INTEGRAL contribution to the discovery of the nature of Galactic ridge X-ray emission

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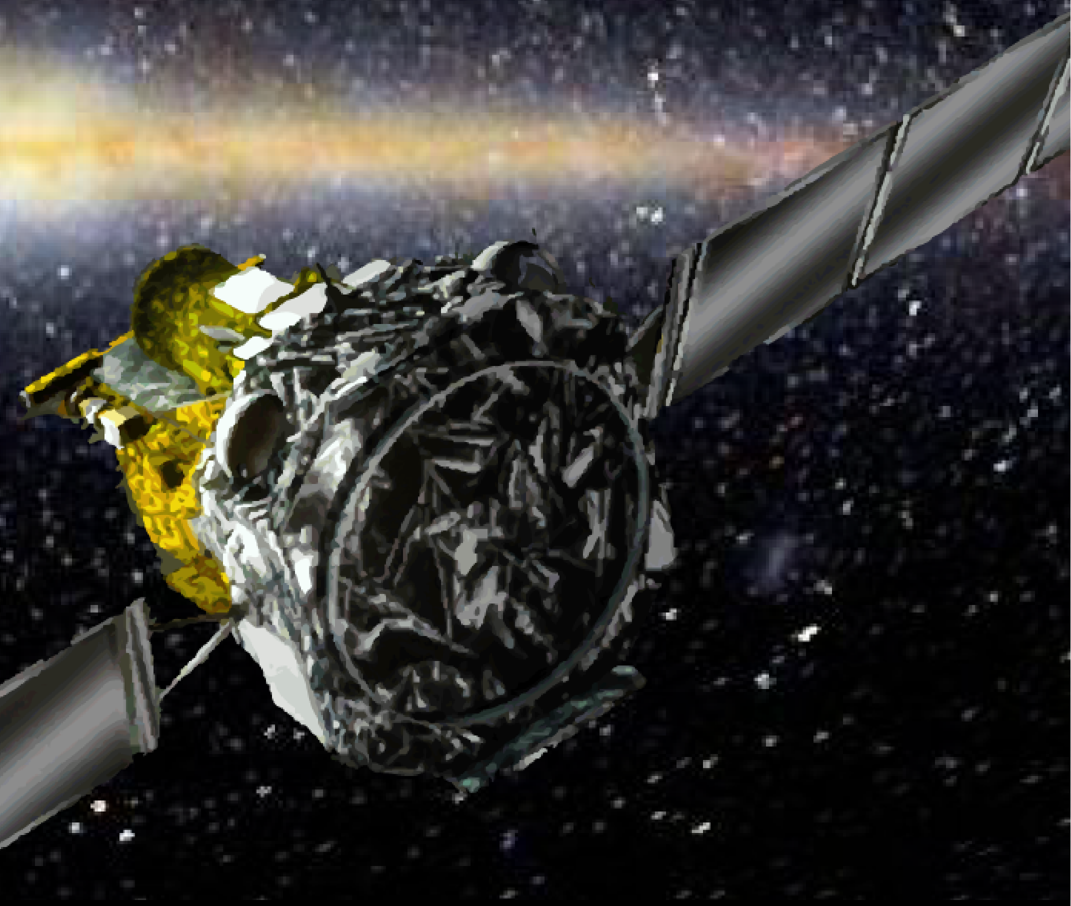
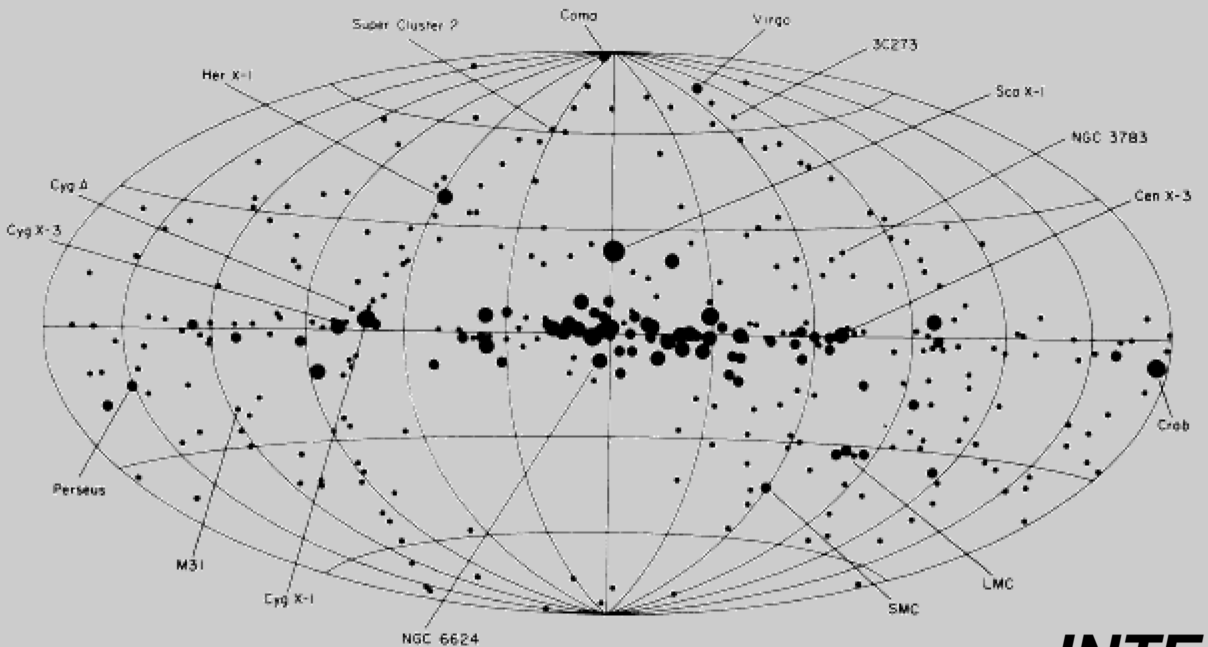


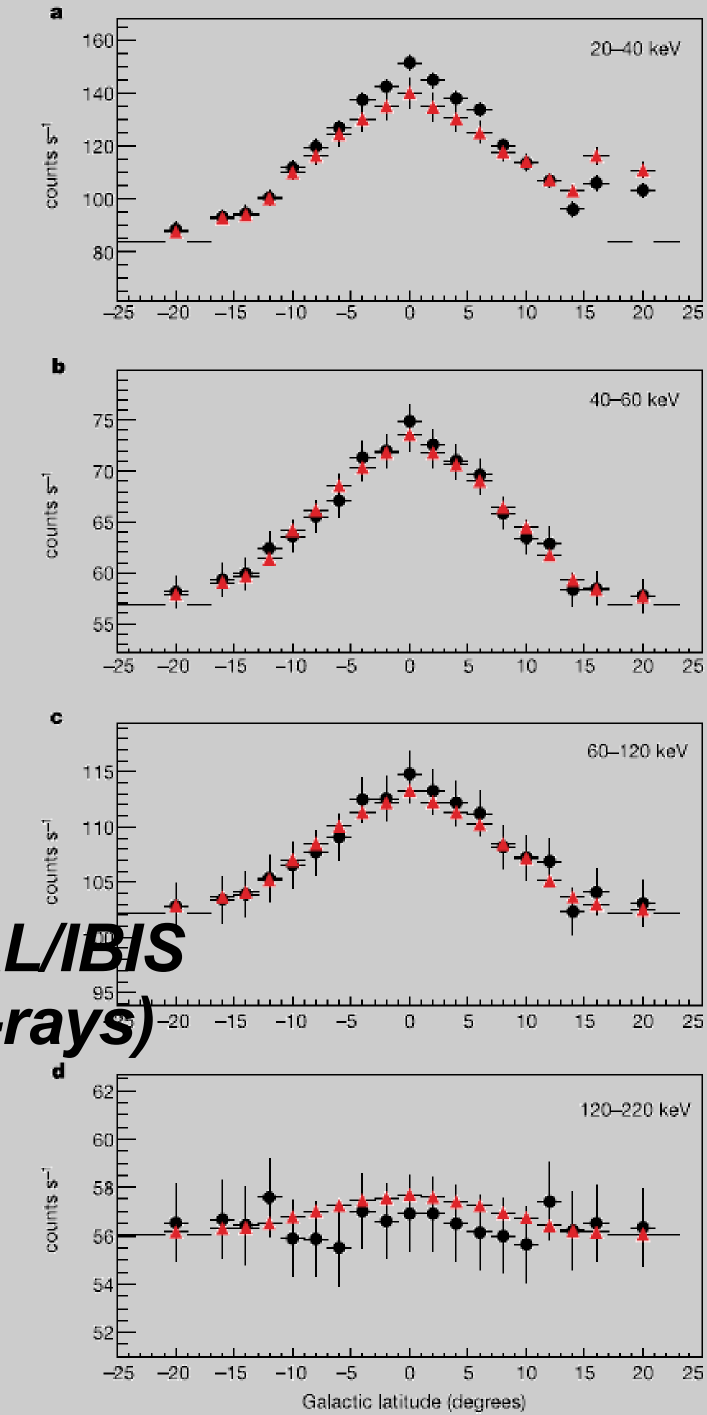
In general

Galactic emission in all X-ray bands is known to be dominated by bright point sources

Lebrun et al. 2004, Terrier et al. 2004

UHURU (standard X-rays)

