INTEGRAL spectra of Galactic Bulge sources

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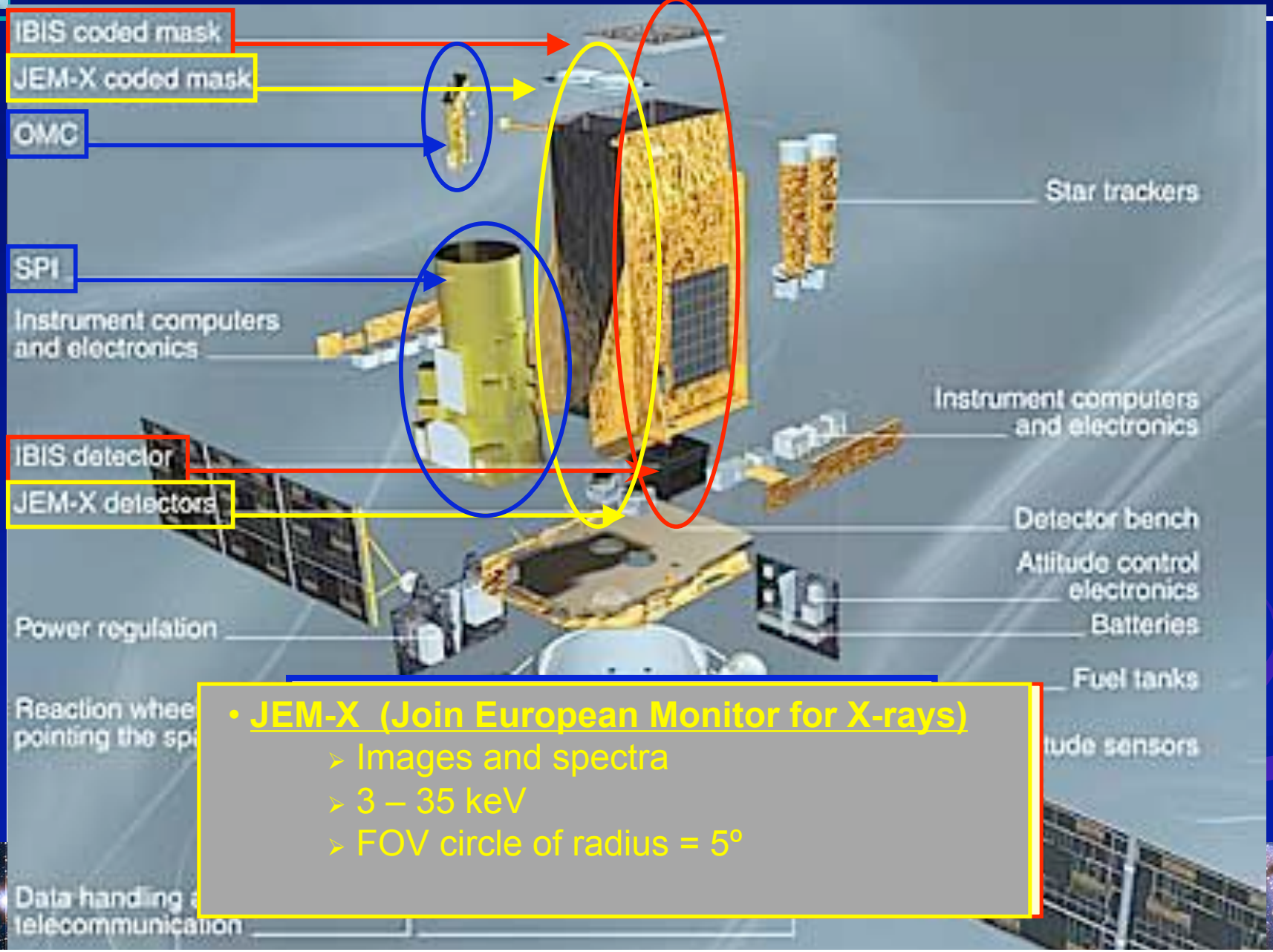
MY PROJECT

INTEGRAL spectra of Galactic Bulge sources

- INTEGRAL: the payload
  - Instruments onboard and their main characteristics
- Introduction to the project
  - Low Mass X-Ray Binaries
  - The Galactic Bulge Monitoring Program
- The project
  - The models
  - Results
  - Conclusions
  - Perspectives

INTEGRAL: THE PAYLOAD



- **JEM-X (Join European Monitor for X-rays)**
  - Images and spectra
  - 3 – 35 keV
  - FOV circle of radius = 5º

LOW MASS X-RAY BINARIES: LMXB

- **NS / BH** + companion star (reddish stars or even degenerate stars): M ≤ Msun
- Mass transfer → Accretion Disk
  - Matter from companion radiated in X and Gamma-Ray → releases its kinetic energy as it falls to the compact object → converted into heat by viscous processes
  - The accretion disk dominates in the optical
- Magnetic field in LMXRB (10^8-10^9 G)
- Period + inclination → Mass function → lower limit for Compact Object
- Signatures:
  - for a BH → its mass
  - for NS → pulsations or bursts

