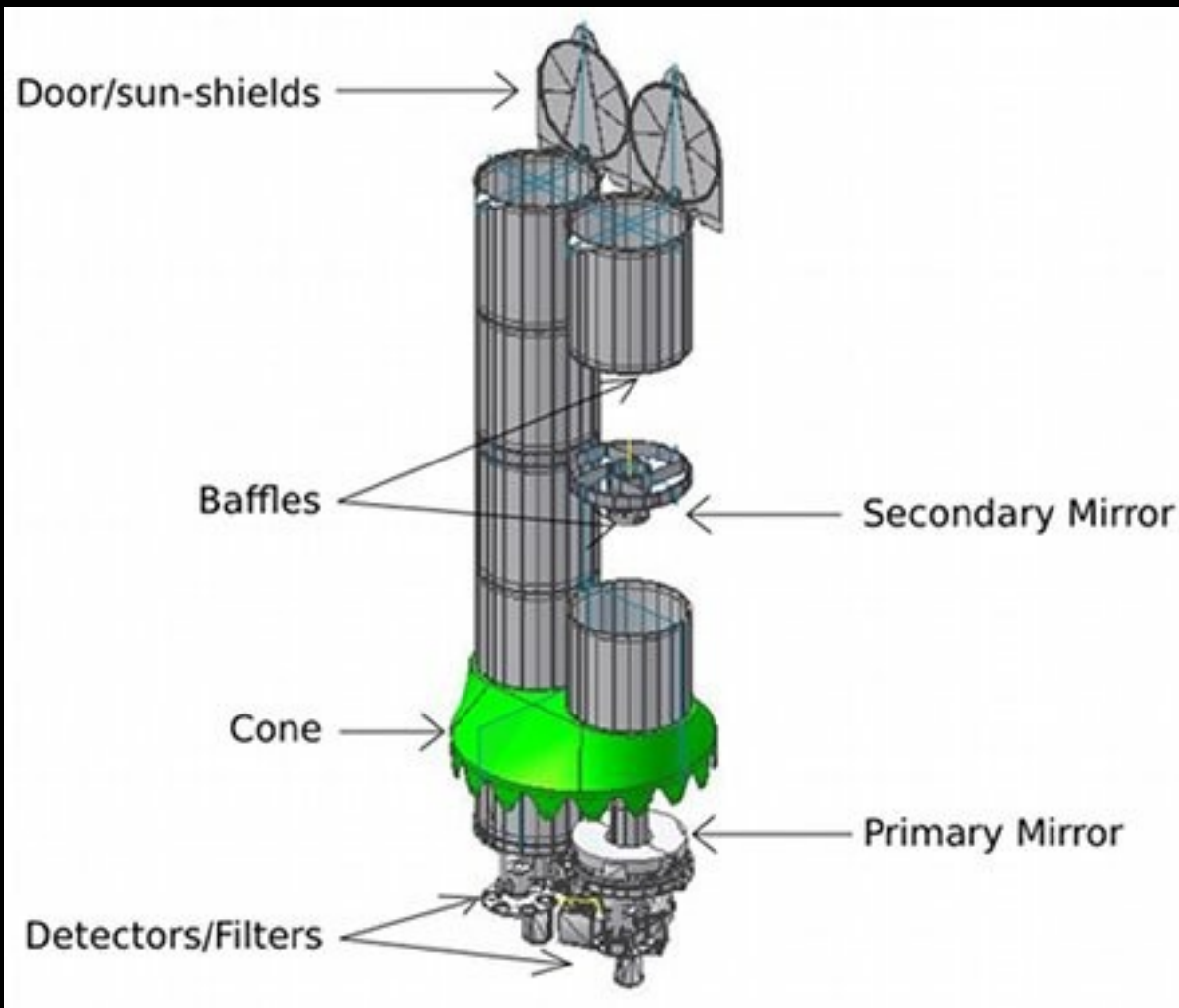


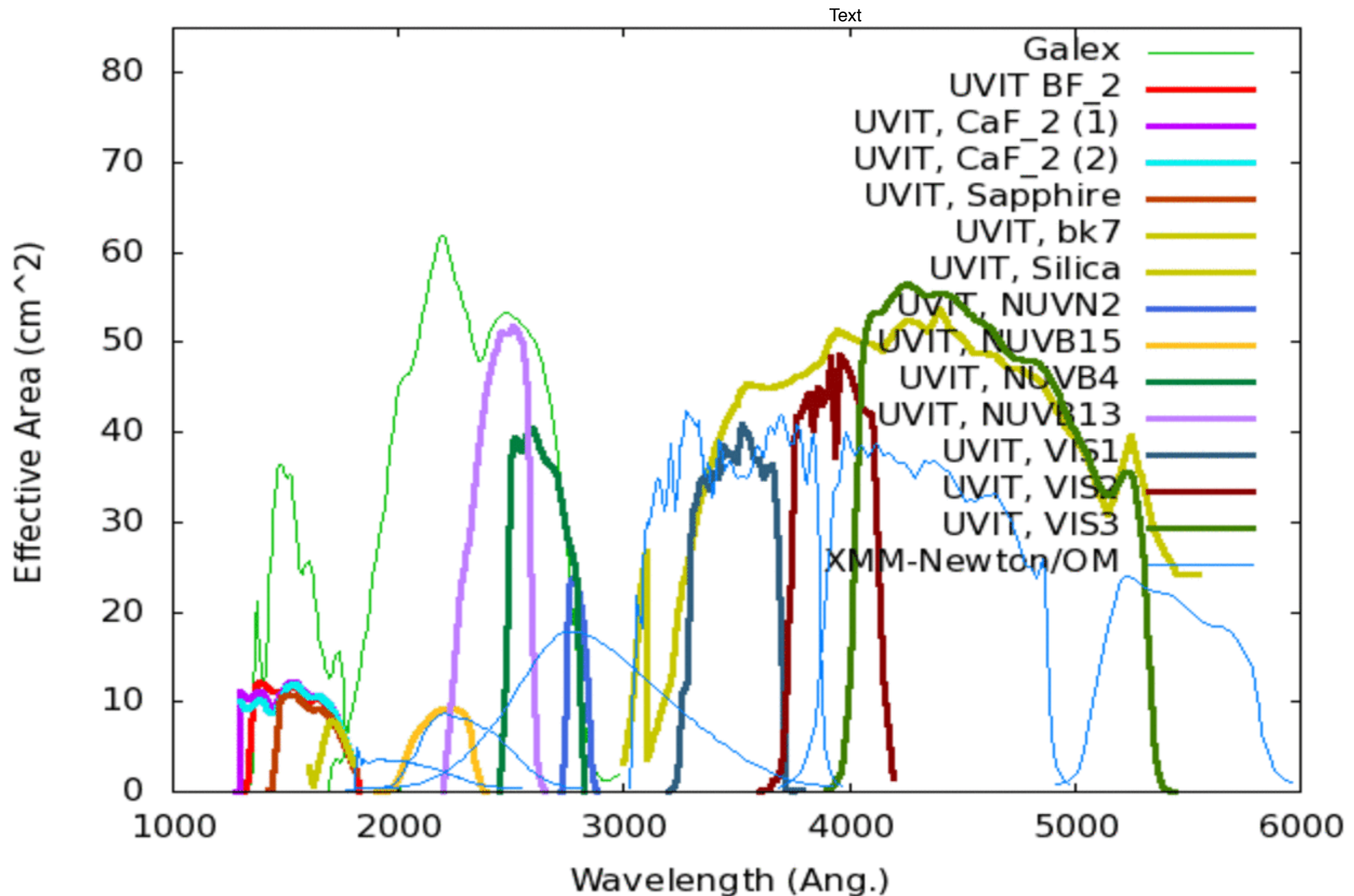
Hot Stars with UVIT

F. K. Sutaria, J. Hutchings,
interested members of the UVIT science
team



Acknowledgment:
All Astrosat instrument PIs
& teams

Comparing effective areas / sensitivity across instruments



Primary instruments across various science target

Stars, stellar clusters: UVIT ($T_{\text{exp}}=800$ s, for $T_{\text{eff}}=50000$, 10σ Detection), SXT, possibly LAXPC

Dosage limit: 20,000 counts / frame in UVIT