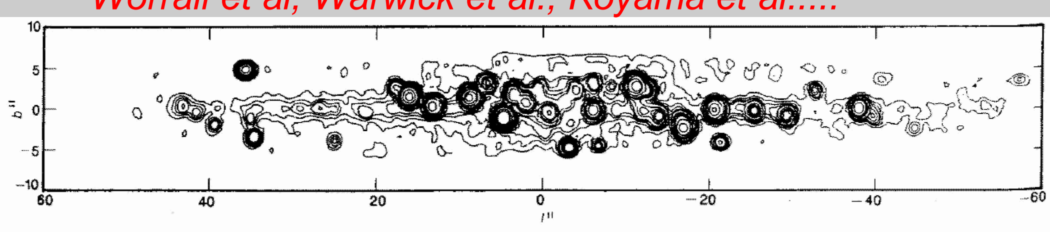


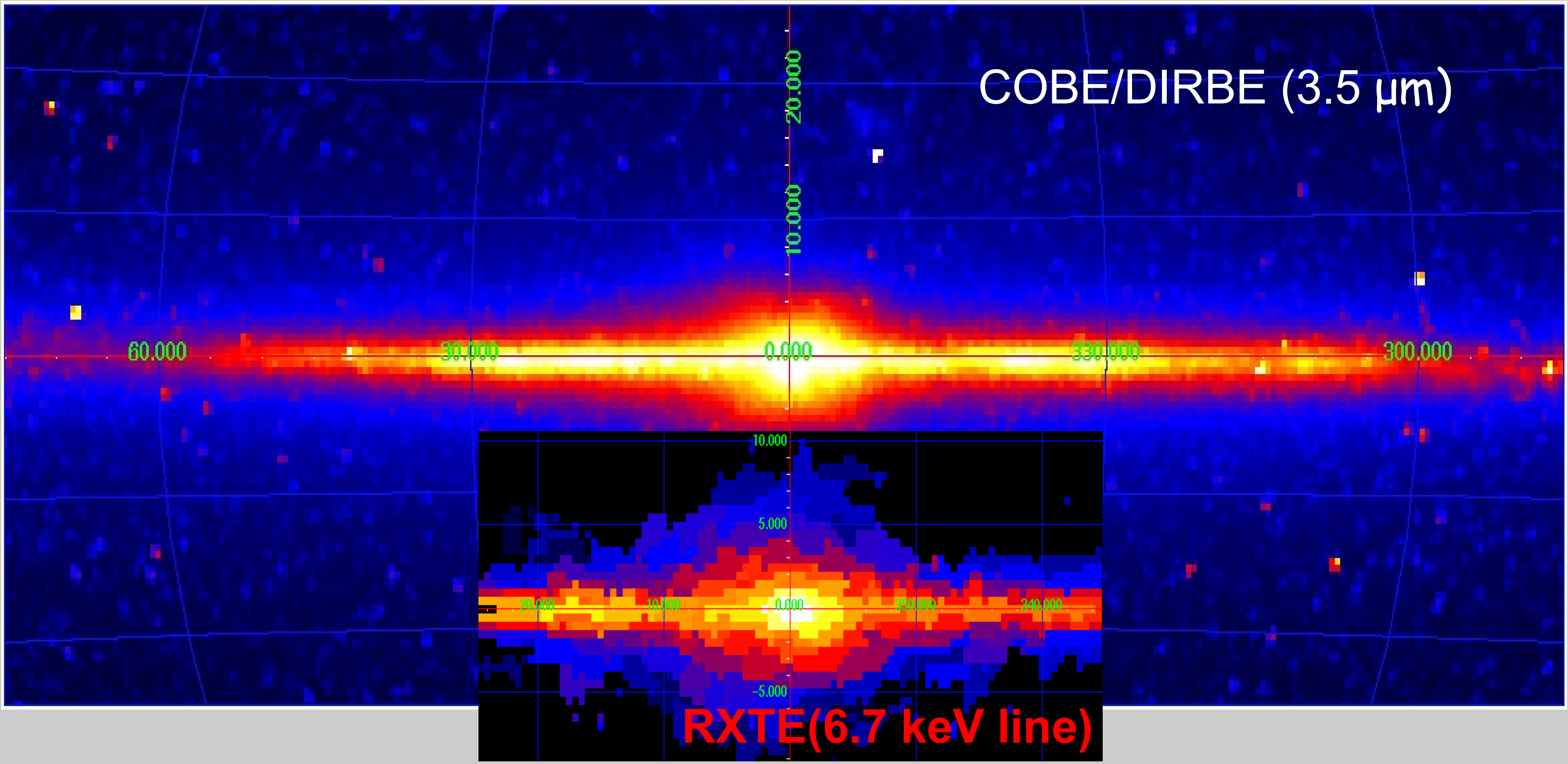


INTEGRAL/IBIS (hard X-rays)

BUT! Some «ridge» emission remains (HEAO1, EXOSAT, TENMA, GINGA....)

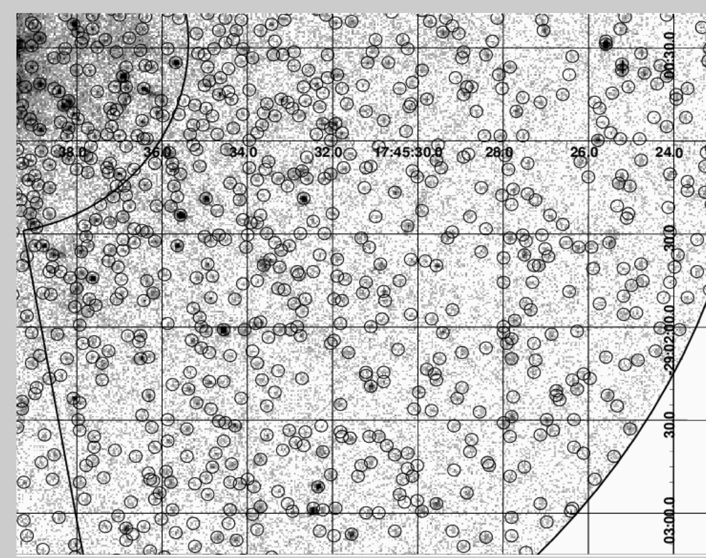
Worrall et al, Warwick et al., Koyama et al.....





Study in standard X-rays:

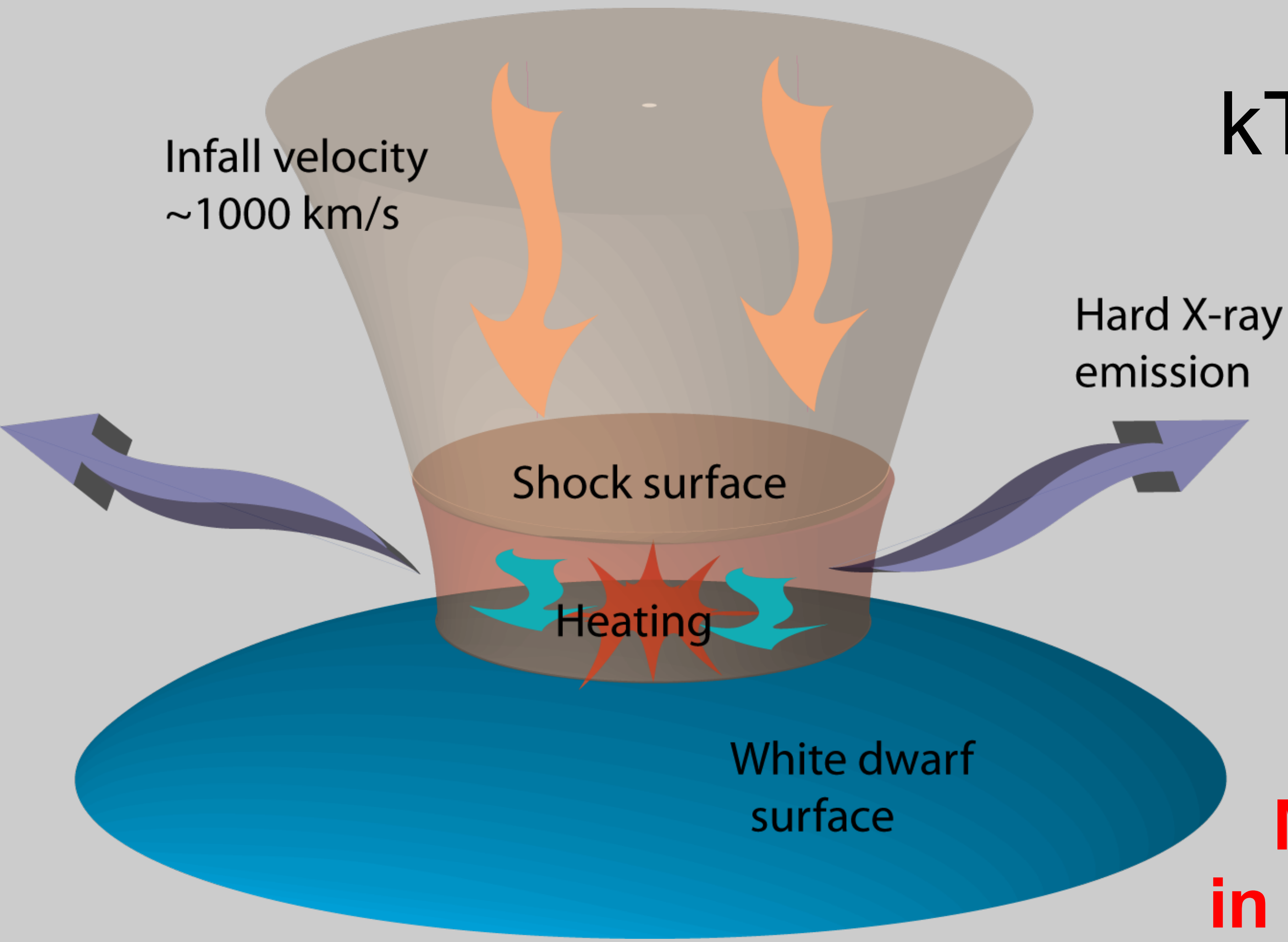
-> point sources origin (CVs+ABs)



BUT! ONLY IF HARD X-RAYS WILL ALLOW!