⇒ **BLACK HOLES DON'T HAVE A SURFACE**

SPECTRAL CHANGES

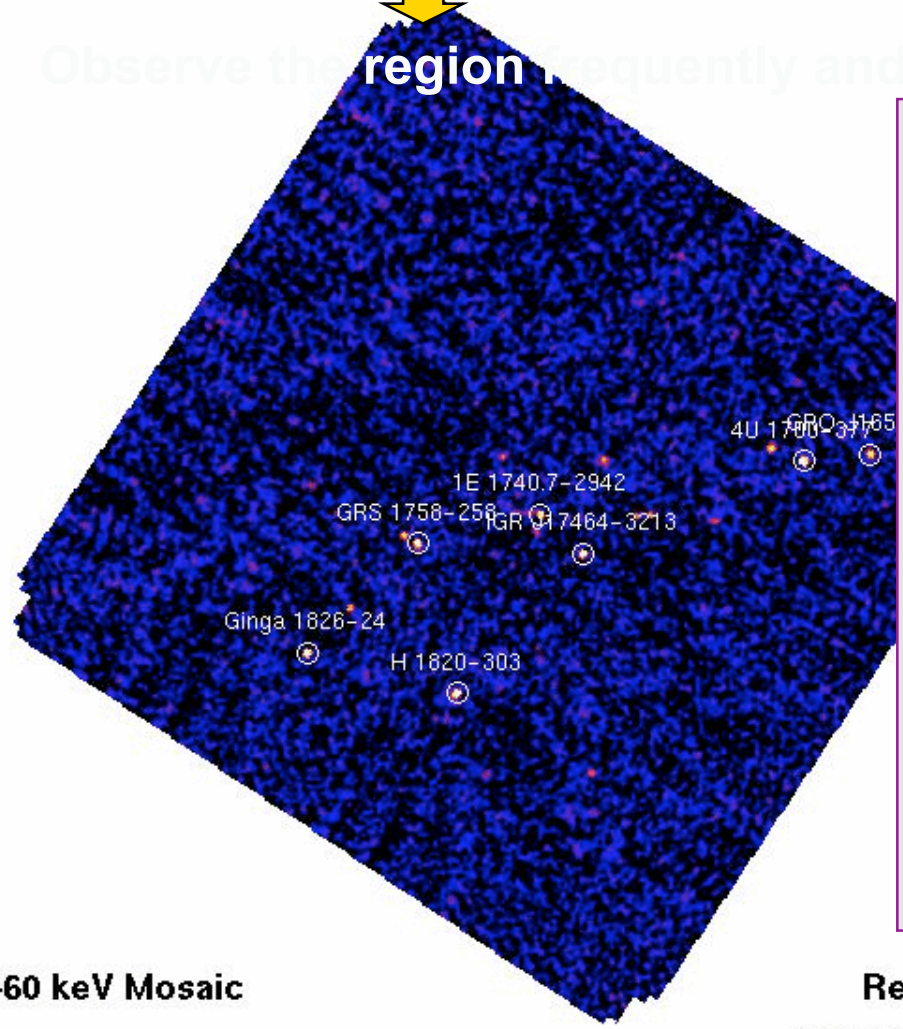
- **Spectral states**
  - HARD STATE:
    - **Low emission: 1 - 10 keV**
    - **High emission: 20 - 100 keV**
    - Spectrum: power law + cutoff between 50-100 keV
  - SOFT STATE (thermal dominant state):
    - **Emission in 1-10 keV band ➡ 5 times the previous case**
    - **Decreases above 30 keV**
    - Important thermal component ➡ dominates the spectrum
    - Hard X-Ray emission is missing
  - QUIESCENCE: "turned off state"
    - Source ➡ very weak or undetectable
    - Transients stays on it most of the time

The INTEGRAL Galactic Bulge monitoring program

Observe the region frequently and regularly :

INTEGRAL Galactic Bulge Monitoring

region



ISGRI 20–60 keV Mosaic

Revolution 0347

MJD 53598, 2005–08–16

⇒ **study the source variability and transient activity**

- Days to weeks to months
- Relatively soft (δ 10 keV) and hard (τ 10 keV) energies