Exoplanets: UVIT (grating + transit photometry) SXT ? SSM ?

Supernovae: UVIT, SXT, SSM

SNRs: UVIT, SXT

Compact objects:

CVs: UVIT (grating), SXT, LAXPC, SSM

LMXBs/HMXBs: LAXPC+CZT, SXT, UVIT (companion/counterpart)

Bursting X-ray sources: SSM, LAXPC + CZT

Isolated, X-ray bright NS: SSM+LAXPC, CZT

Magnetars: SSM+LAXPC, CZT (too faint for UVIT)

ULXs: SXT (resolving individual sources may be a problem), UVIT

Extragalactic objects:

AGNs: UVIT, SXT, LAXPC

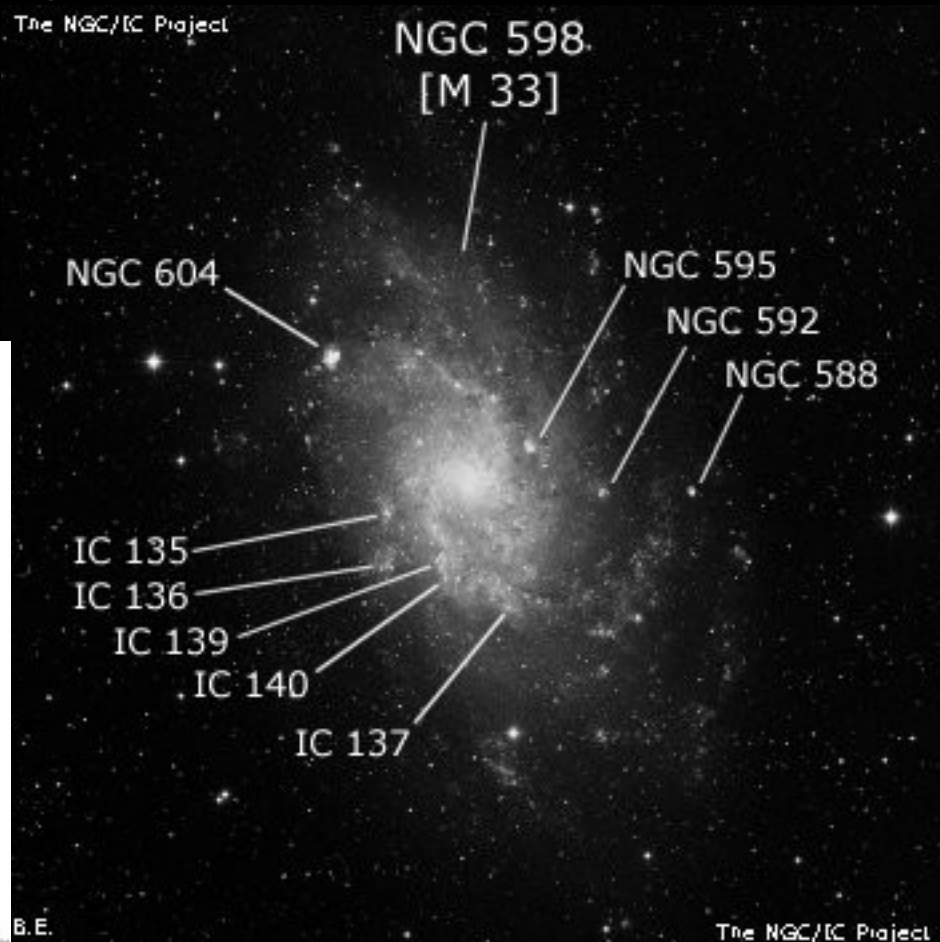
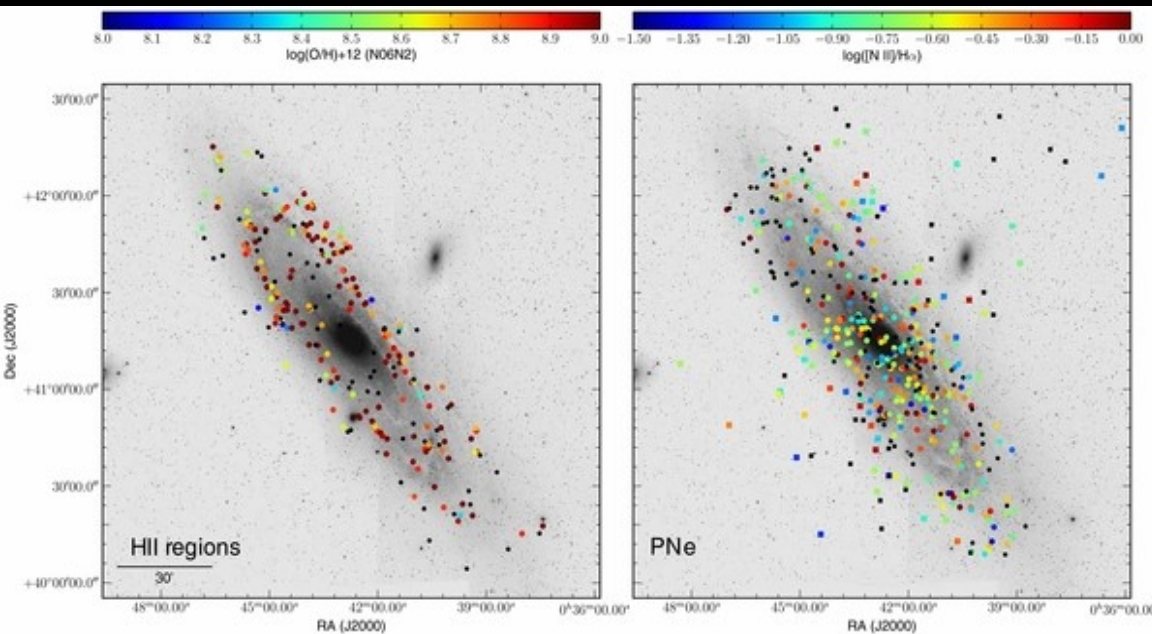
Nearby Galaxies: UVIT,