If Galactic background ~ Coronal stars + CV

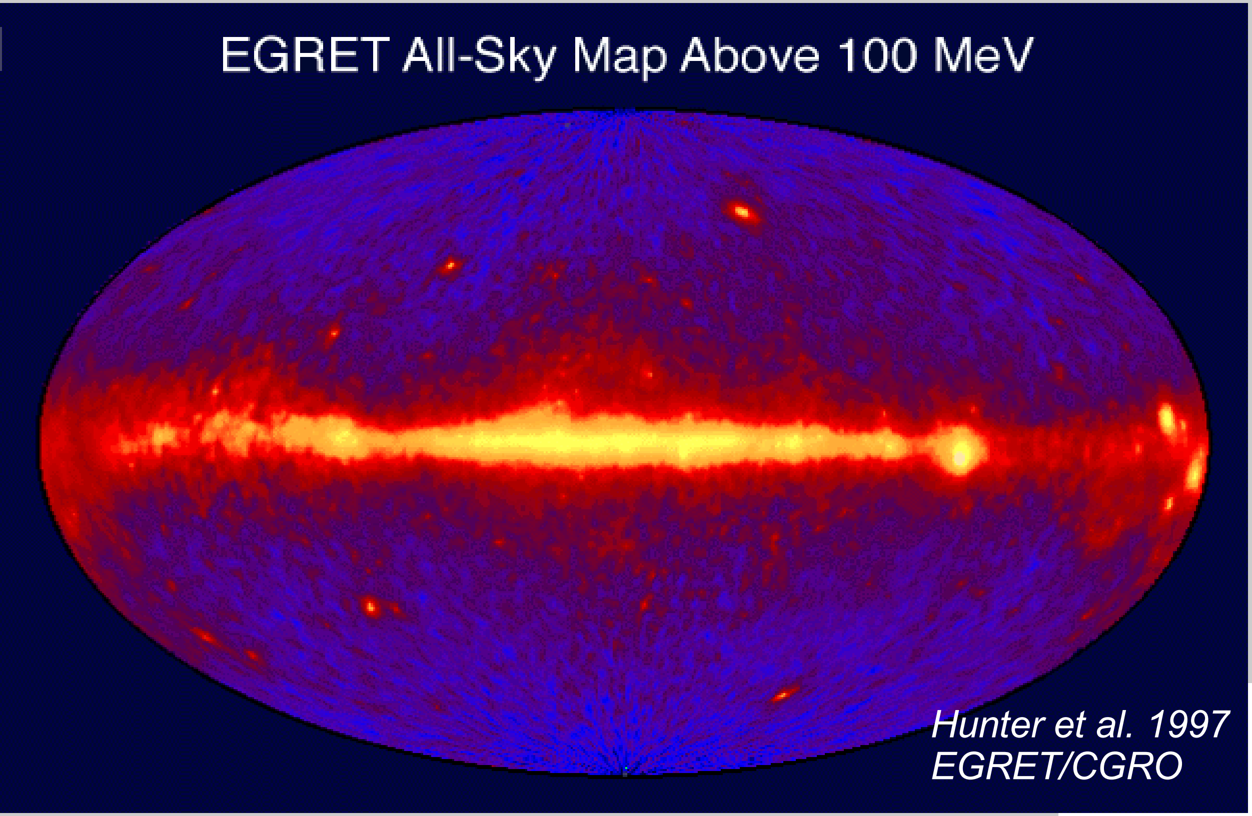
Maximal temperature ~20-30 keV (intrinsic property of CVs)



$kT \sim GM/R \sim 20$ keV

Maximal energy in X-ray background emission - ~30-40 keV?

Alternative? Similar to γ-ray bkg?

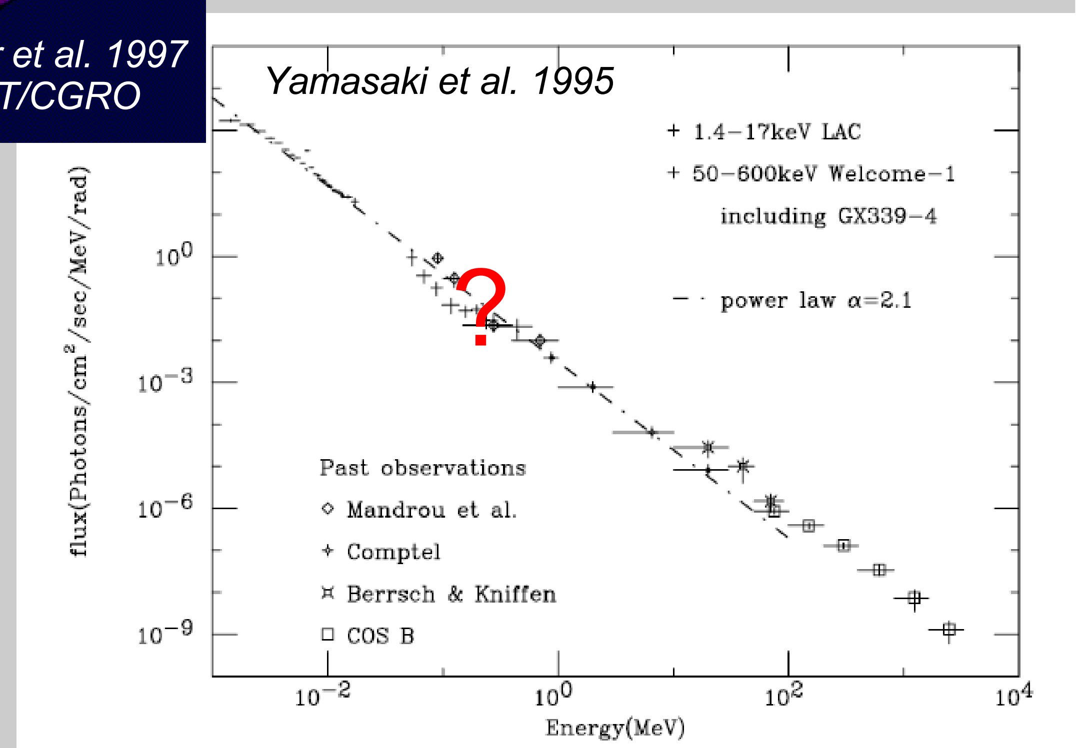


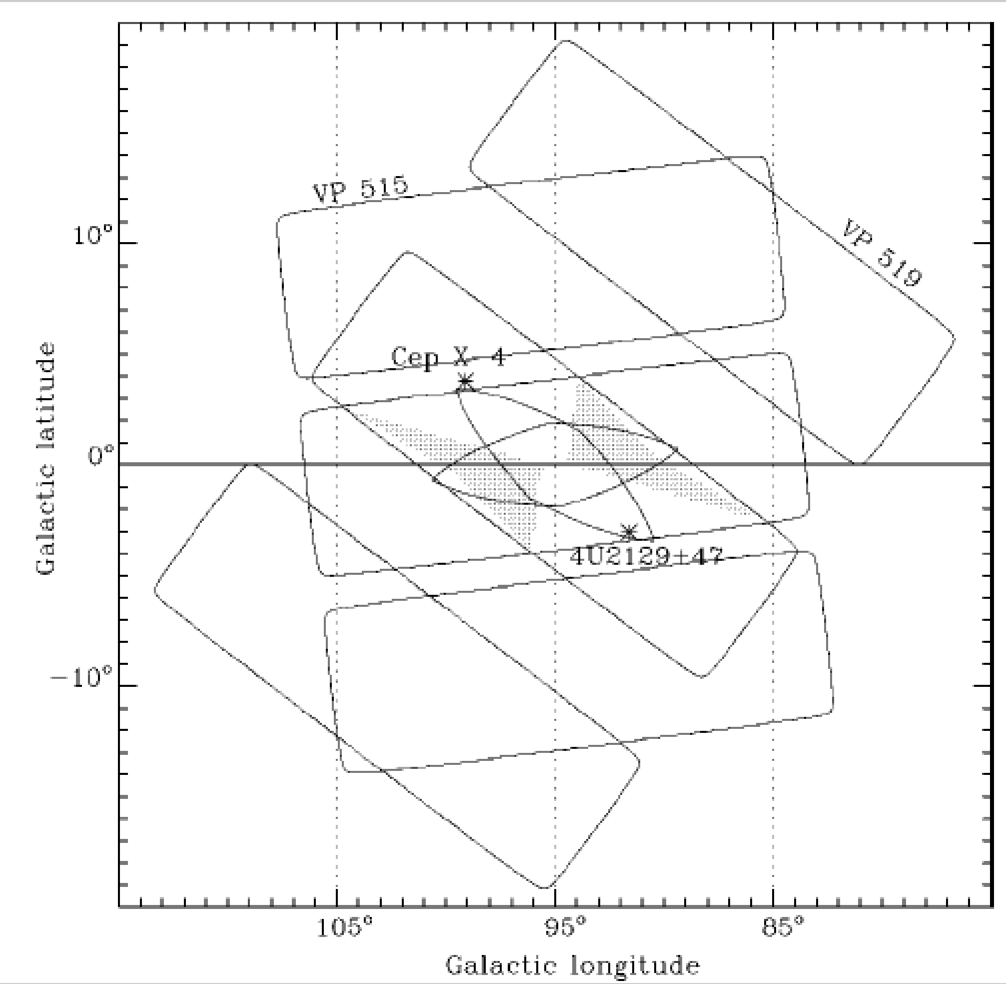
Known since late 1960ies

Luminosity ~10^{39} erg/sec

Originates as a result of cosmic ray interactions with ISM
~10^{-2}-10^{-3} of SN energy release in the Galaxy

POWER LAW IN HARD XRAYS?