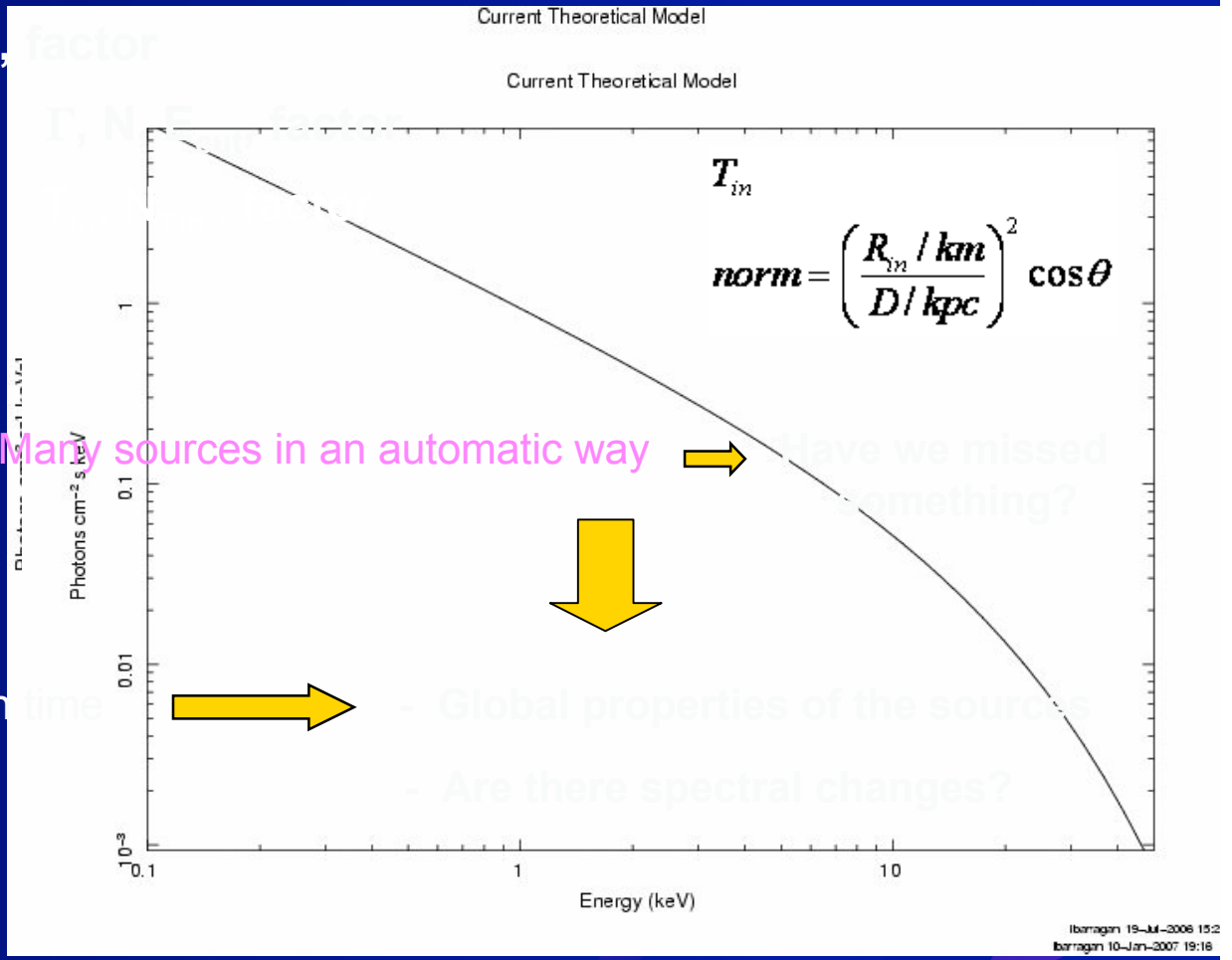
INTEGRAL spectra of Galactic Bulge Sources

THE MODELS:

- **Fit the data with XSPEC to simple models:**
  - **Powerlaw:** Γ, N, factor
  - **Cutoffpowerlaw:**
  - **Disk black body:**

