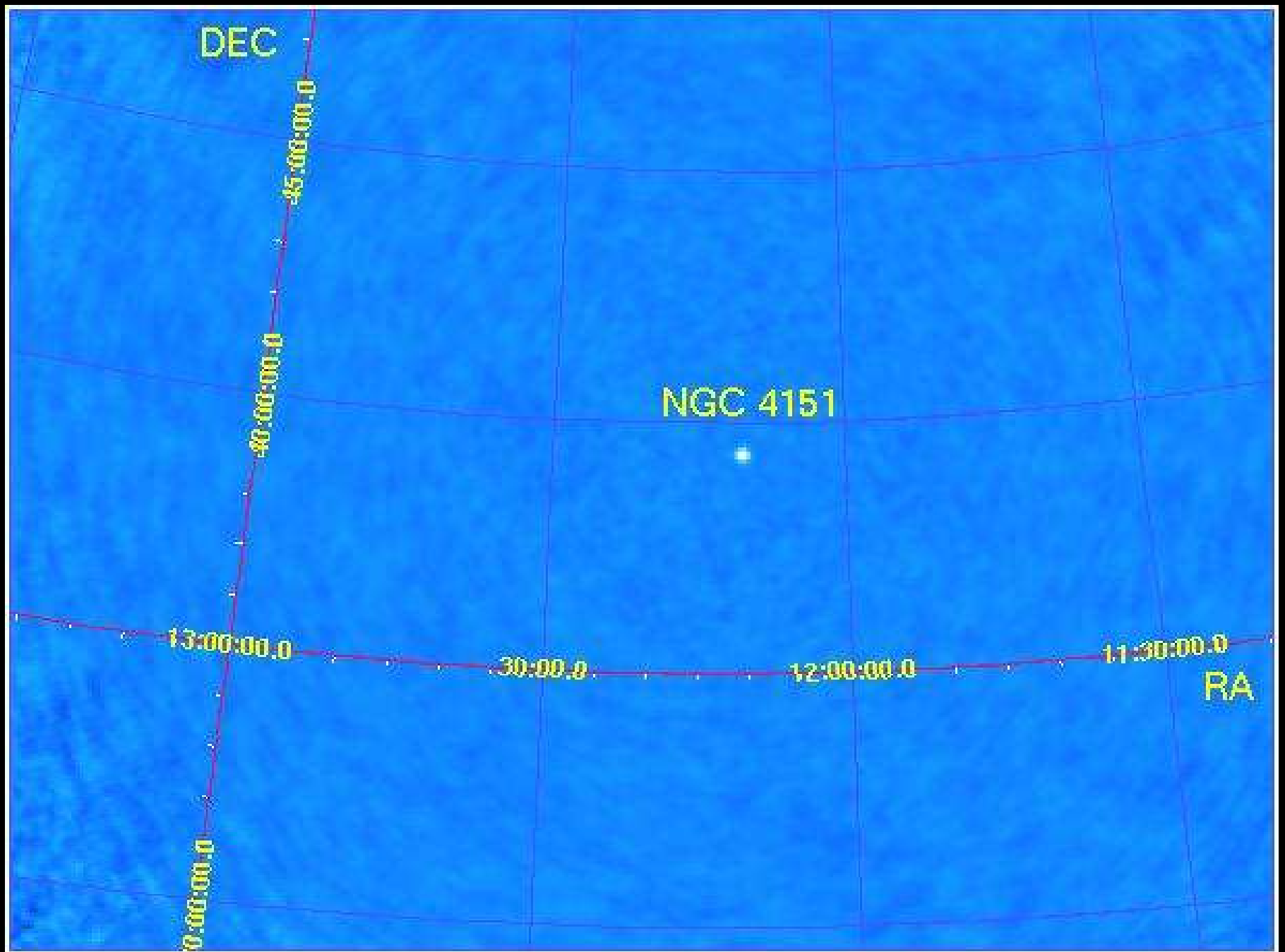
#### Further Actions:

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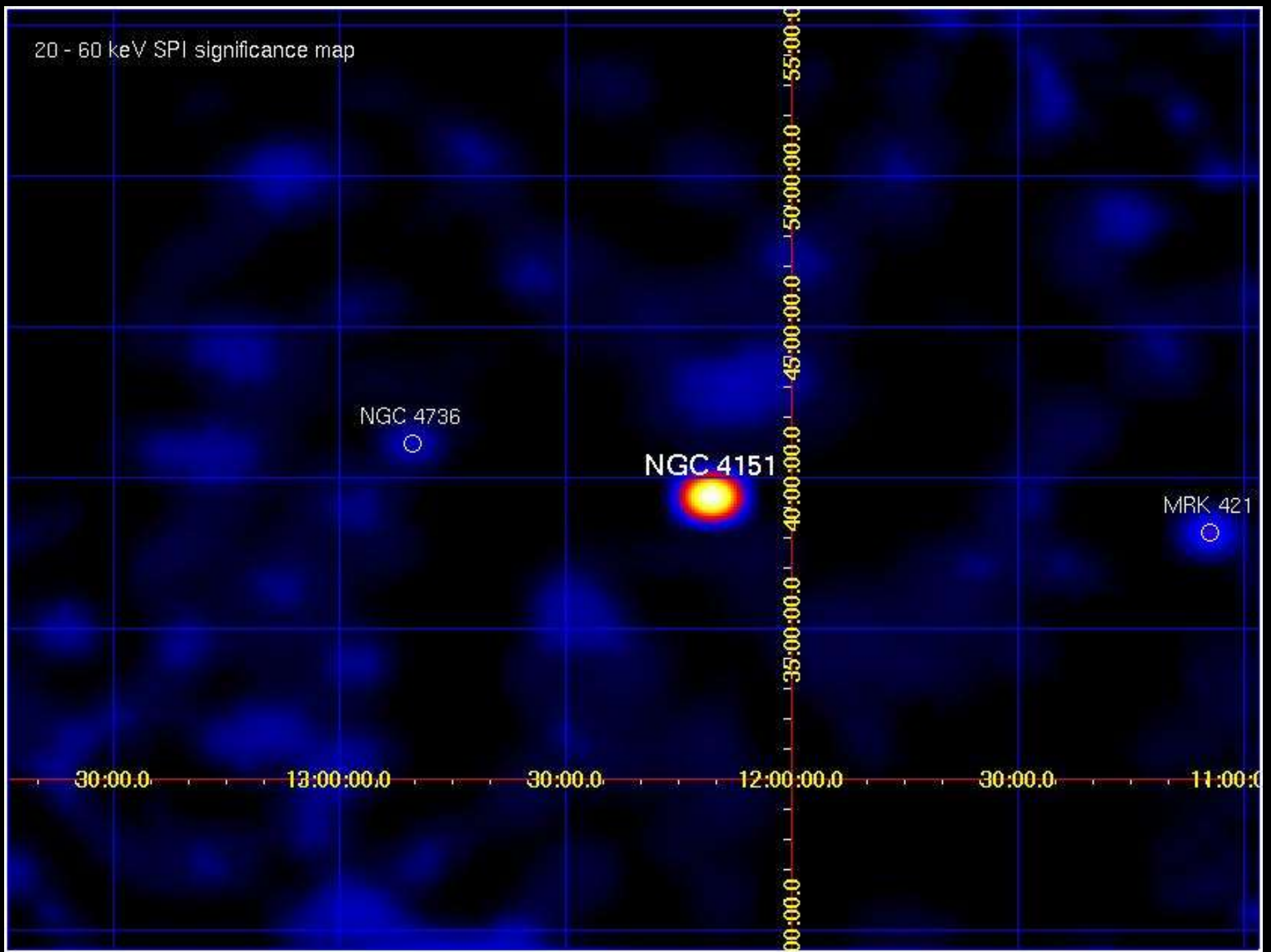
Services:



Chandra and HST image of the Seyfert 1.5 NGC 4151



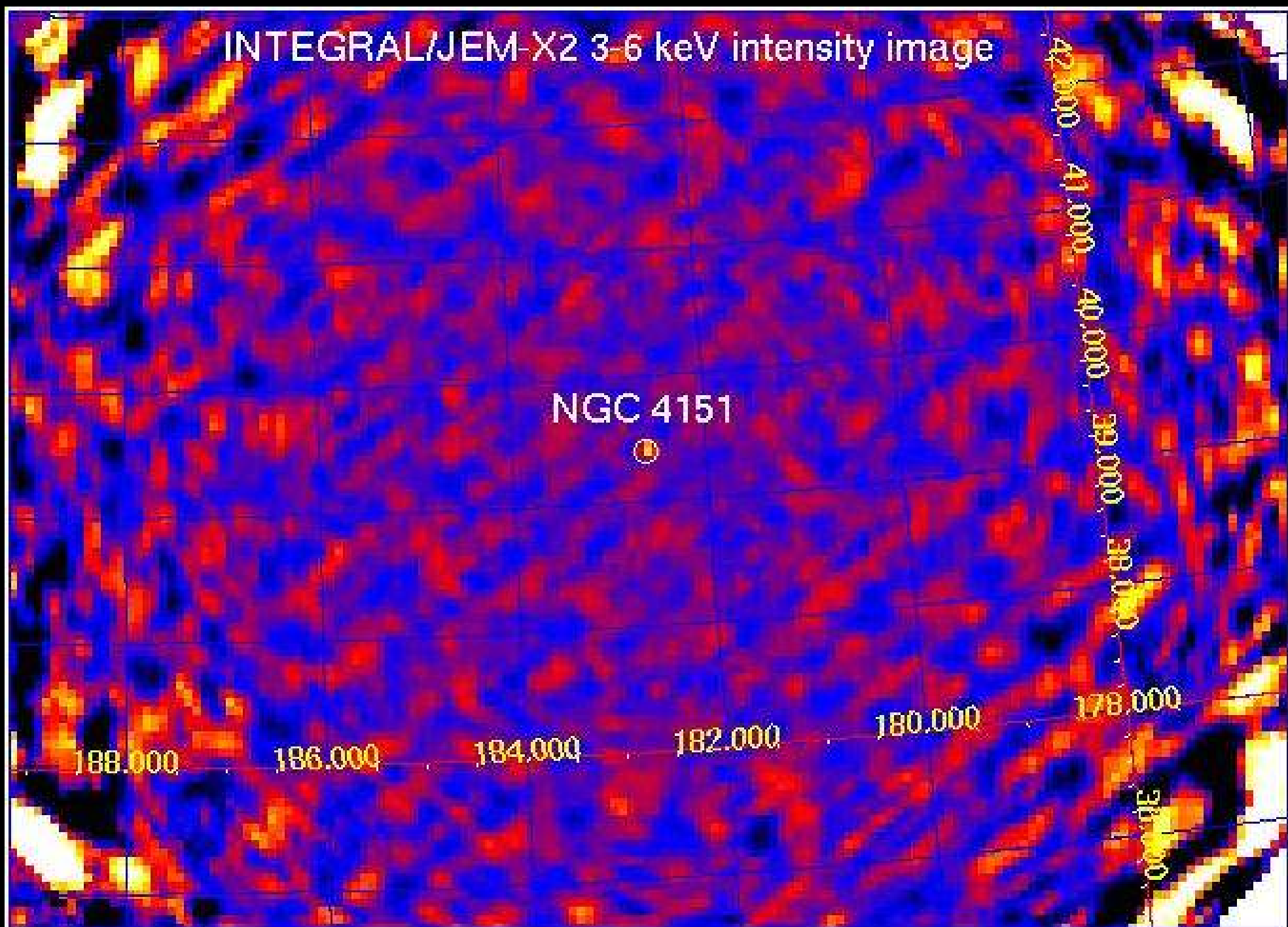
ISGRI 20-40 keV 400 ksec image of NGC 4151