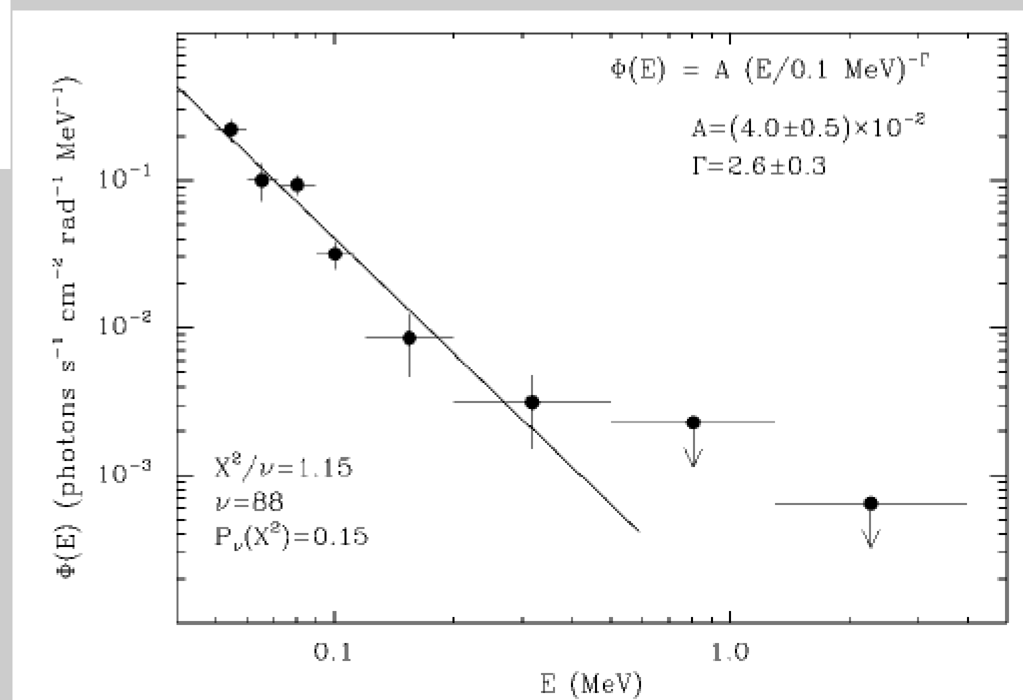




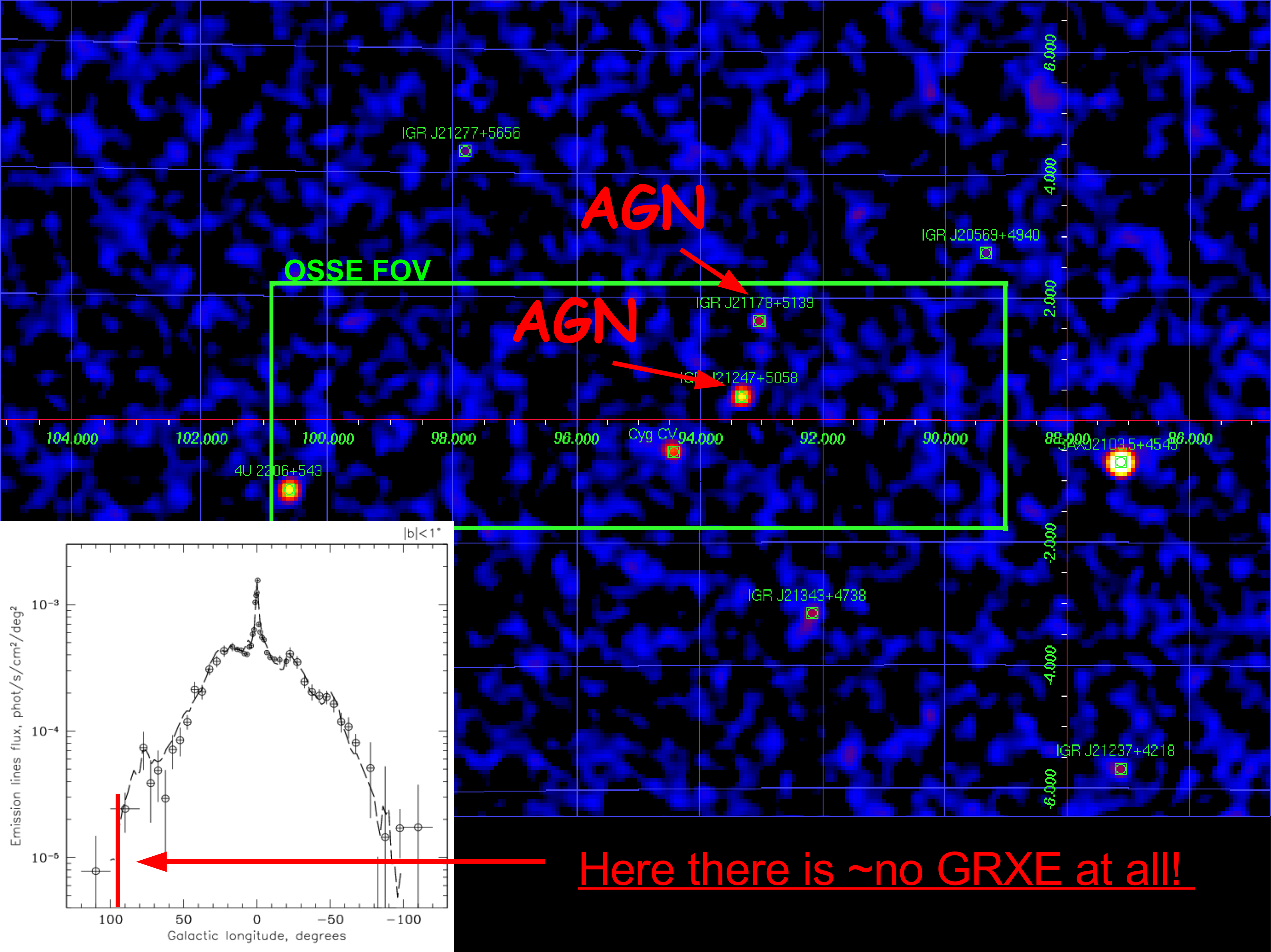
Skibo et al. 1997

VERY WEAK
$<10^{-7}$ phot/s/cm^2/deg^2/100 keV
(<100 phot/Msec/deg^2/1000cm^2)