Simple models → Many sources in an automatic way →

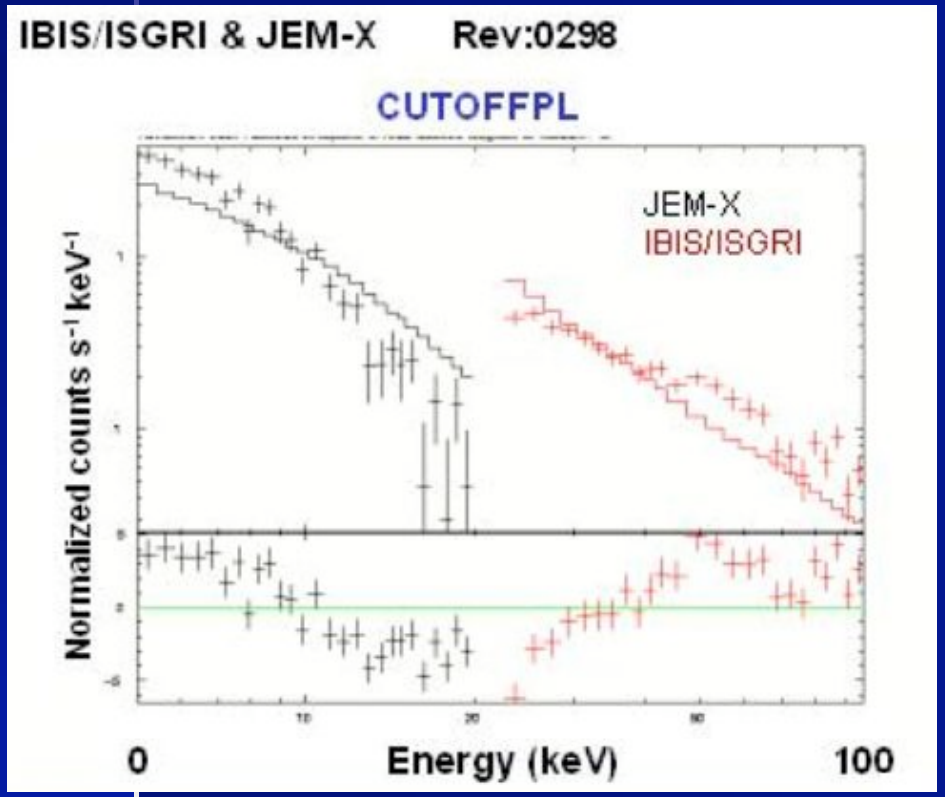
Plot the parameters with time



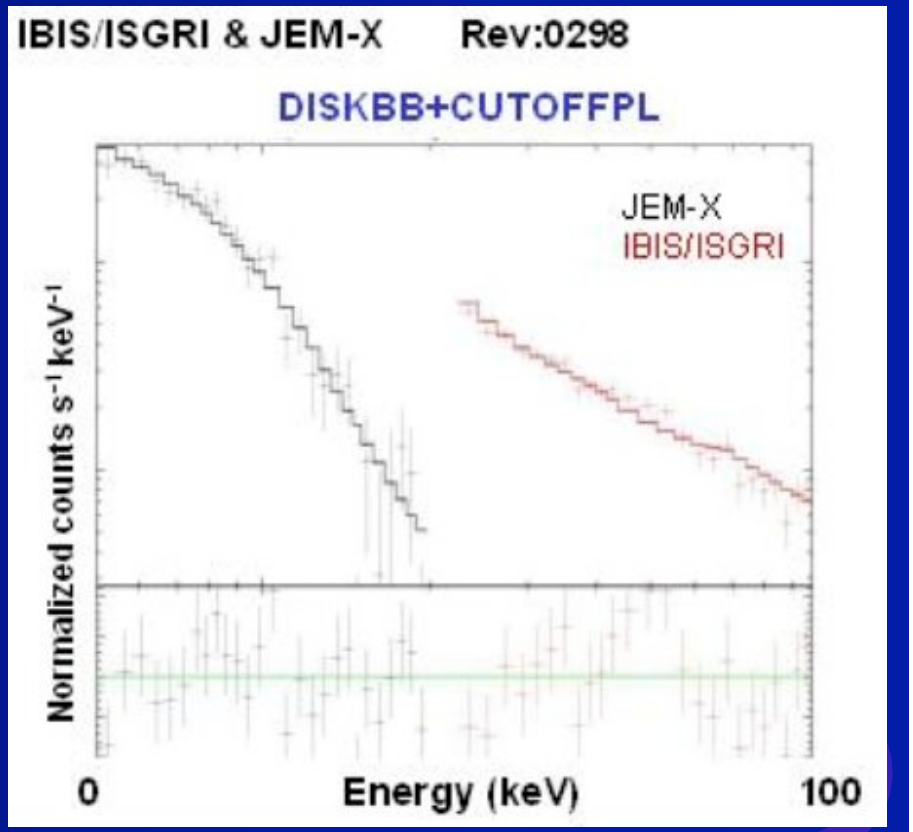
- Have we missed something?
- Global properties of the sources
- Are there spectral changes?