SPI 20-60 keV image of NGC 4151



INTEGRAL/JEM-X2 3-6 keV intensity image



NGC 4151



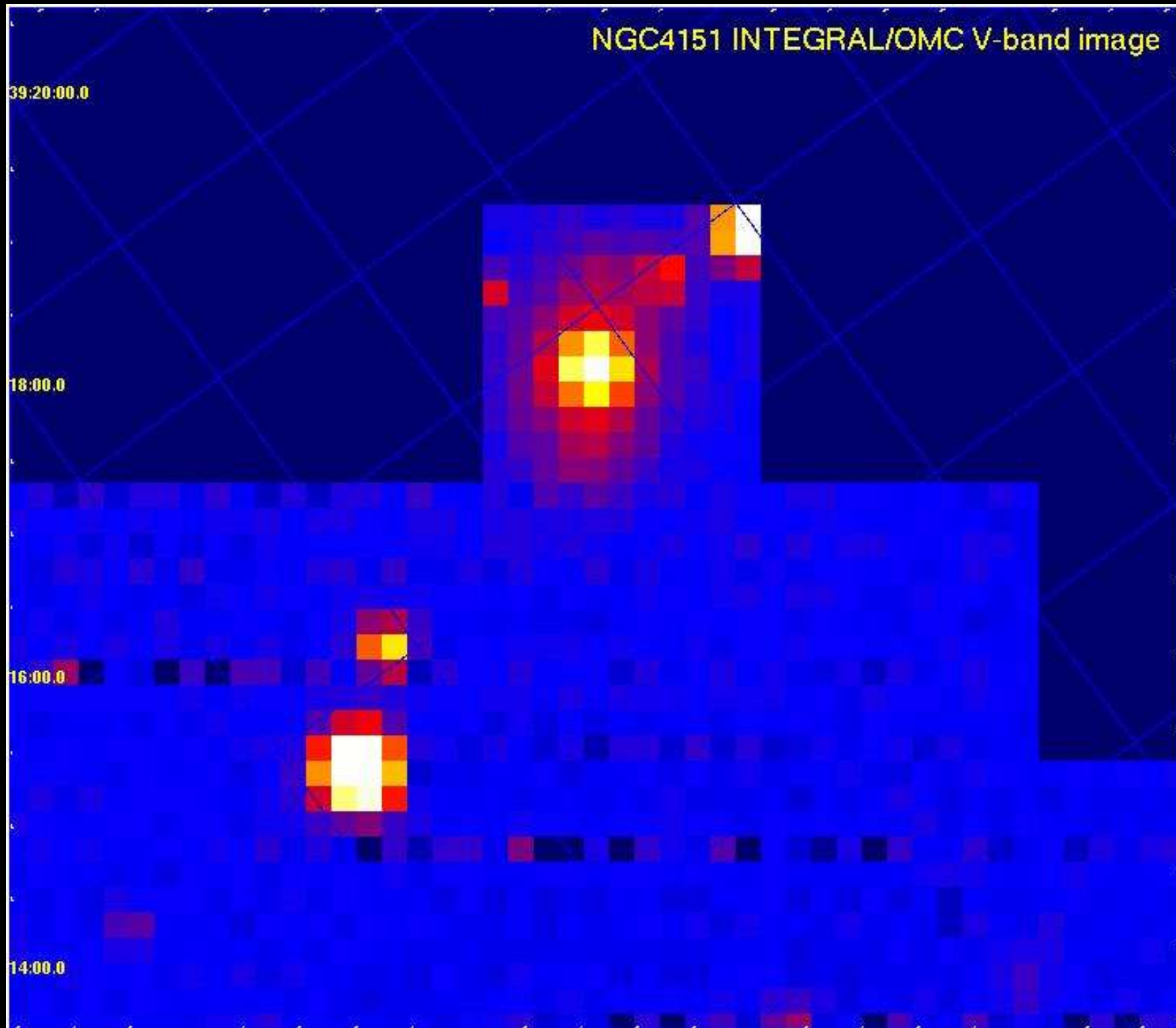
NGC4151 INTEGRAL/OMC V-band image

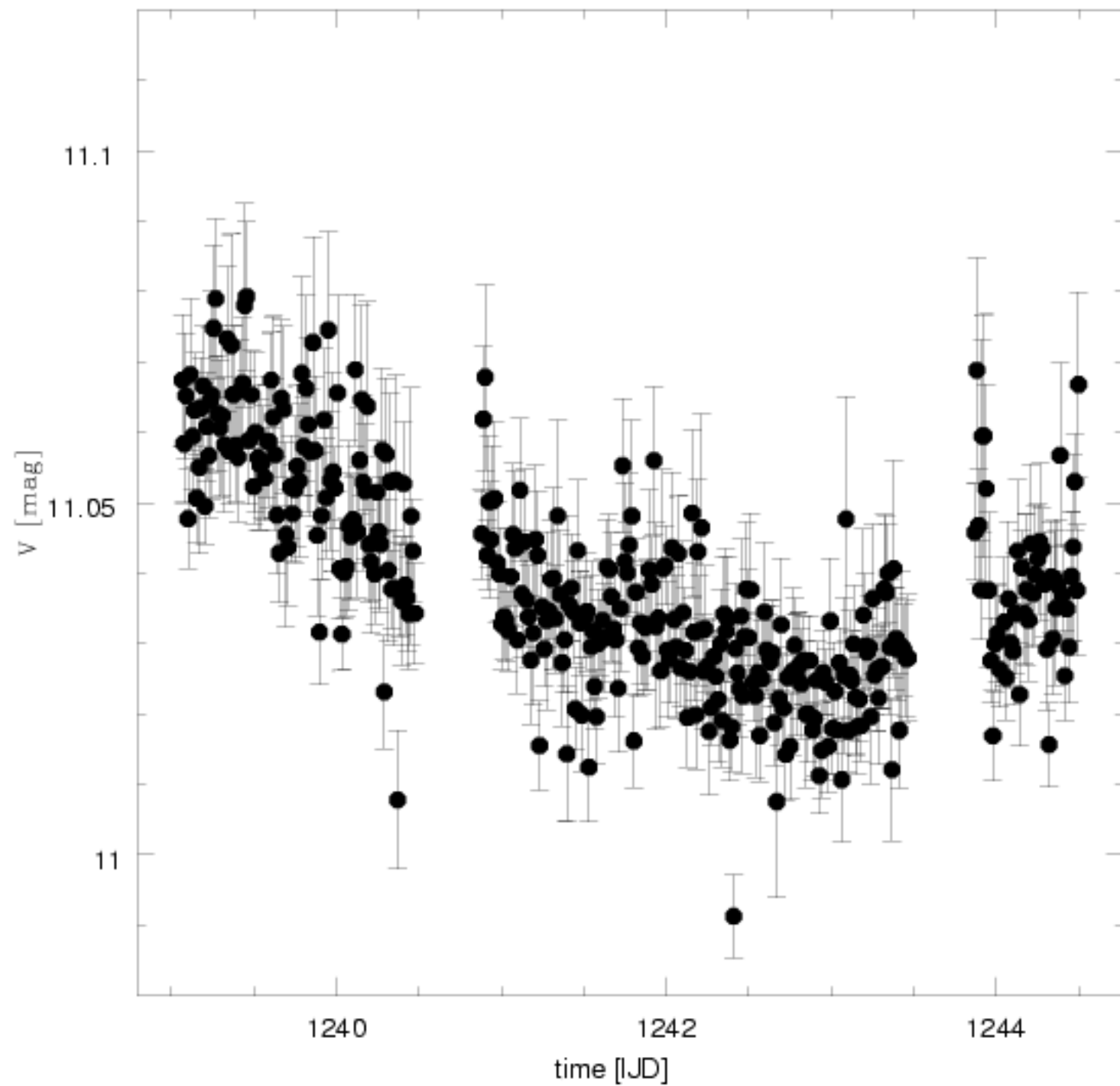