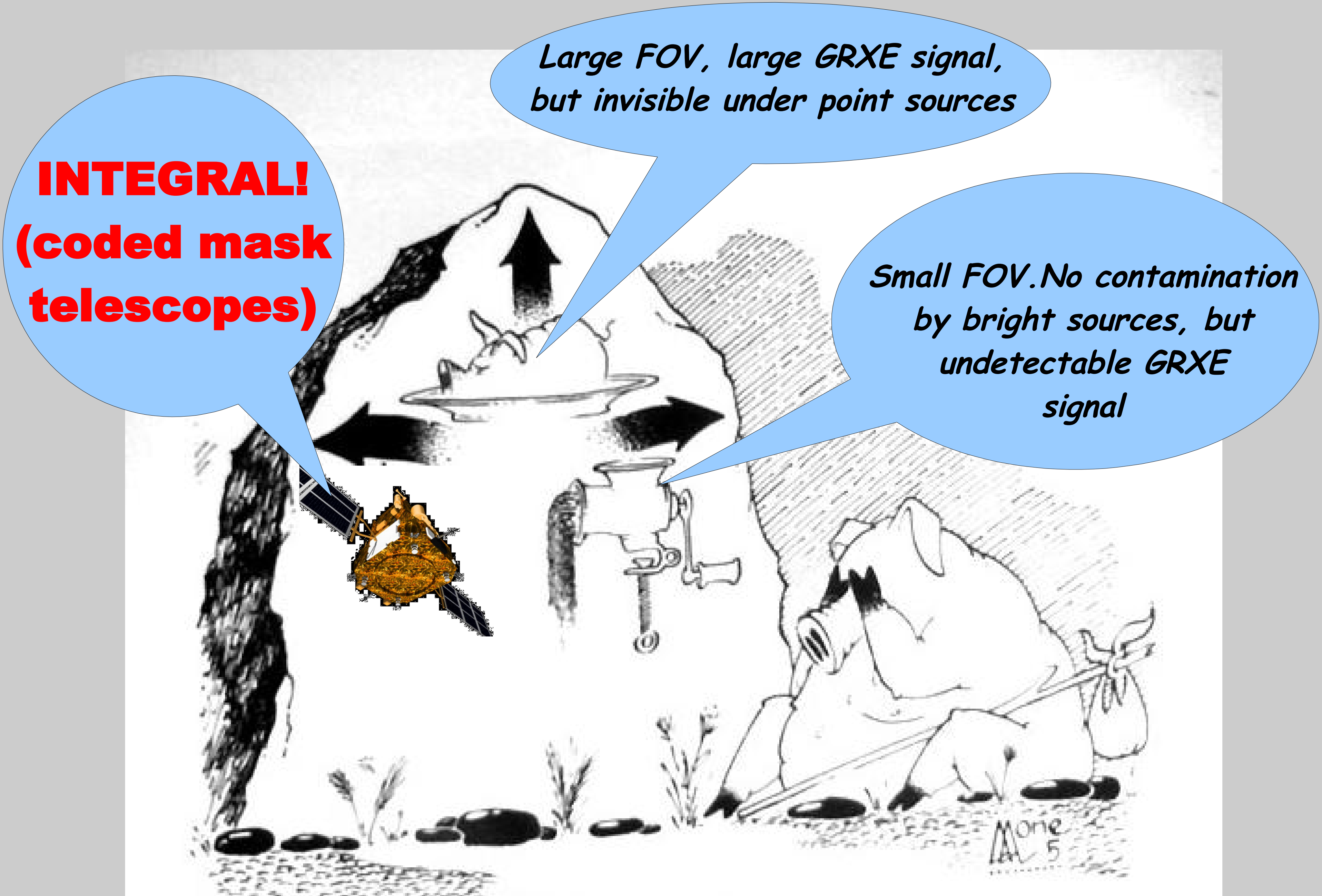
Example: CGRO/OSSE measurement



HUGE PROBLEMS WITH POINT SOURCES



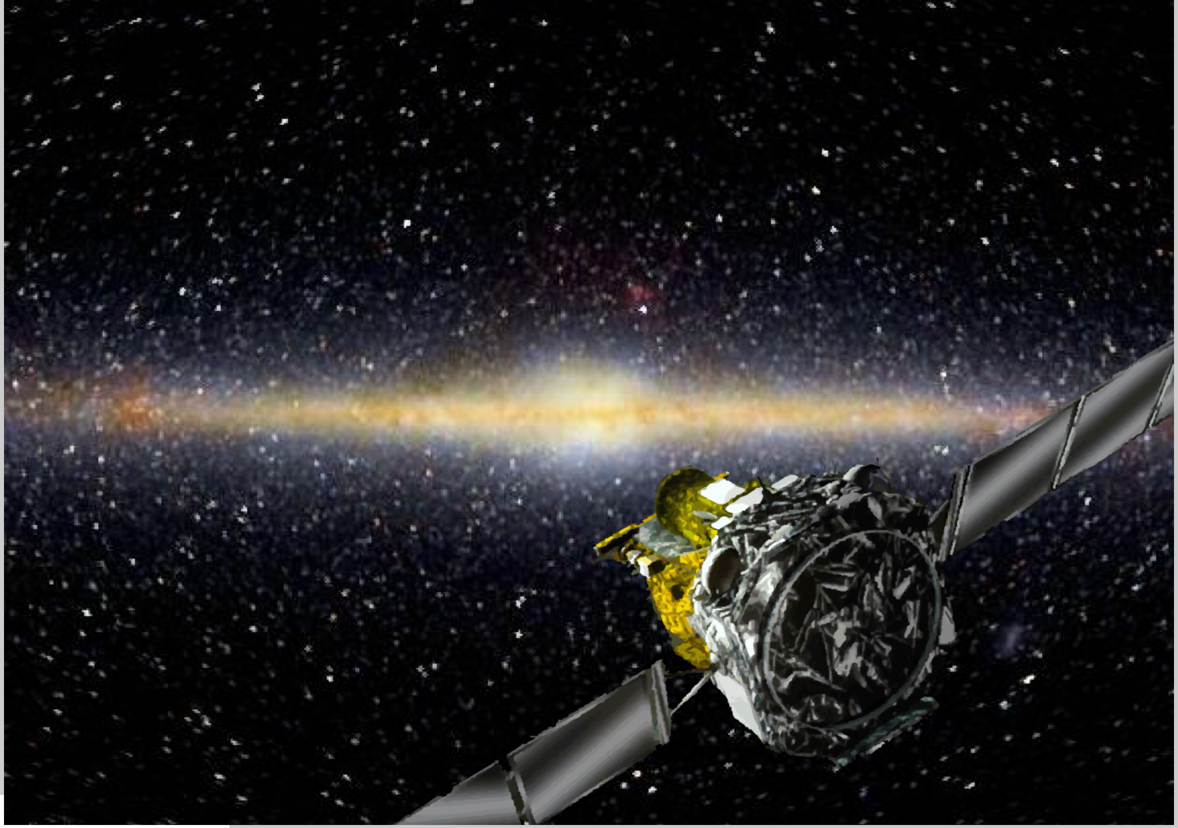
IGR J21277+5656
AGN
IGR J20569+4940
OSSE FOV
IGR J21178+5139
AGN
IGR J21247+5058
104.000
102.000
100.000
98.000
96.000
Cyg CV
94.000
92.000
90.000
88.000
86.000
SAX J2103.5+4545
4U 2206+543
6.000
4.000
2.000
-2.000
-4.000
-6.000
IGR J21343+4738
IGR J21237+4218
|b|<1°
Emission lines flux, phot/s/cm²/deg²
10^{-3}
10^{-4}
10^{-5}
100
50
0
−50
−100
Galactic longitude, degrees
Here there is ~no GRXE at all!

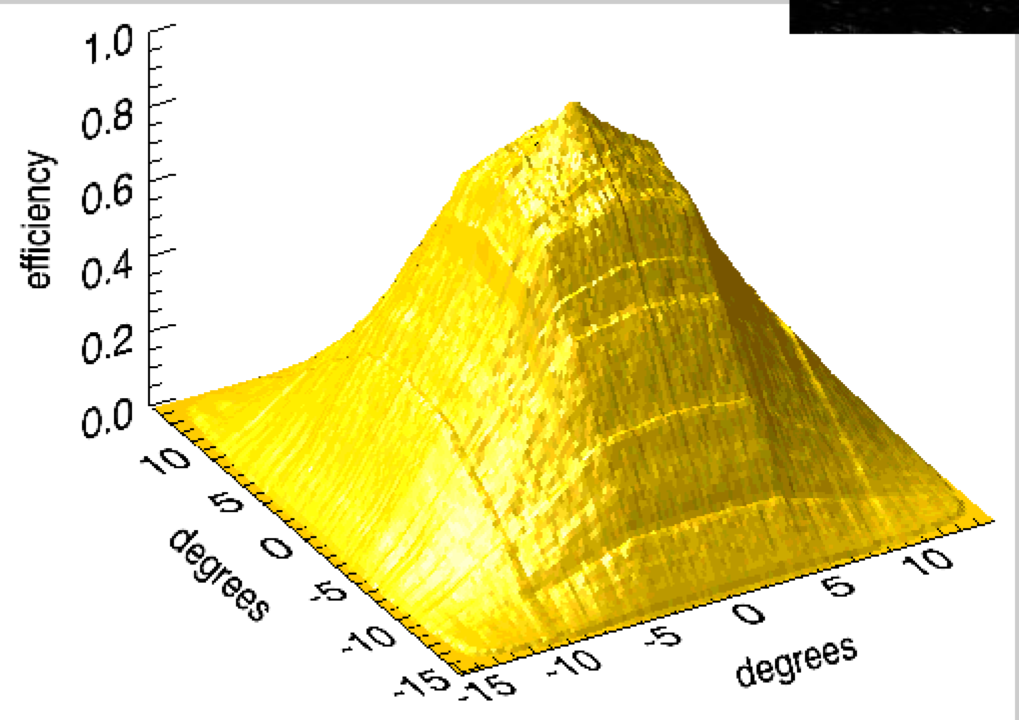

INTEGRAL! (coded mask telescopes)
Large FOV, large GRXE signal, but invisible under point sources
Small FOV.No contamination by bright sources, but undetectable GRXE signal

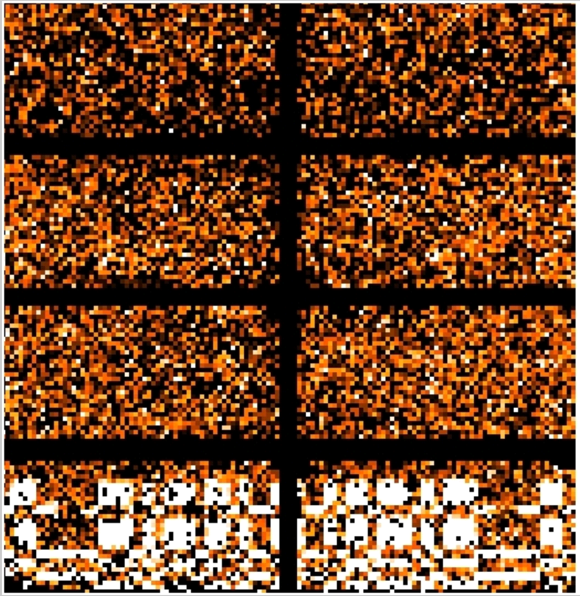
INTEGRAL

IBIS/ISGRI

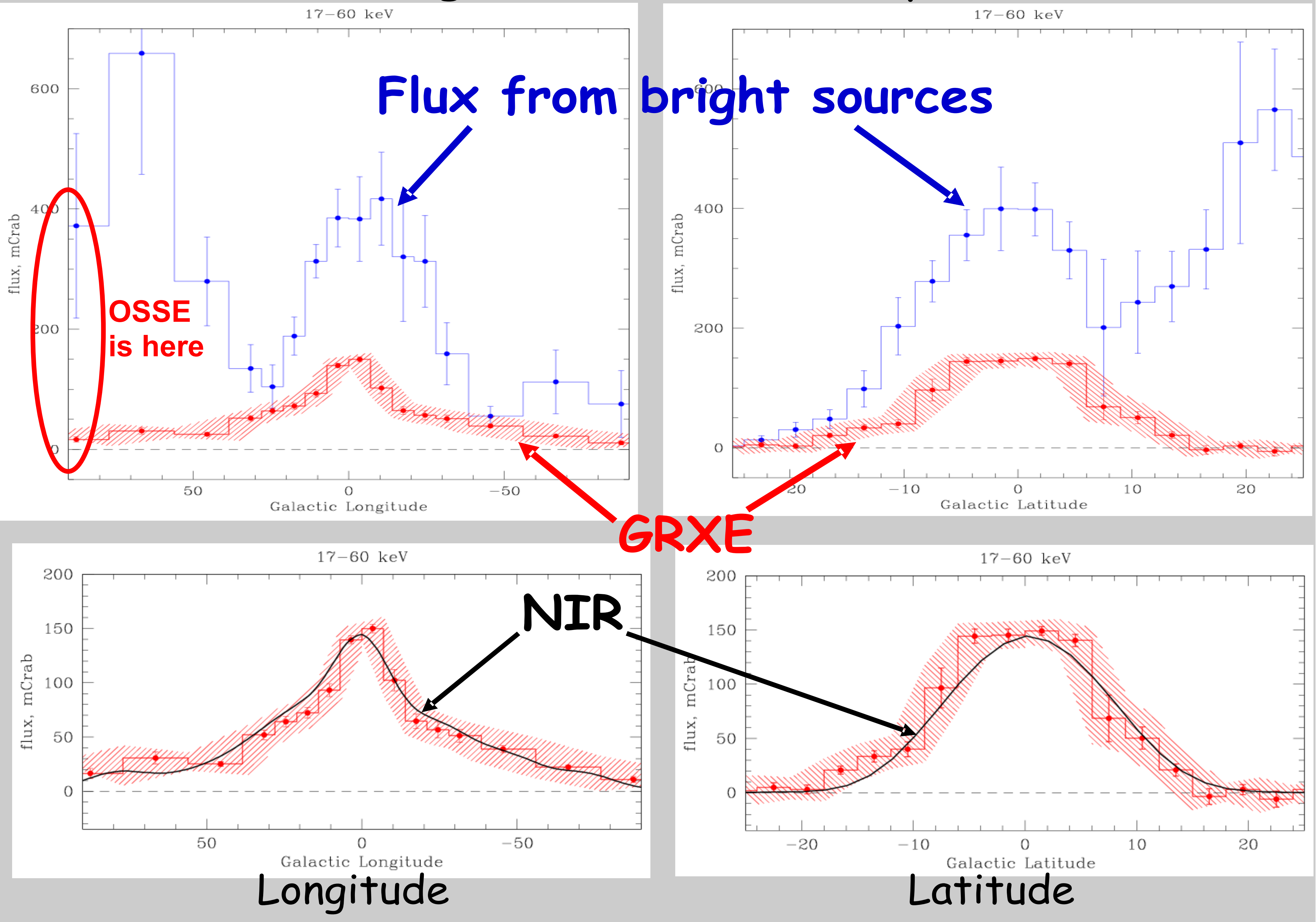
- 17 keV – 2 MeV
- FOV 28^o x 28^o
- angular resolution 12′