RESULTS 0: The models

GRS 1758-258

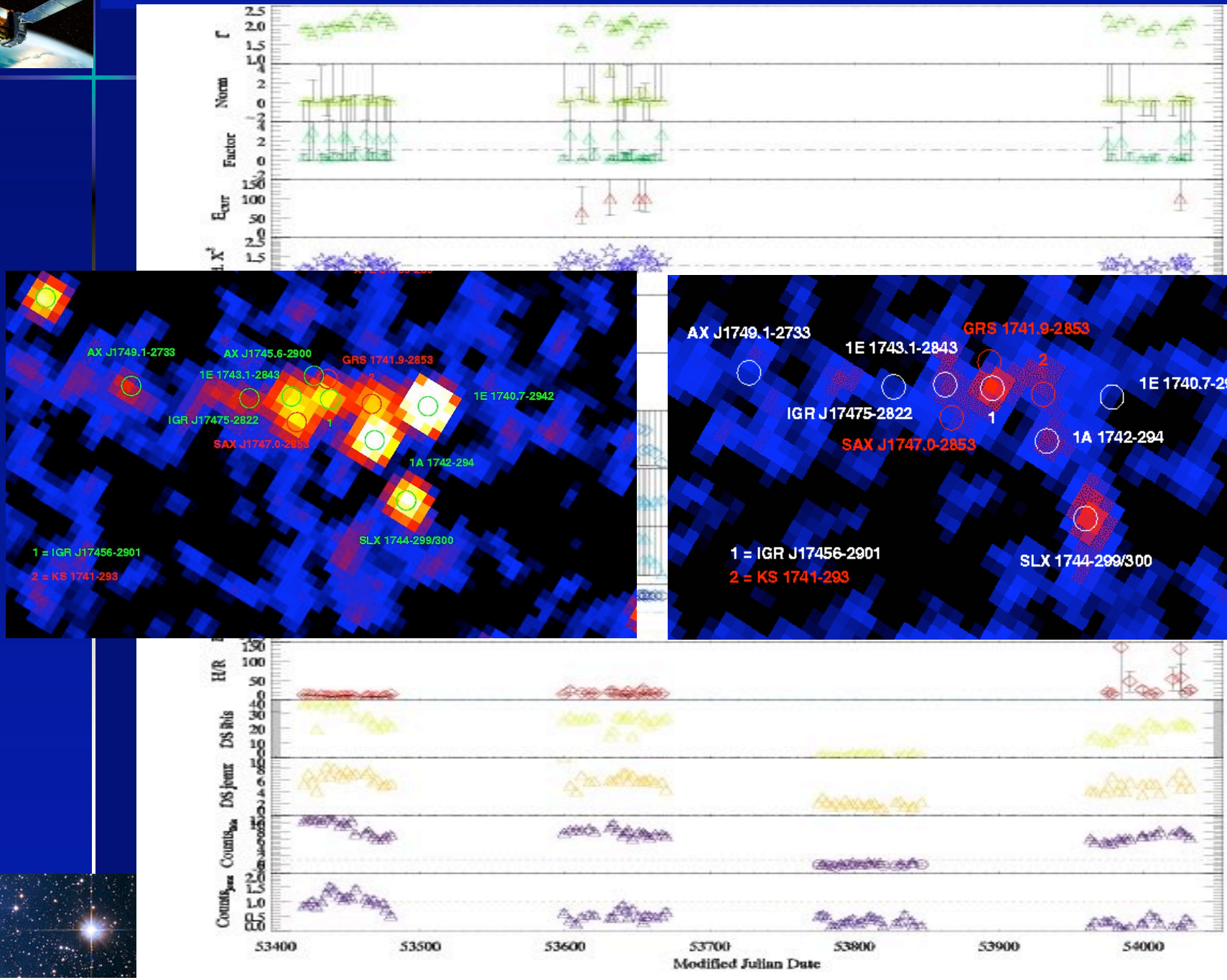


Reduced χ^2 ~ 6

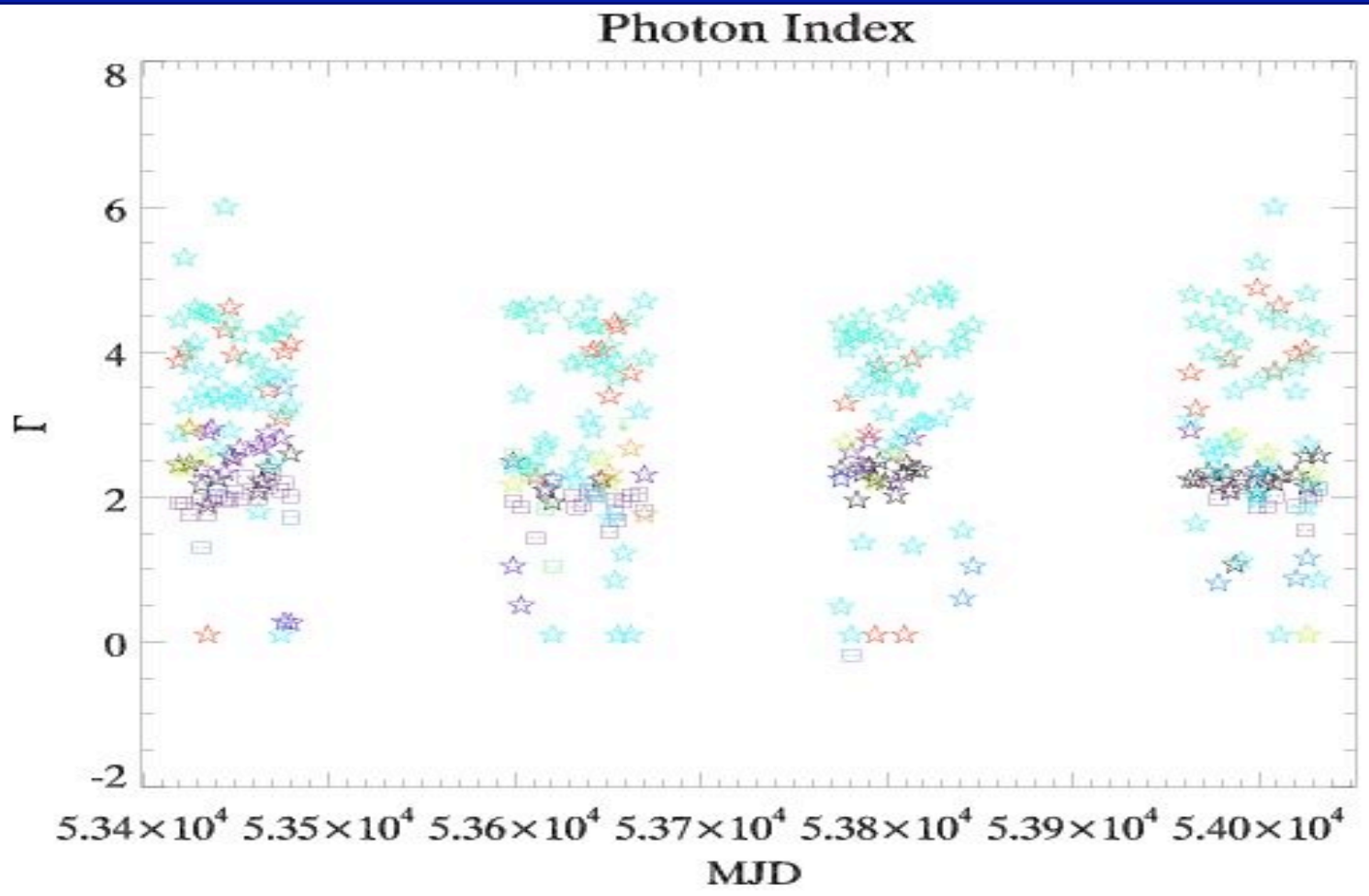


Reduced χ^2 ~ 1.01

RESULTS I: 1E 1740.7-2942 => Black Hole Candidate



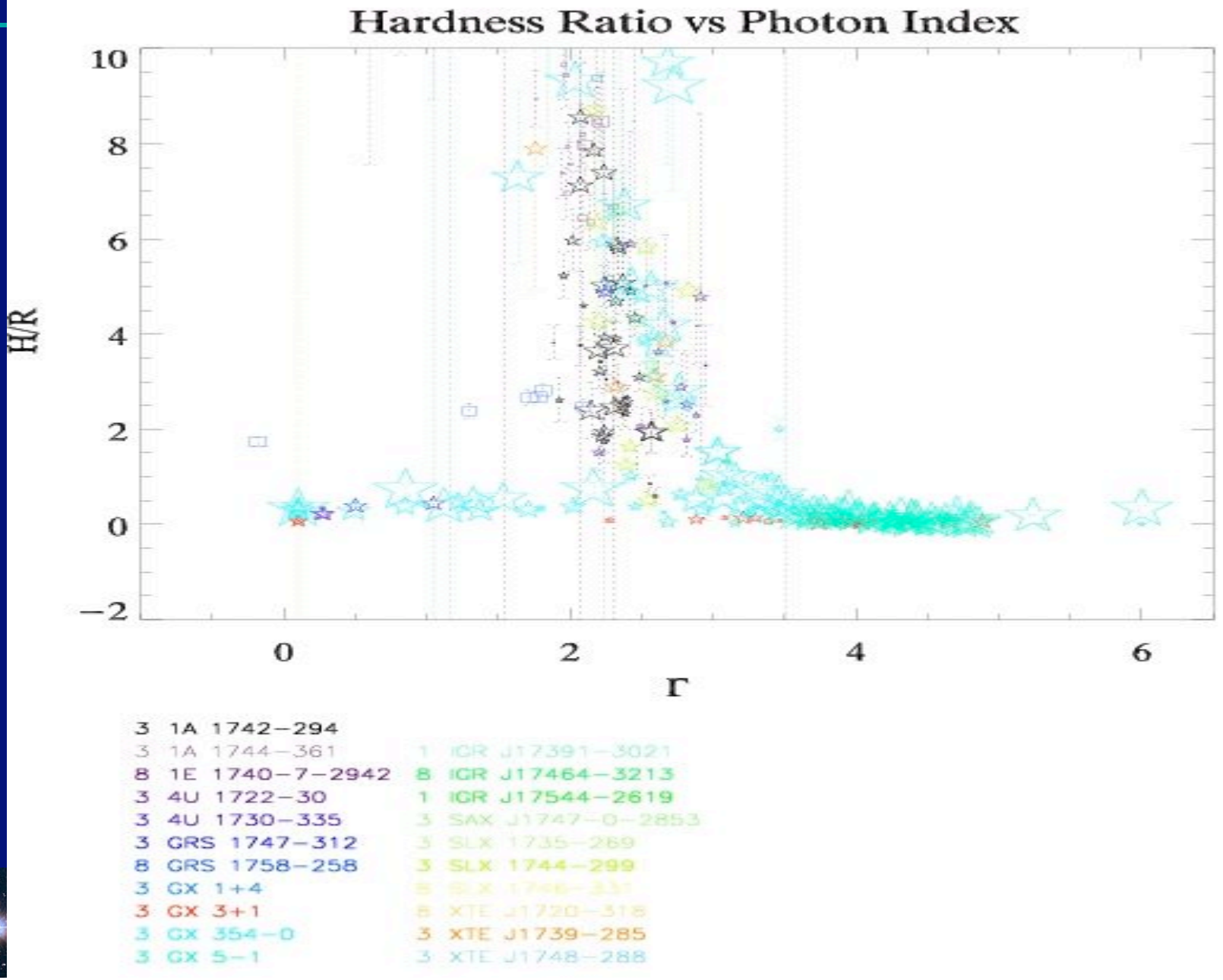
RESULTS II: Plotting all the sources (time)



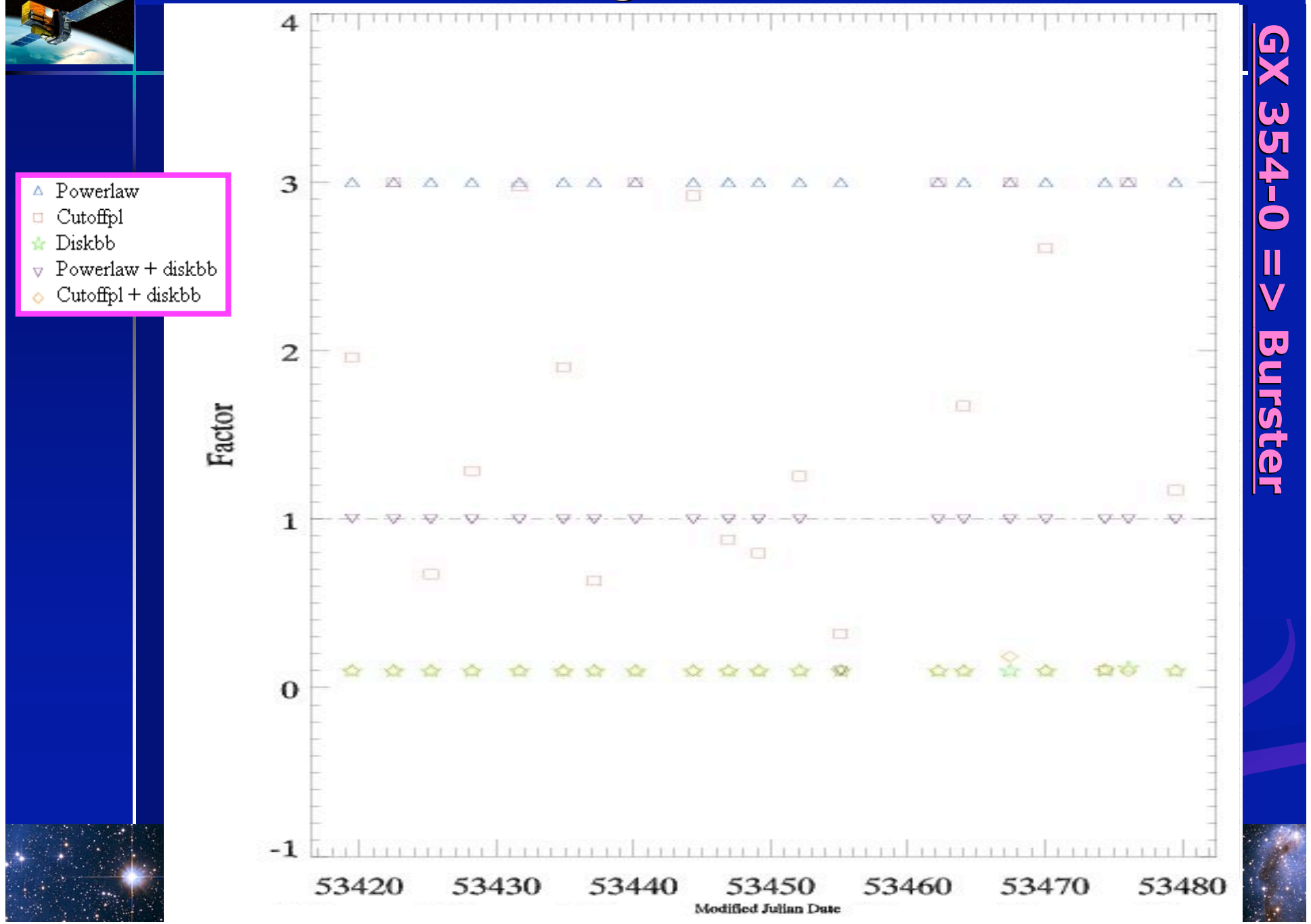
3	1A 1742−294		
3	1A 1744−361	1	IGR J17391−3021
8	1E 1740−7−2942	8	IGR J17464−3213
3	4U 1722−30	1	IGR J17544−2619
3	4U 1730−335	3	SAX J1747−0−2853
3	GRS 1747−312	3	SLX 1735−269
8	GRS 1758−258	3	SLX 1744−299
3	GX 1+4	8	SLX 1746−331
3	GX 3+1	8	XTE J1720−318
3	GX 354−0	3	XTE J1739−285
3	GX 5−1	3	XTE J1748−288