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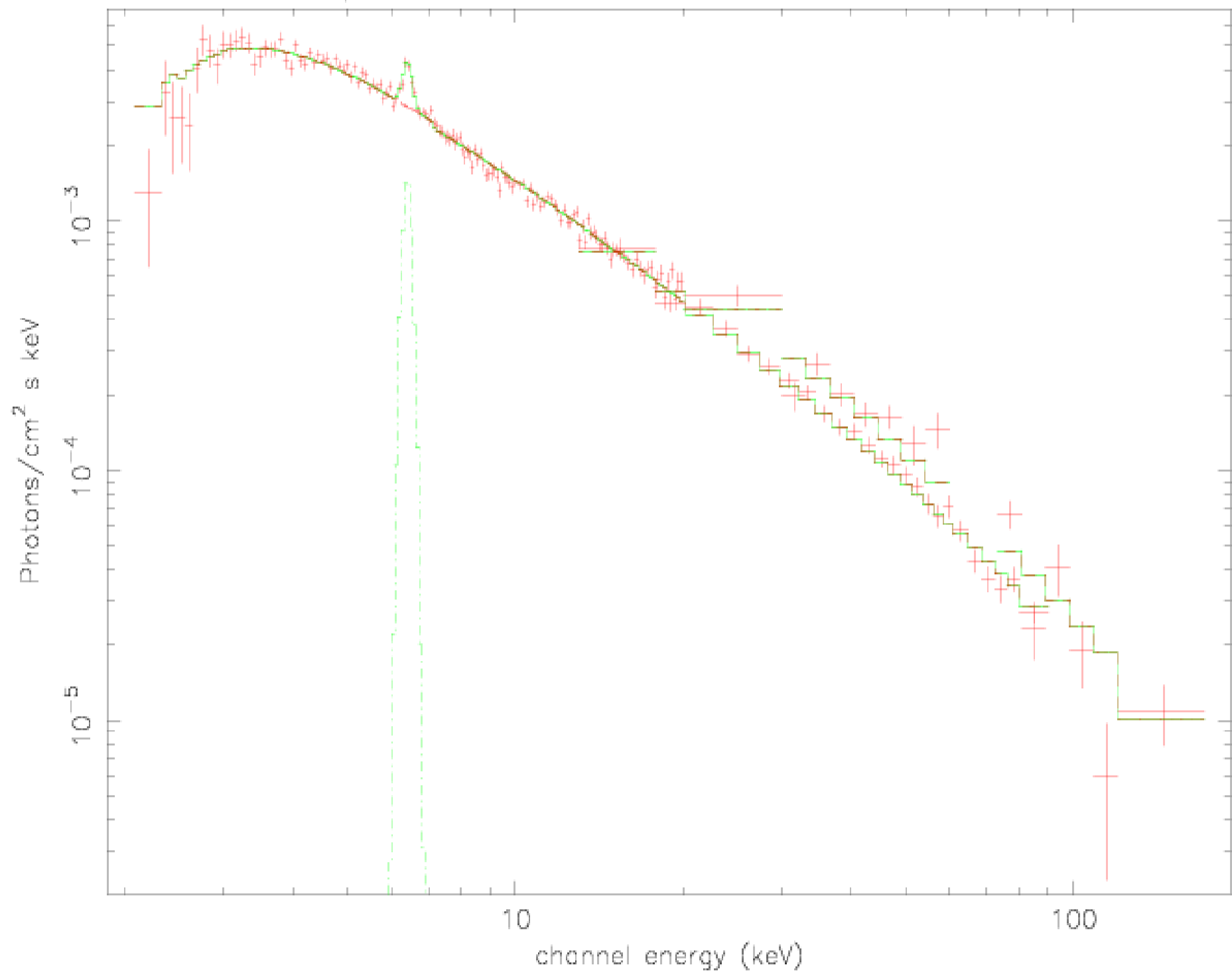


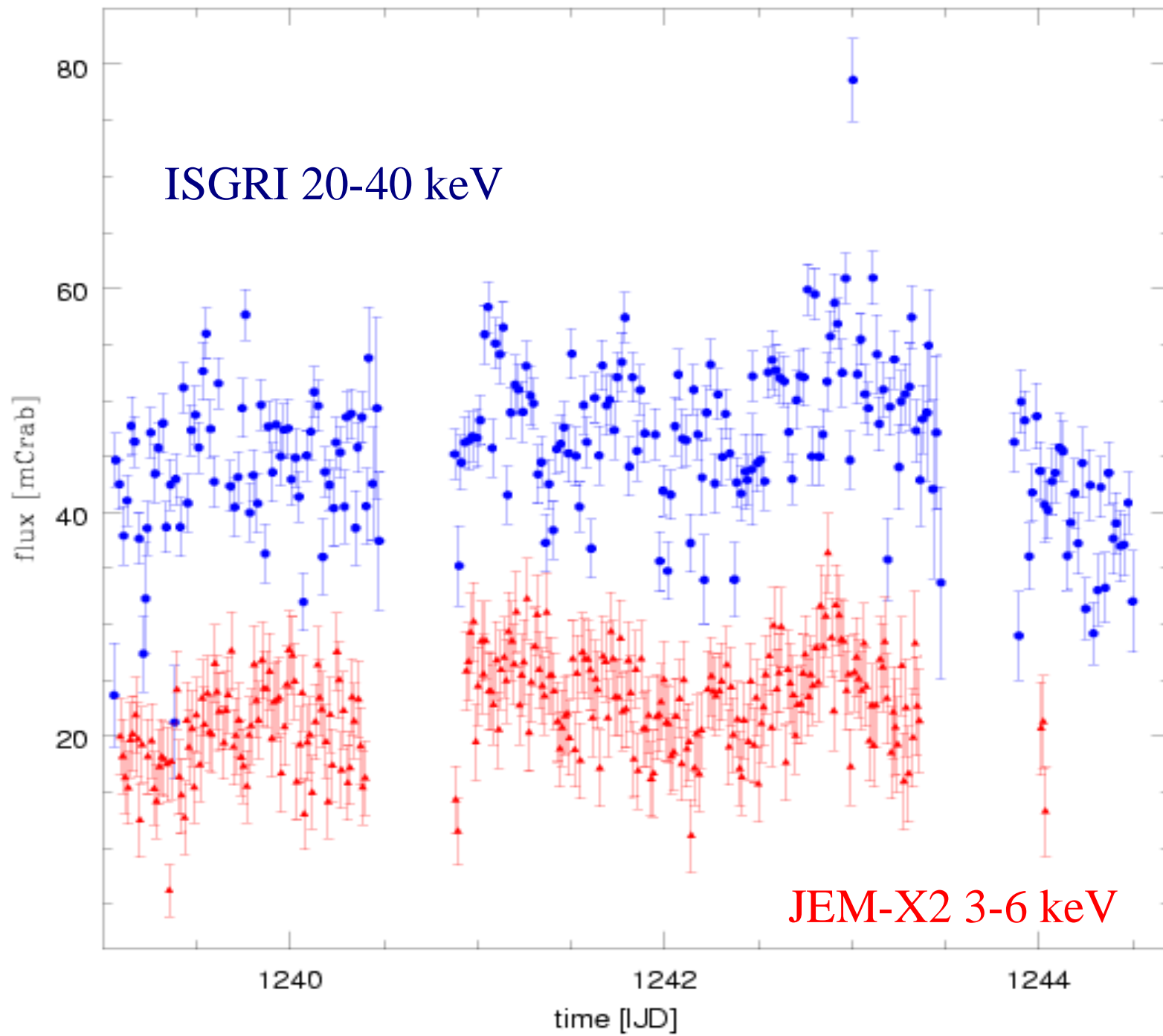


OMC  
V-band  
lightcurve

# NGC 4151 INTEGRAL spectrum

absorbed cut-off power law with Gaussian line





# Comptonisation feature in NGC 4151

- cut-off power law is just a fit
- physical model: comptonisation of 'cool' photons (e.g. from the optical thick disk) on hot material (e.g. the corona above the disk)
- two characteristic temperatures: seed photons, and corona
- further evidence for reflection on cold material: the iron fluorescence line at 6.4 keV (139 eV) and compton reflection hump (10...30 keV)
- time resolved study of the variations of the reflection component

# Comptonisation in NGC 4151

Model	Mission	Photon Index	EC or kT [keV]	Tau	Red. Chi sq.
Power law	INTEGRAL	1.76			1.9
Power law	CGRO/OSSE	2.7			2.43
PL-exp	INTEGRAL	1.55	113		1.51
PL-exp	CGRO/OSSE	1.6	96		0.71
Th. comptonisation	INTEGRAL		21.3	2.2	1.4
Th. comptonisation	CGRO/OSSE		44	2.1	0.81

15-150 keV flux :

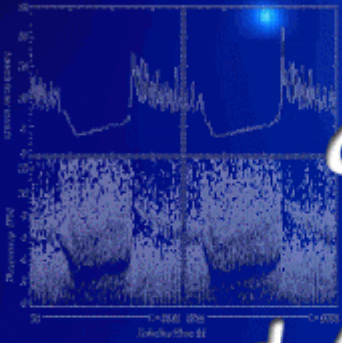
OSSE average  $2-4 \times 10^{-3}$  ph/cm<sup>2</sup>/sec

INTEGRAL  $15.6 \times 10^{-3}$  ph/cm<sup>2</sup>/sec

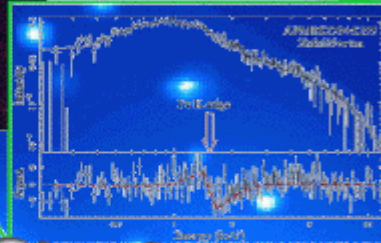
# Conclusion

- INTEGRAL allows the monitoring of the Comptonisation features in bright AGN
- NGC 4151 showed parameters consistent with comptonisation; power law (Gamma=1.55) with cut-off at ~110 keV, Fe-K alpha line EW=139 eV ( $5 \times 10^{-4}$  ph/cm<sup>2</sup>/sec),  $NH = 5 \times 10^{22}$  cm<sup>-2</sup>
- though the flux is 5 times higher, the model fit to the data shows similar parameters as for the CGRO/OSSE observations -> no change in temperature of corona and disk?
- still to be done: analysis of the 'high' and 'low' flux spectra





# Observing the X- and Gamma-Ray Sky



April 3-14 2006

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