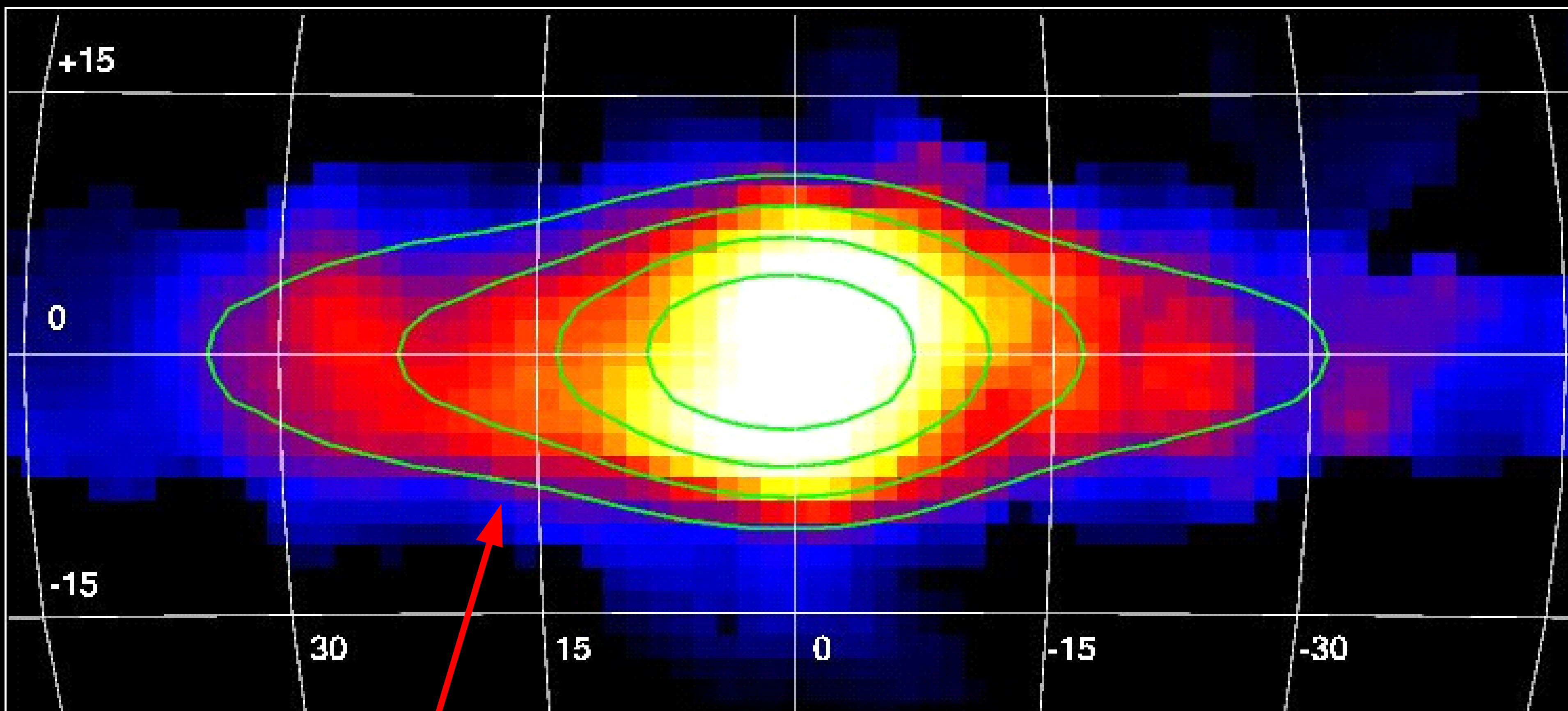




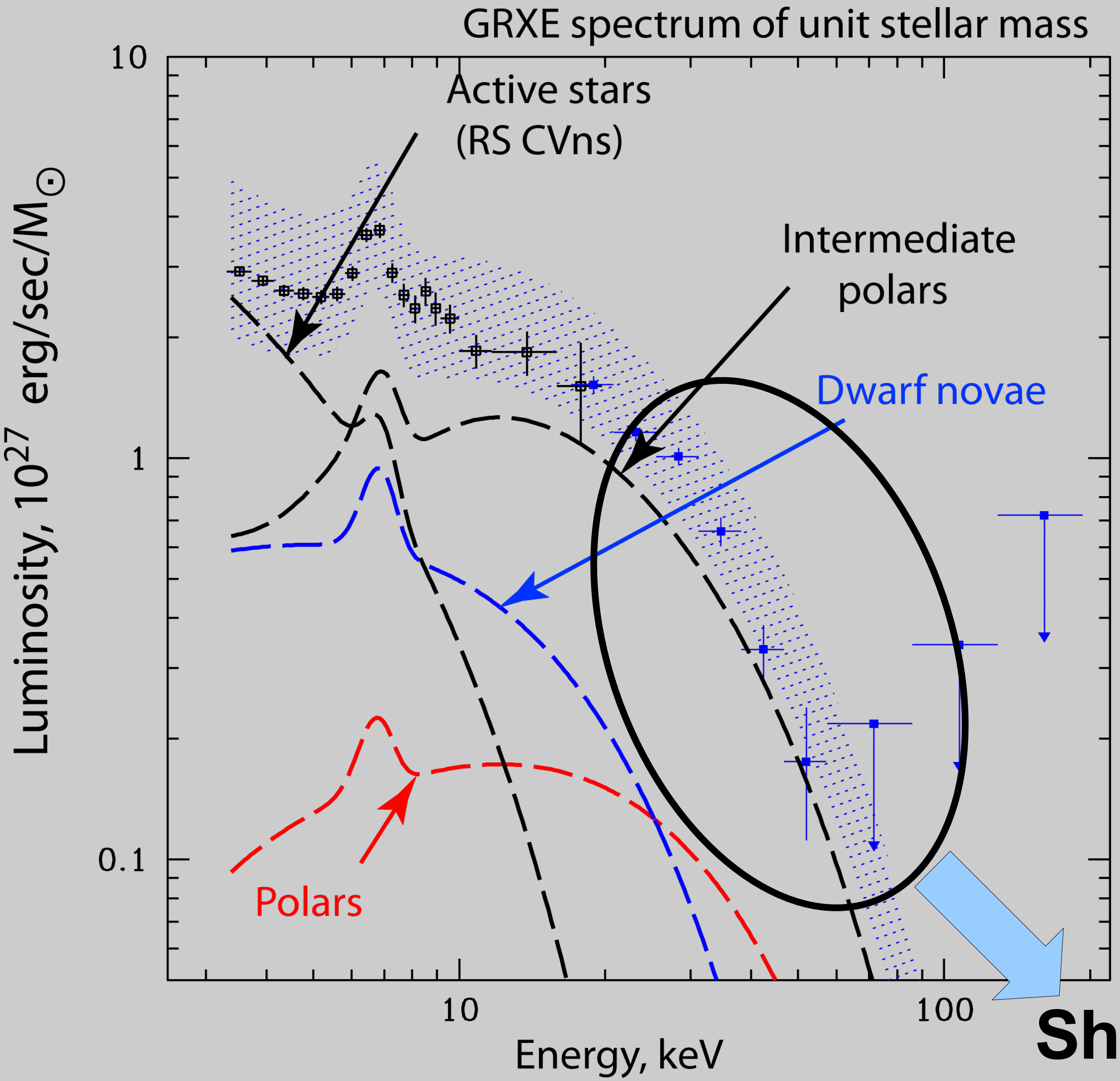
GRXE longitude and latitude profiles



GRXE map in hard X-rays (17-60 keV)