RESULTS II: Plotting all the sources

(a parameter vs another one)



RESULTS III: Plotting all the five models



GX 354-0 => Burster

TABLE: MODELS

	Powerlaw	Cutoffpl	Diskbb	Diskbb+Powerlaw	Diskbb+Cutoffpl
1A 1742-294	YES*	YES*	YES*	YES*	NO
1E 1740.7-2942	YES*	**YES**	YES*	YES*	NO
4U 1722-30	YES*	**YES**	YES*	YES*	NO
GRS 1758-258	YES*	**YES**	YES*	YES*	NO
GX 1+4	YES*	YES**	YES***	YES**	NO
GX 3+1	YES*	**YES**	YES*	NO	NO
GX 354-0	YES*	YES*	YES*	***	NO
GX 5-1	YES*	**YES**	YES**	***	NO
IGR J17464-3213	YES *	YES**	NO	YES***	NO
SLX 1744-299	YES**	YES**	YES**	YES***	NO

CONCLUSIONS

- ✓ Simple models do not work in general for an automatic fit
- ✓ Diskbb + cutoffpl never seems to work automatically
- ✓ We detect spectral changes in some sources

PERSPECTIVES

- Plotting all the sources together with the "good model"
- Analyze the most interesting cases manually
- Quantification of the variations in the spectra
- Similarities and differences among the sources