Others:

Diffuse UV background: UVIT, (imaging obviously!)

Massive star fields in M31 and M33 (spiral galaxies)

- **Search for** massive stars in Giant HII regions .
- **Aim:** Study star formation & stellar evolution.
- **M33-** NGC 604, NGC 595, NGC 592, NGC 588 –
- All fields are well studied with XMM-OM.
- NGC 588 & NGC 592 also with HST (F170W, F140 W).
- Several massive stars, including 6 Wolf Rayet stars
- **Typical star counts** in 17' x 17', UVW2 = 97 sources (NGC 588),
- **Typical stellar flux:** $M_B=18$ to 20.
2 cps (BaF2) to 5 cps (NUV15)



Case Study: Massive star fields in M33 (NGC588)

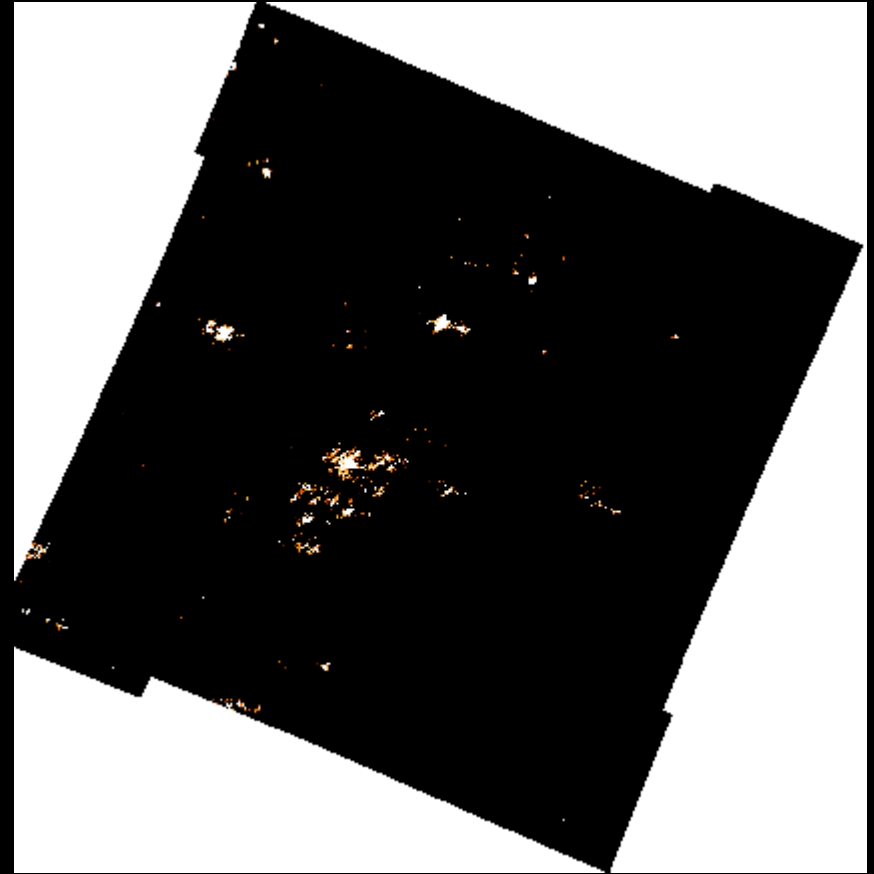
Observational advantage:

Sparse fields (~ 100 objects in the FUV).

Bright sources: 1 to 0.01 ct/s (UVW2).

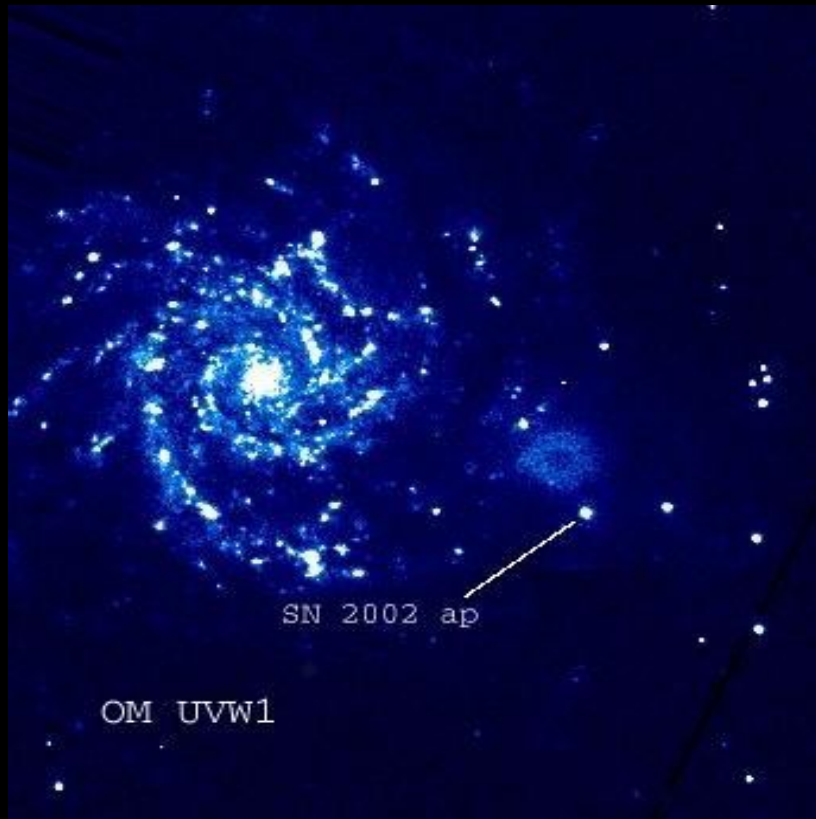
NGC 588-UIT 008:

peculiar object (type Ofpe/WN9),
Quiescent states of LBVs.



NGC588 in XMM-OM/UVW2, ~ 14 ks
Exposure.

Supernovae & SNRs with UVIT & other Astrosat Instruments

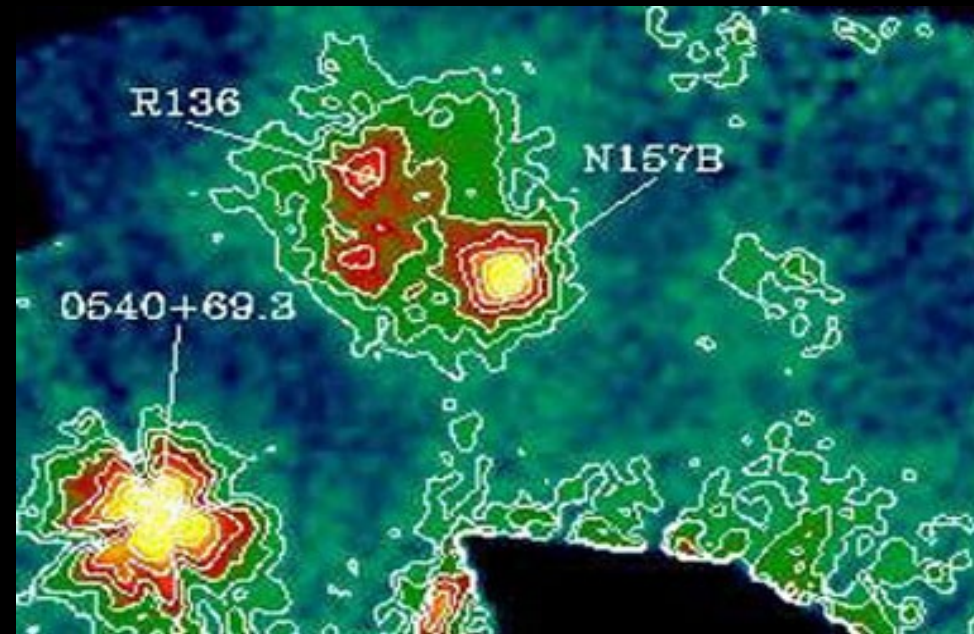


▲ SN2002ap in XMM-OM, UVW1

SNRs in LMC: ASCA SIS maps of 30 Dor Region (Image credit ASCA / Wang)

Early time UV monitoring of type-IIIn SN2011ht
Lead to estimate of ρ_{CSM} .

▲ ASCA observations of the supernova remnant SNR 0540-693 in the LMC with pulsar PSR B0540-69 (Image credit ASCA)

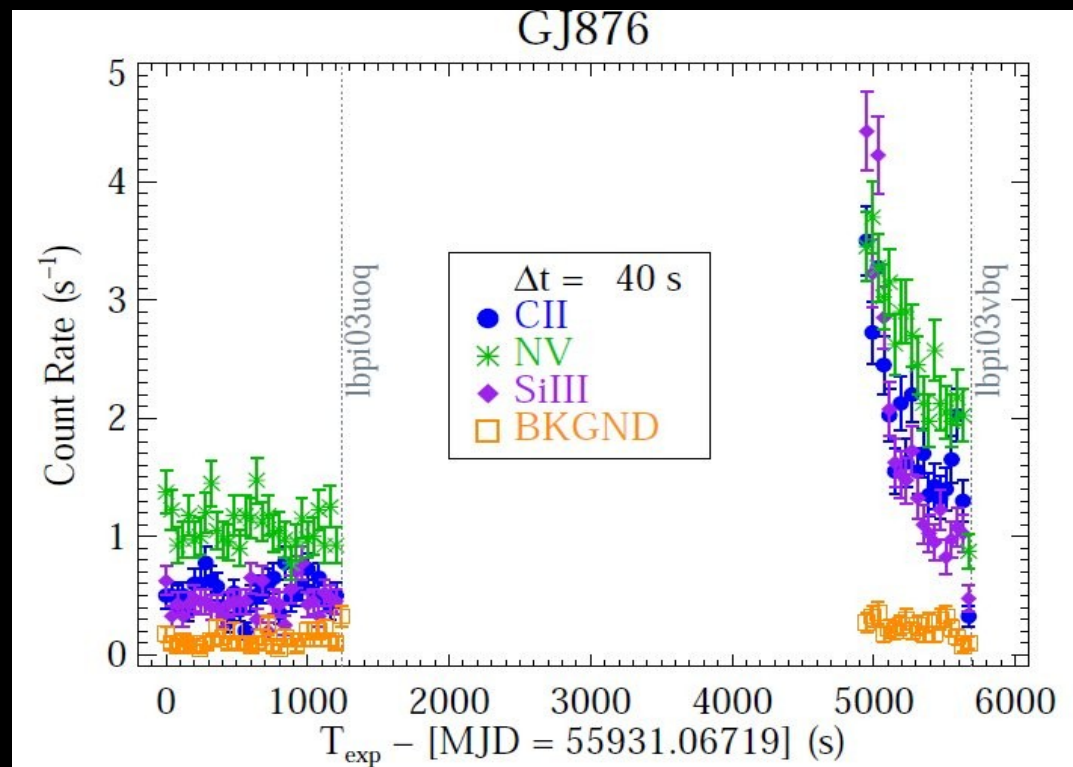


Exoplanets & AstroSat

- Hot Jupiters with bloated atmospheres, highly irradiated by host star.
- Exoplanets around hot stars (F-type and hotter).
- UV + VIS transit photometry needed to understand influence of stellar wind on planetary atmosphere's morphology.
- Transit spectroscopy & the search for bio-markers (900 nm absorption feature of H₂O, using IR studies).
- Stellar flares

Direct observation of an FUV flare on an “inactive” M-dwarf GJ 876 with HST-COS. The count rates are for various chromospheric and transition region emission lines – C II 1335 Å [blue circles], N V 1240 Å [green stars], Si III 1206 Å [purple diamonds]. The peak observed flare emission is 10× the quiescent level, although the true flare peak (which apparently occurred during Earth occultation) could have been much larger. The detector background level is shown as orange squares.

(France et al. 2012)



UVIT and the X-ray bright targets planned for AstroSat observations

Case studies to assess damage to the UVIT detectors.

Several galactic plane fields are very crowded.

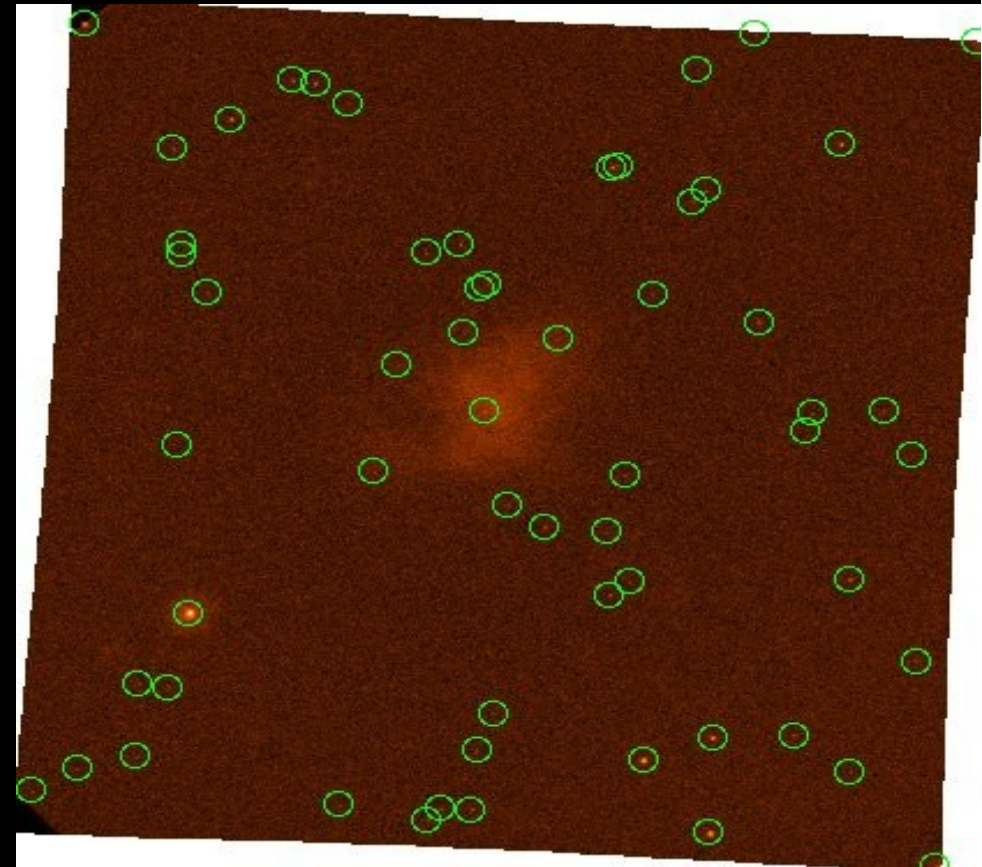
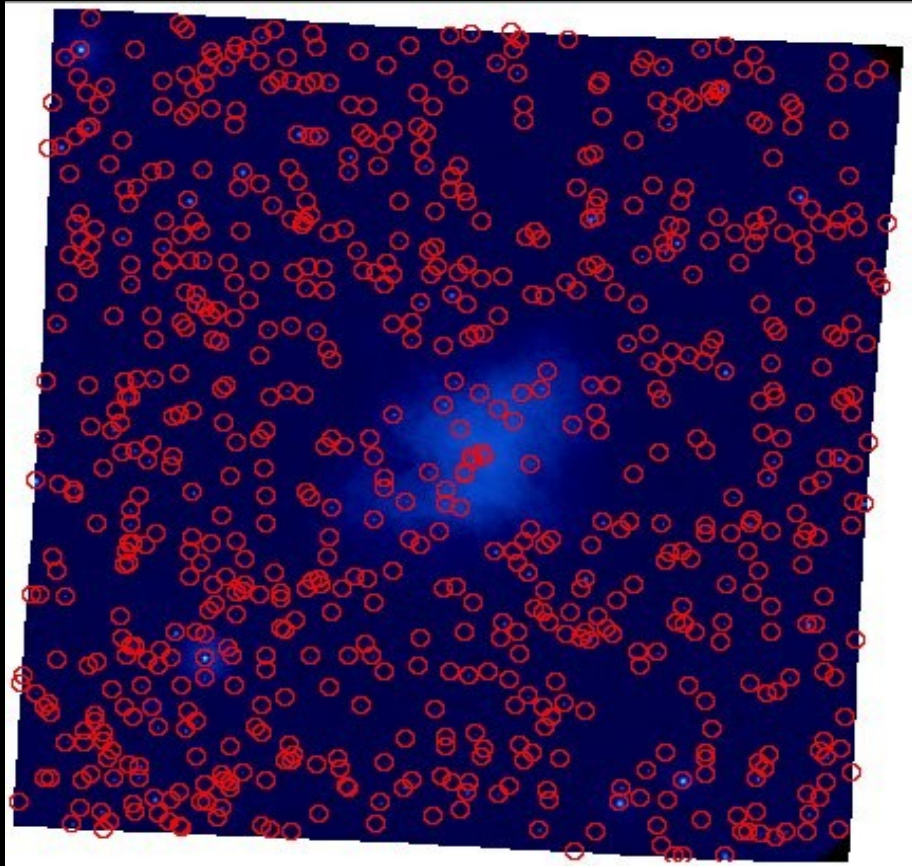
UVIT brightness limits: 20000 cps/frame, full frame.

Crab: $V=16.5$, However, the UVW1, UVW2 fields are very crowded.
Total flux: 9.83×10^{-9} erg/cm²/s/Ang.
Field too bright for the full frame mode.

S.No	Object	Filters
1	XTE J1856-3754	UVW1,UVW2 & UVM2
2	cygnus x-2	UVW1, UVW2& UVM2
3	2s 1755-338	UVW1,UVM2
4	4U1957+115	UVW1
5	1E 2259+586	UVM2
6	Crab	UVW1, UVW2 & UVM2
7	GROJ1655-40	UVW2
8	Tycho	U, B,V, UVW1, UVW2& UVM2
9	Cygnus X-1	UVW1 &UVW2
10	RXJ0720.4-3125	UVW1, UVW2 & UVM2
11	Arlac	UVW2
12	cas A	UVW1, UVW2 & UVM2

Crab in UV (a case study)

The NUV field is extremely crowded (



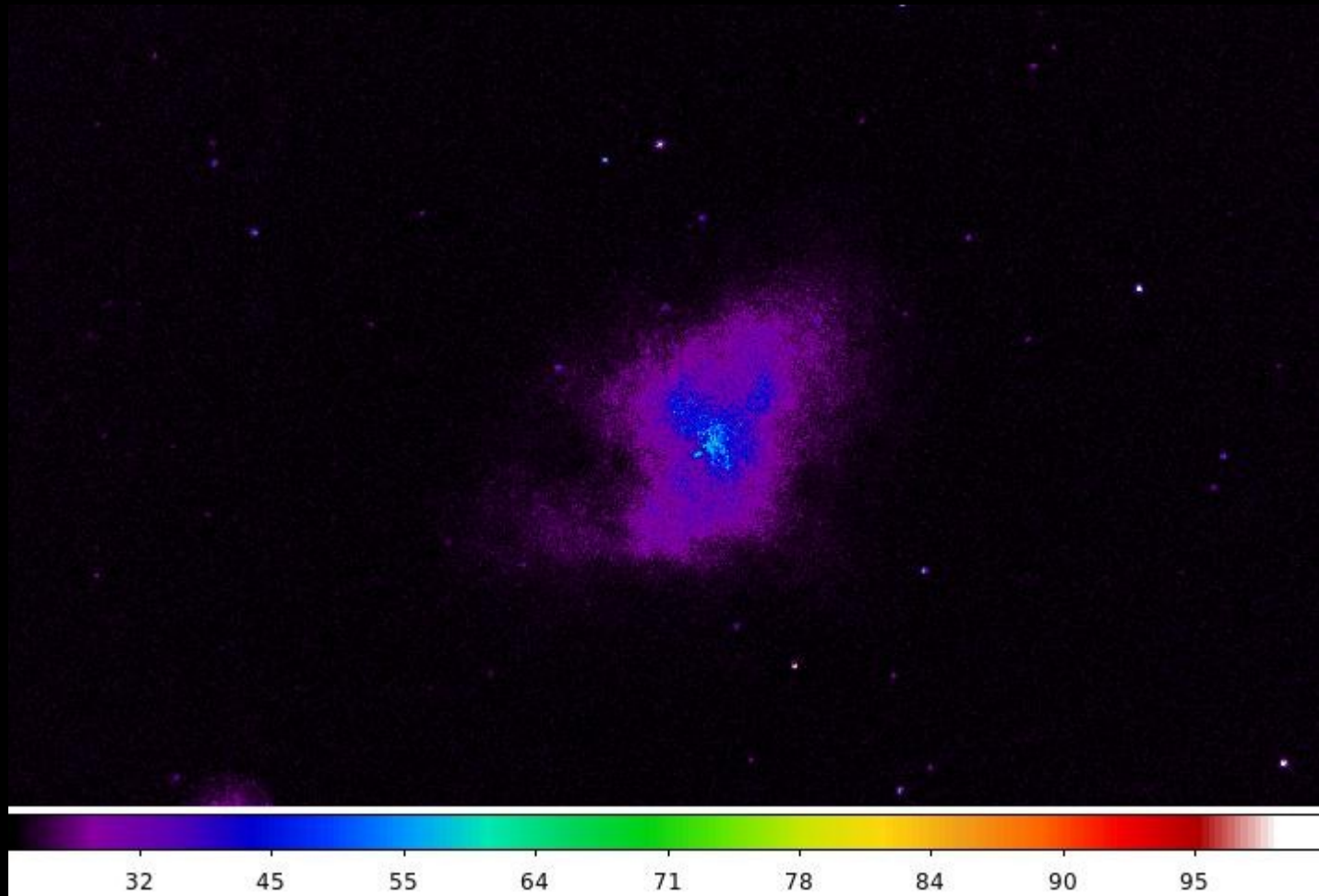
Crab (17'x17') XMM-Newton OM FoV

(t) UVW1

(r) UVW2



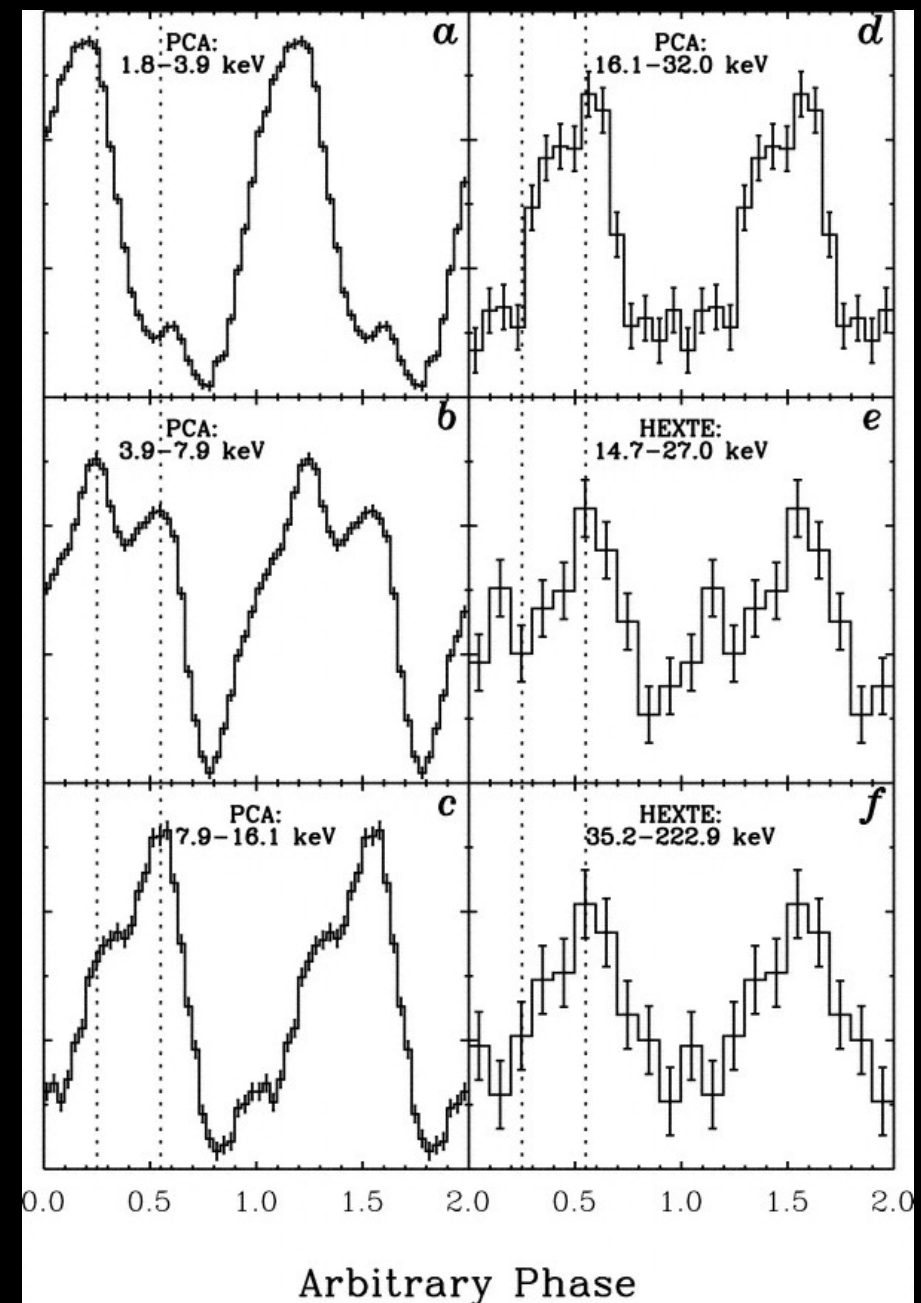
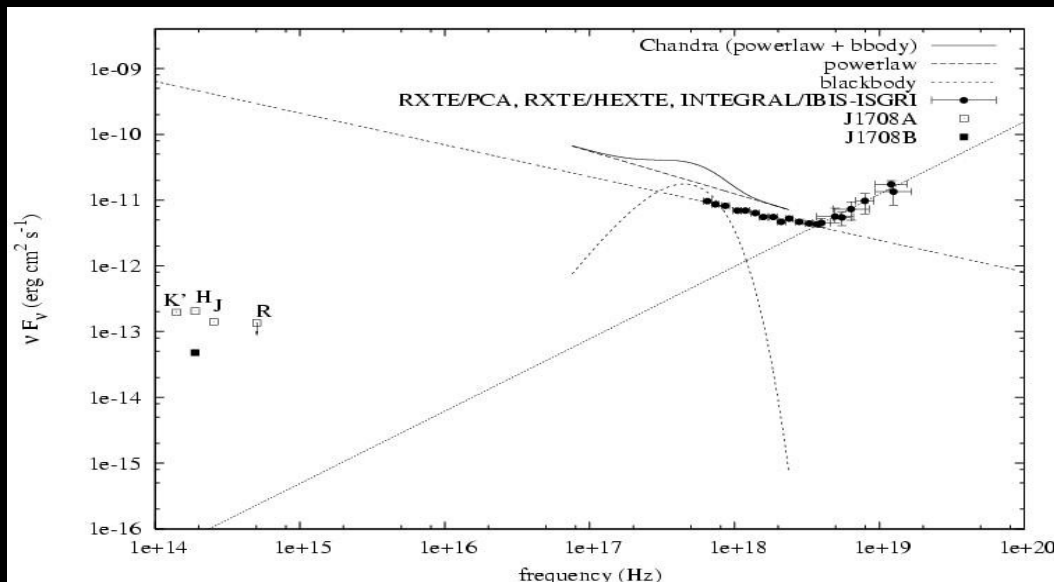
A closer look at Crab PWN



XMM-OM UVM2 17'x17' FoV of crab nebula showing the PWN with jet at the center

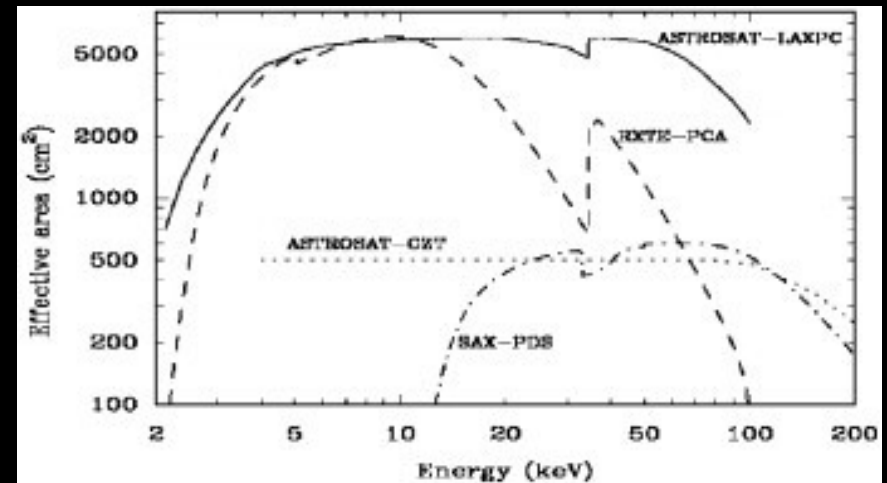
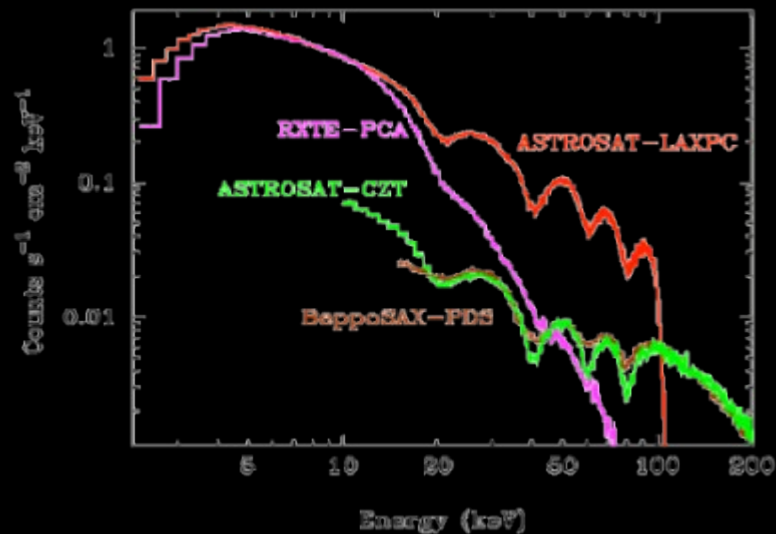
Magnetars & AstroSat

- NS with $B \geq 10^{14}$ G
- Only 22 detected so far
- Very X-ray bright ($L_X \sim 10^{38}$ ergs/s) but extremely UV-faint.
- Bursts, glitches, outbursts seen in a few systems
- Show considerable variation in pulse morphology & spectral properties from 2-200 keV.
- Excellent candidates for regular monitoring by LAXPC, CZT, SXT.



AXP J1708-4009, 0.5-200 keV
Pulse morphology (t) and spectra (l).

Comparing instrument capabilities



	UVIT	SXT	LAXPC	CZT	SSM
FoV	30'	21'	60'x60'	6°x6° (< 100 keV), 17°x17° (>100 keV)	
Energy resolution	<100 nm	2% at 6 keV	9% at 22 keV	5% at 10 keV	19% at 6 keV
Angular resolution	1.2" (on axis)	3'-4' (HPD)	1'-5' (scan mode only)	8'	10'
Timing	10 ms (small frame)	2.6s, 0.3s, 1 ms	10 μ s	1 ms	1 ms
Sensitivity	$M_{AB} = 21$ (5 σ , 1800s)	10 μ Crab (5 σ , 10 ks)	0.1 mCrab (5 σ , 1000s)	0.5 mCrab (3 σ , 1ks)	30mCrab (3 σ , 300s)
Energy Range	130-320 nm	0.3-8 keV	3-100 keV	10-150 keV	2-10 keV