NIR contours

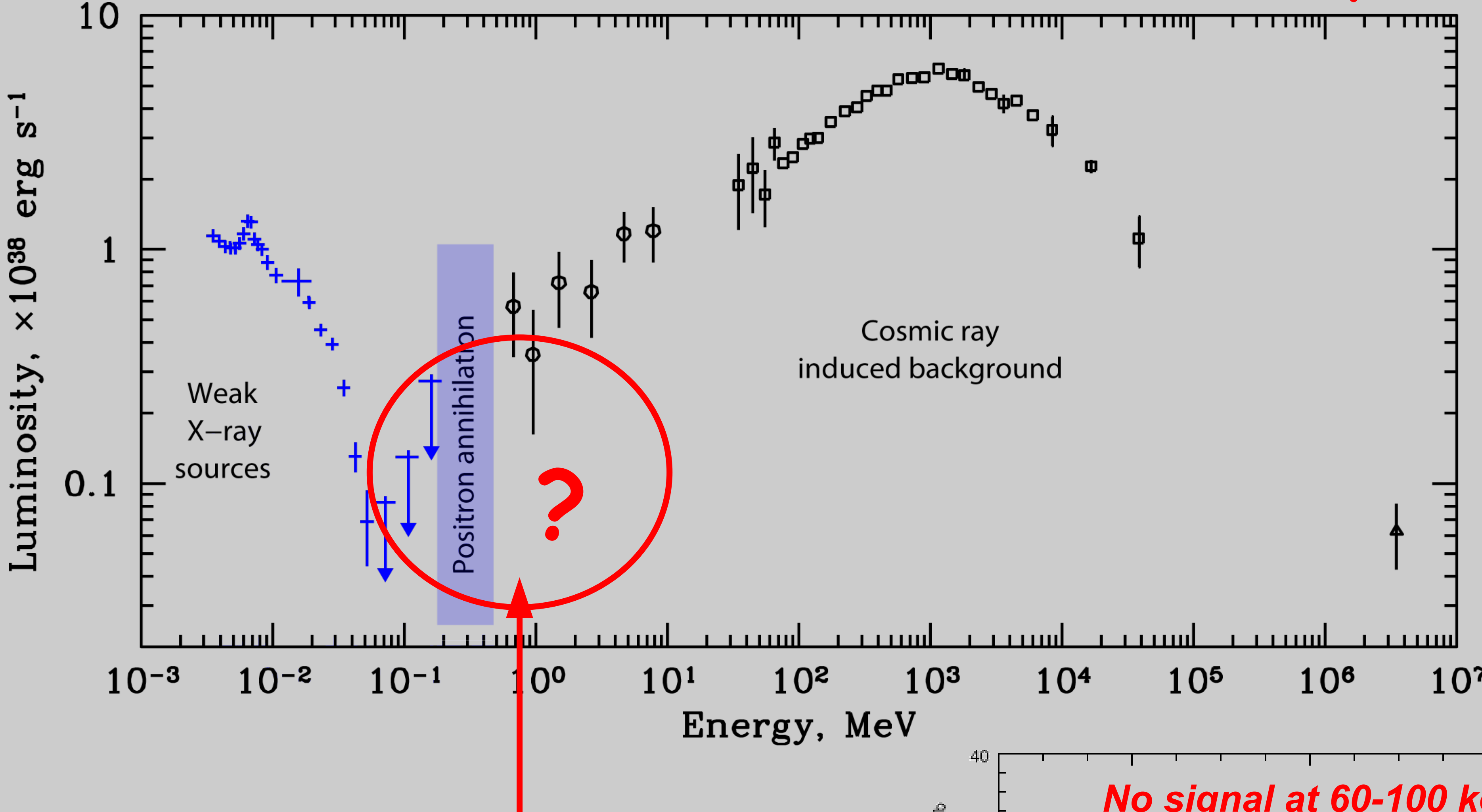


Galactic ridge emission in hard X-rays consists of emission of millions of CVs

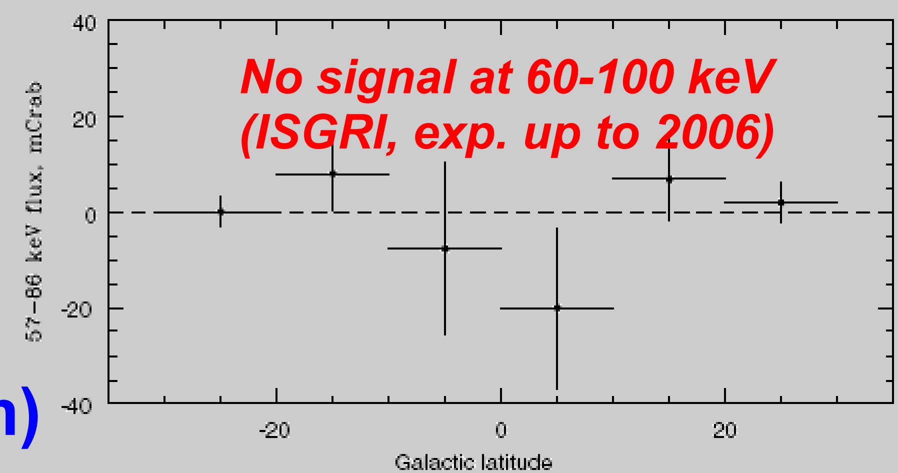
Shape of cutoff → average mass of WDs

$<M_{wd}>\sim 0.5\text{-}0.6\ M_{sun}$

Total extended emission of the Galaxy



What is here?

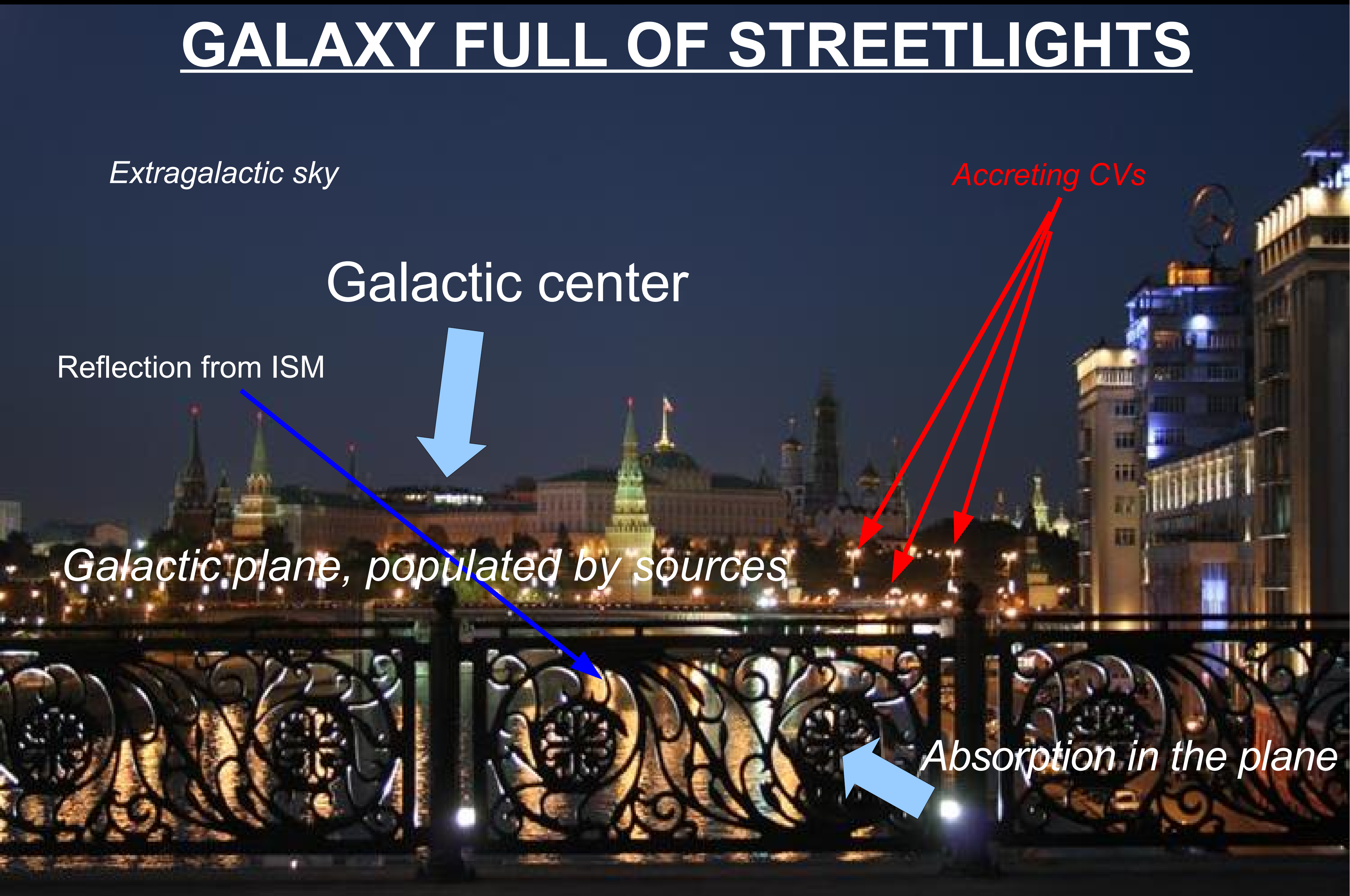


Hope we will know within next year (speciall designed INTEGRAL program)

Now we know the origin of pale stripe along the plane

Prospects for future?

Focusing hard X-ray optics?



Summary

1. GRXE study is one of very few areas where INTEGRAL results will not be surpassed for a long time!

2. Galactic ridge emission in hard X-rays is a result of activity of CVs

3. Shape of the ridge spectrum gives us the average mass of accreting WDs in the Galaxy

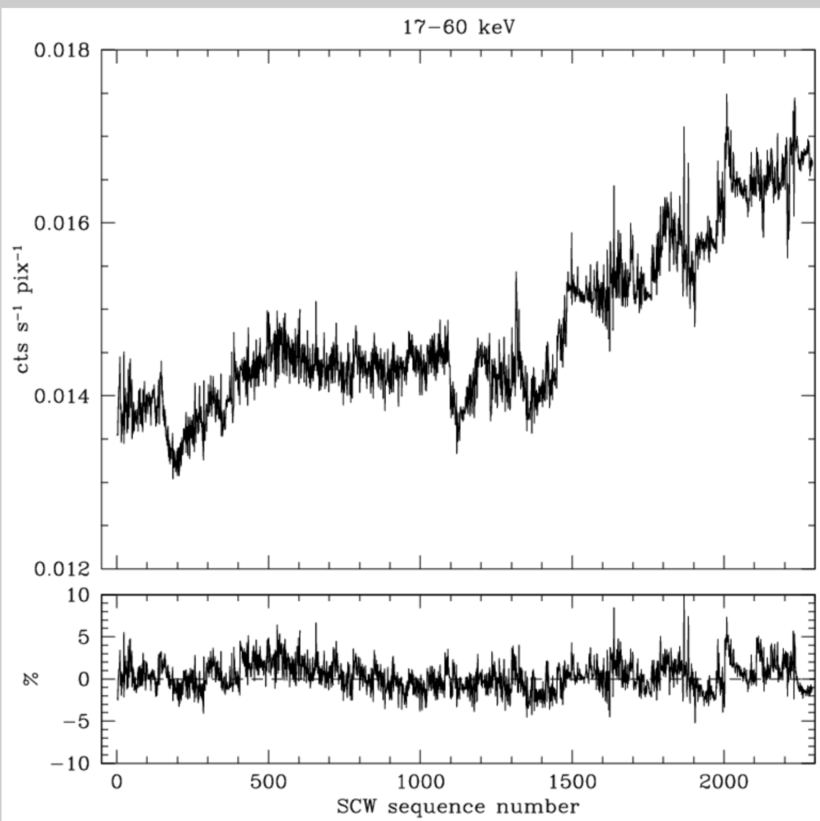
4. No unresolved emission is detected at 60-150 keV energy band. What is at higher energies? Where CR emission starts?