THANK YOU

CODED MASK

NO MIRRORS IN GAMMA RAY

⇩

NO OPTICAL-LIKE IMAGES

⇩

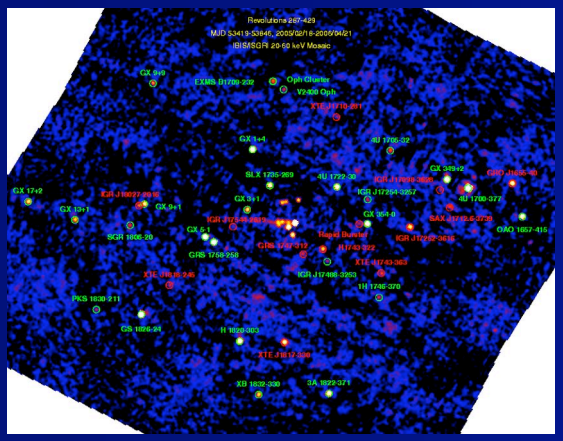
coded mask

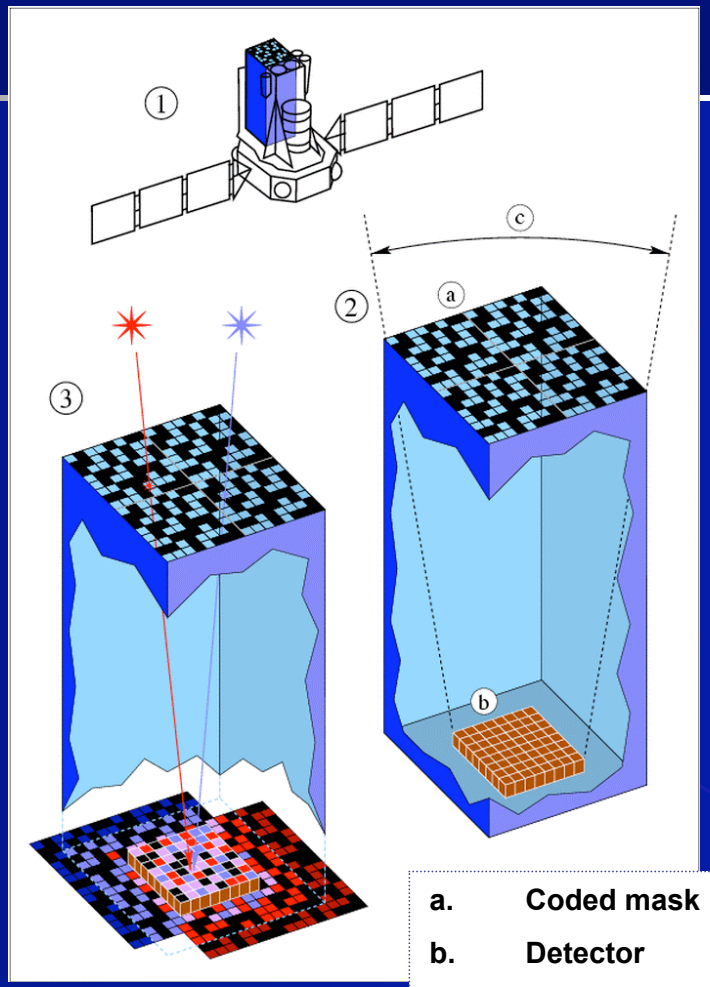
- Mask the opening of the telescope
- Measure its shadow on the detector
- Orientation of the satellite & analysis of data from the detector

⇩

Determine position & intensity of the sources

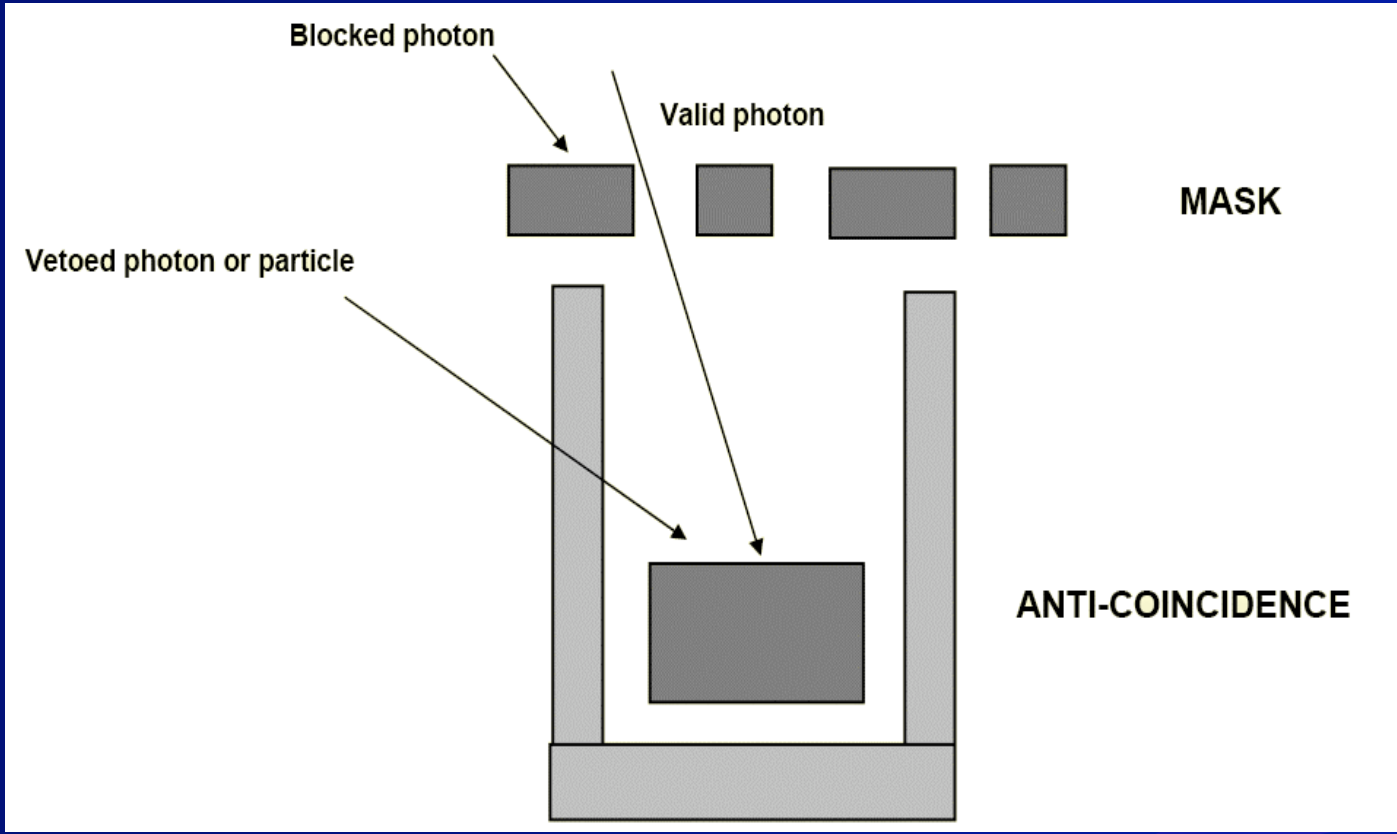
Image of the observed sky:





a. Coded mask
b. Detector
c. Field of view

ANTI-COINCIDENCE SYSTEM



The fitting: how it works