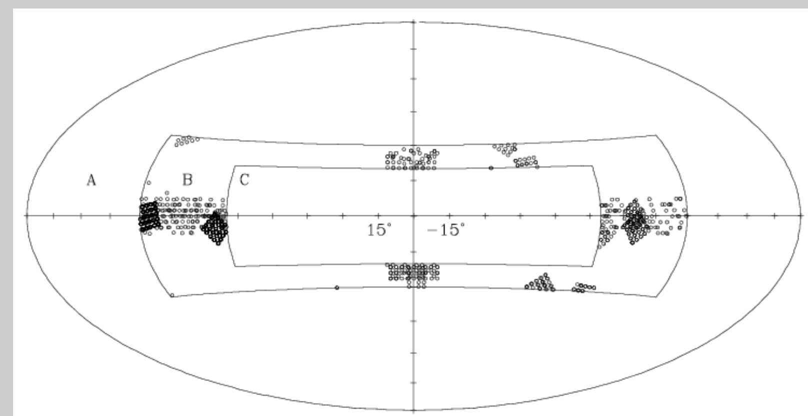
Method 1: Background model with tracers

1) Data filtering (~40% data rejected)

2) Extragalactic: $S_{17\text{-}60\ keV}=F(H_{0.6\text{-}1\ MeV})$

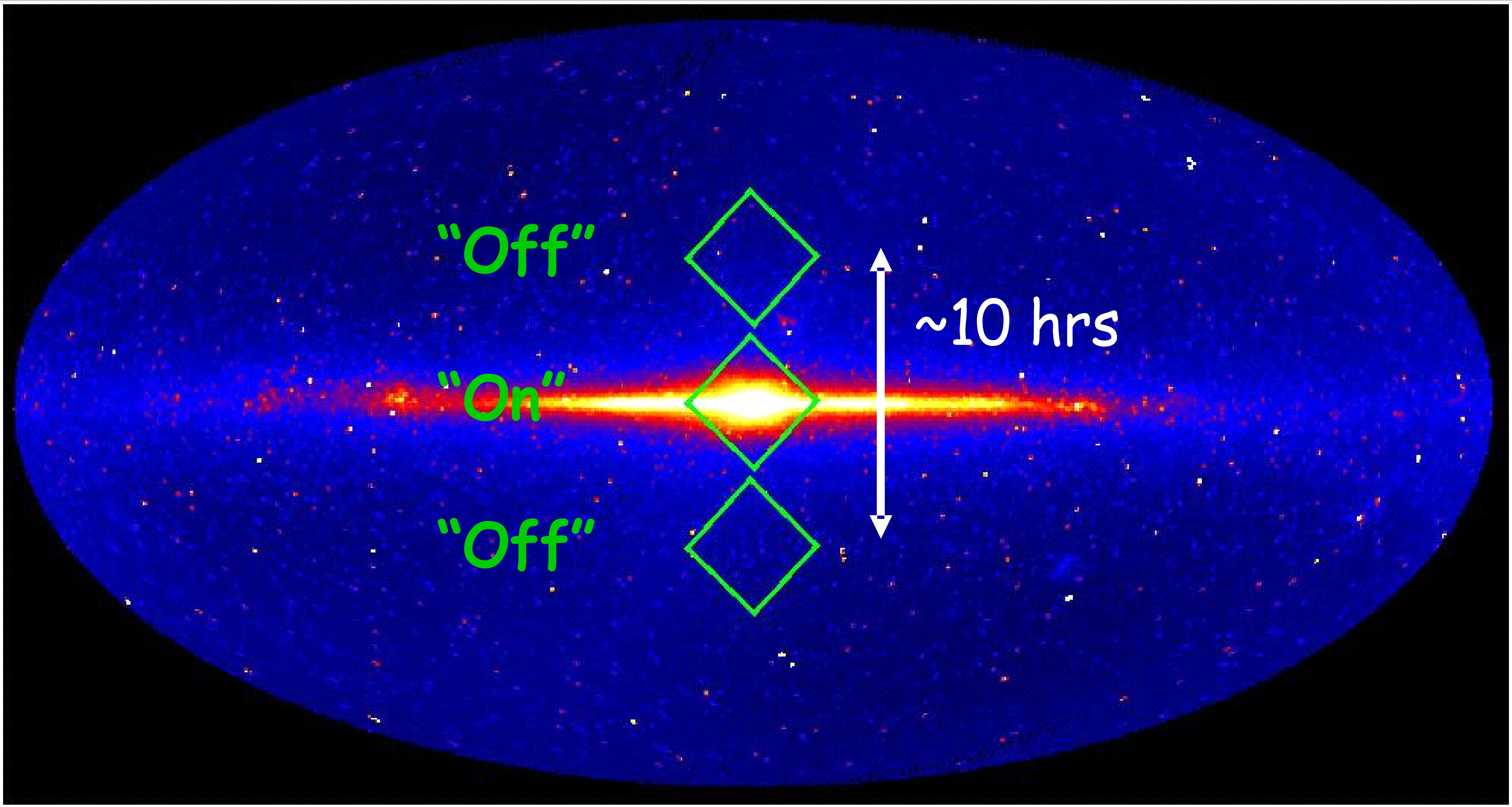
3) Galactic: $(S_{17\text{-}60\ keV} + GRXE) - F(\ H_{0.6\text{-}1\ MeV}\ ) = GRXE$





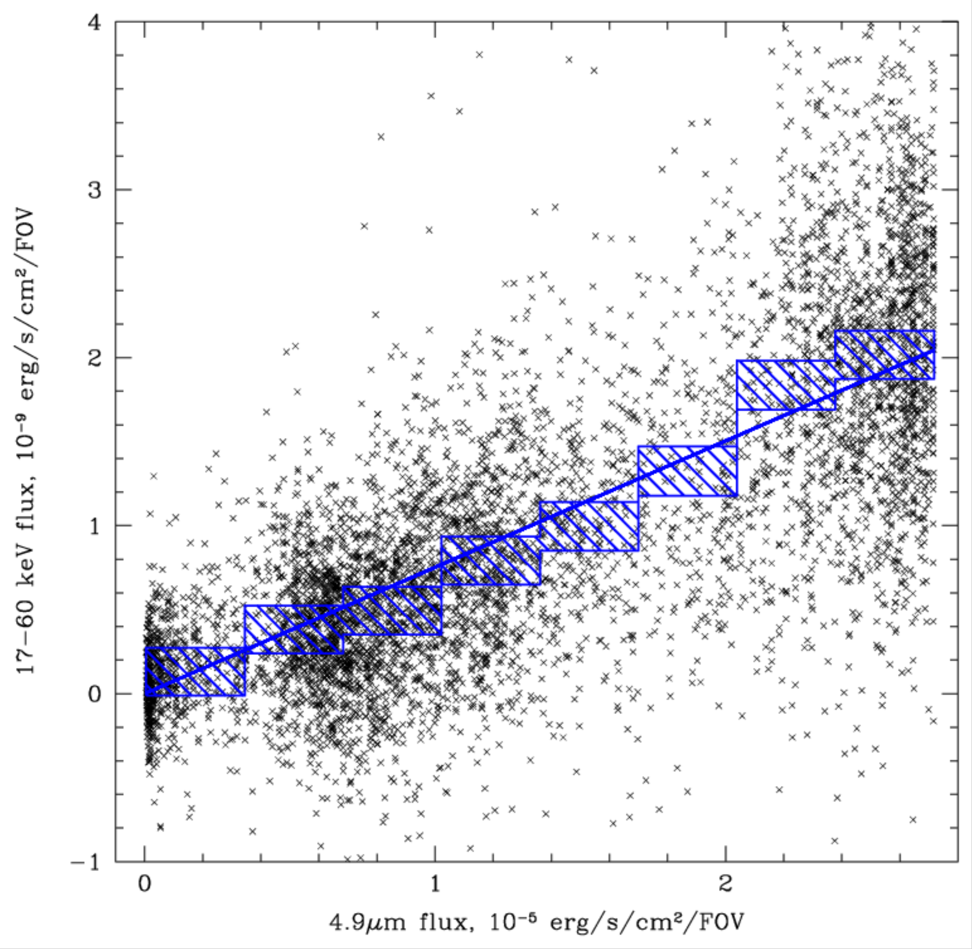
Background model uncertanity:
1-2% (17-60 keV)
or ~15 mCrab

Method 2: Rocking mode approach



* No systematics!
* Statisticaly limited accuracy ~2 mCrab (~1 Msec)

NIR- to X-ray correlation



$I_{17\text{-}60\ keV}/I_{4.9\mu m} \sim 10^{-4}$

$L_{4.9\ \mu m} = 10^{41}$ erg/s

$L_x = \sim 10^{38}$ erg/s

mCV: $\sim 10^{32}$ erg/s

$\sim 10^6$ accreting CVs in Galaxy

Disk/Bulge separately: