INTEGRAL OBSERVATIONS OF SN1006

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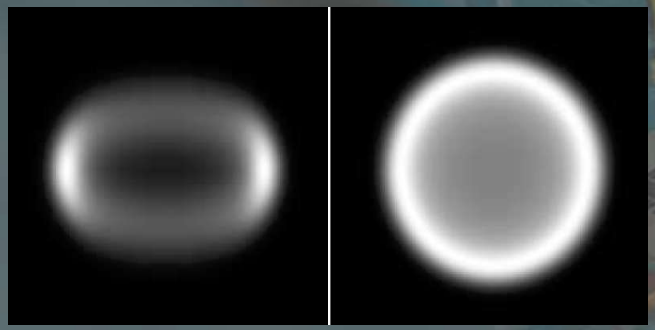
OUTLINE

- Scientific motivation
- JEM-X results
- ISGRI Results
- SPI Results
- Conclusion

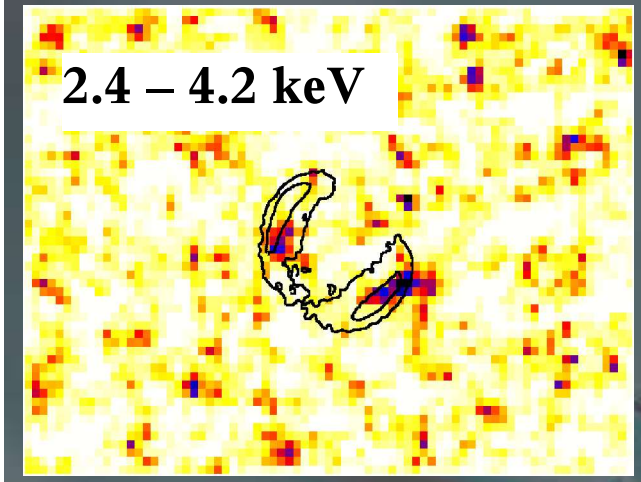
SCIENTIFIC MOTIVATION

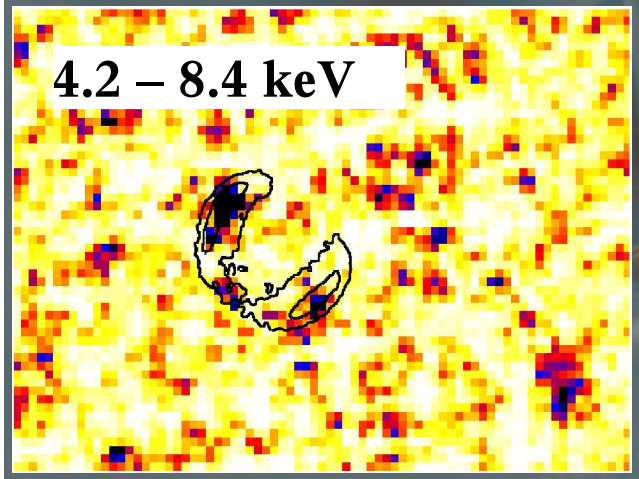
- JEM-X / ISGRI : SN 1006 was observed for ~1000 ks with the main aim of detecting and distinguishing synchrotron and non-thermal bremsstrahlung emission

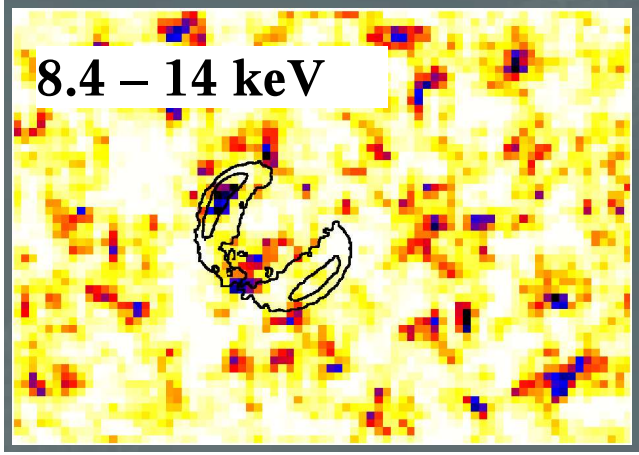


Synchrotron: concentrated at the limbs like radio emission
Bremsstrahlung: uniform emission

- SPI: The detection of positron annihilation radiation from a Type Ia supernova would give an idea of the escape fraction of positrons from the ejecta.
- Help quantifying the contribution of this class to the total Galactic annihilation radiation.





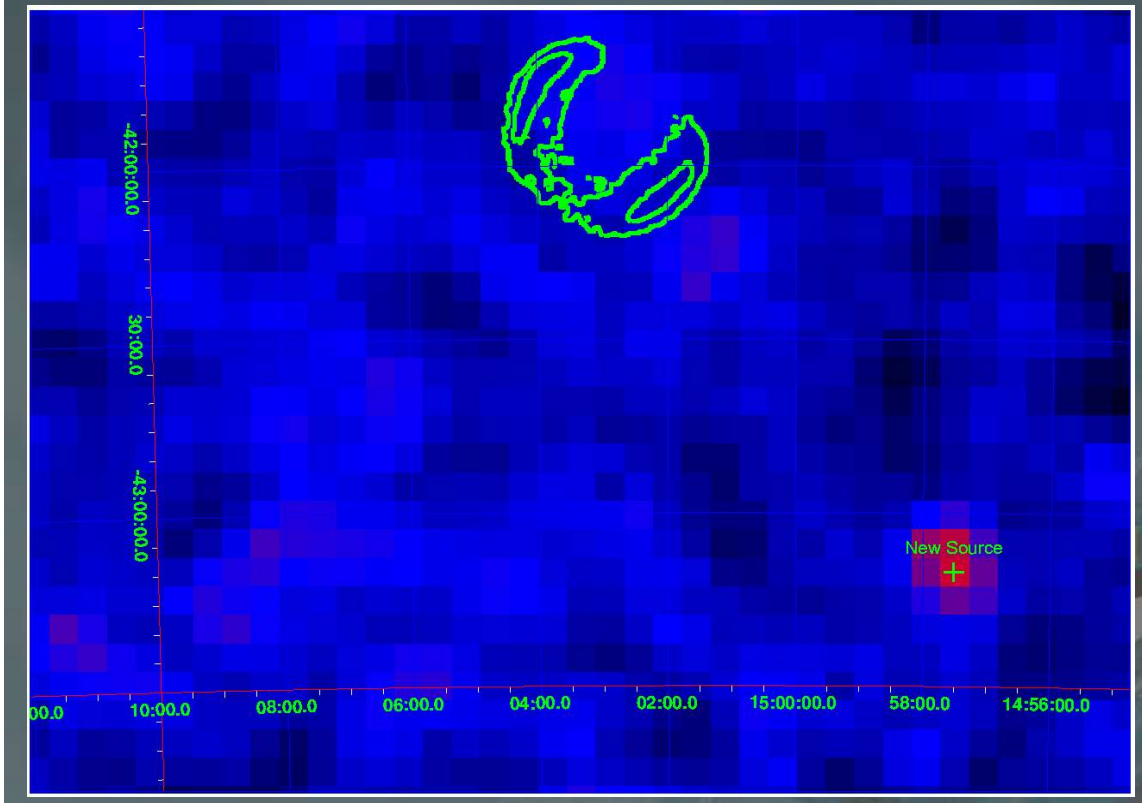


JEM – X results

- Jem -X images were obtained using midisky and mosaic-weight (see N. Lunds talk on Friday)
- The fluxes were obtained by comparing the intensity of pixels to that of a similar Crab observation.

Energy band (keV)	JEM-X Flux (mCrab)	S/N Ratio	ASCA Flux (mCrab)
North-East Limb			
2.4 – 4.2	0.64	2.6	0.8
4.2 – 8.4	1.11	5	0.8
8.4 – 14	0.86	1.7	0.5
South-West Limb			
2.4 – 4.2	0.92	4	-
4.2 – 8.4	0.34	1.6	-
8.4 – 14	-	-	-

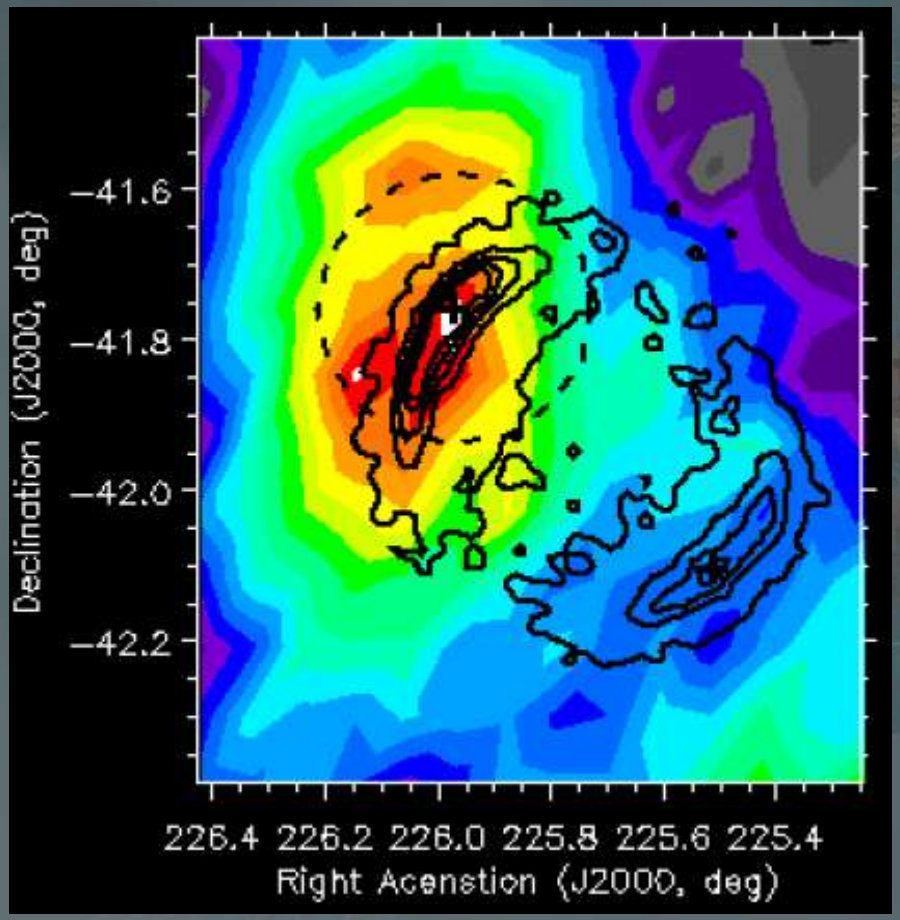
ISGRI Results



ISGRI Image of the area around SN 1006 in 20-40 keV band. No detection of SN 1006, with 3 upper limit flux at each limb 9 10^{-5} phot cm^{-2} s^{-1}

- The supernova remnant was not detected.
- BUT, we possibly detected a new source in the FOV, IGR J14573-4310, 8.68 sigma in 20-40 keV
  - ISGRI spectrum: index 2.2±0.4, 20-50 keV flux=8.8 10^{-12} ergs cm^{-2} s^{-1}
  - No detection in JEM-X.
  - No detection in earlier public observations.

Why no detection in ISGRI ?



Tanimori (1998) Cangoroo image of SN 1006

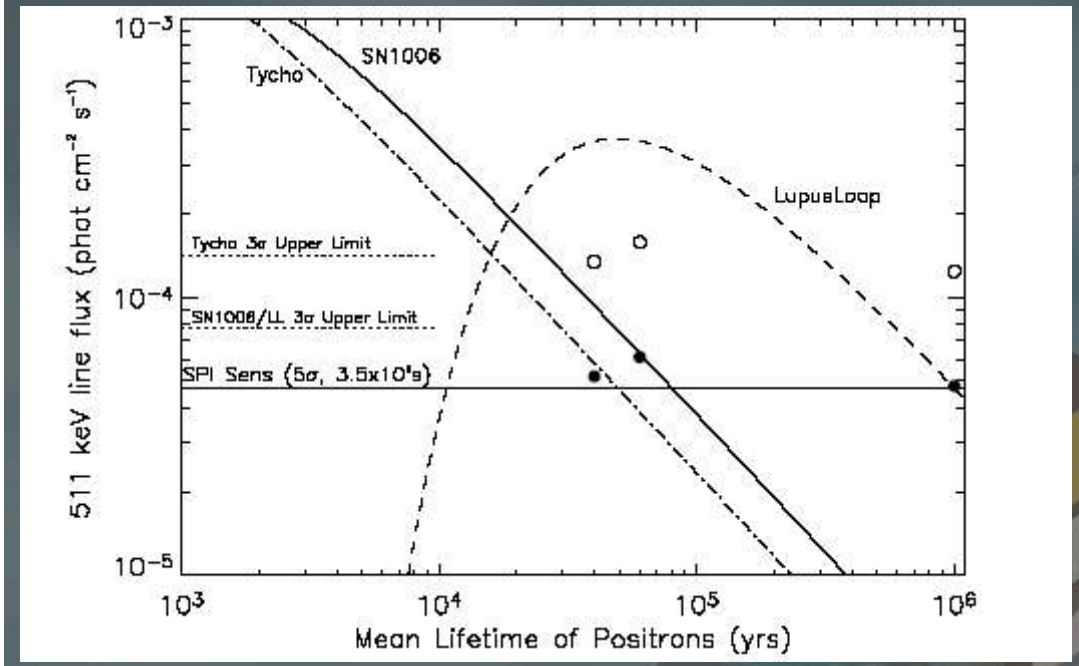
- Initial estimates for observing time were based on Cangoroo detection of the NE limb in TeV. New H.E.S.S results (Aharonian, private communication) dispute this detection with upper limits 8 times lower than the Cangoroo result. This indicates a higher magnetic field, and less non-thermal bremsstrahlung.

SPI Results

- Using the second part of the data (~750 ks, 18 detectors, we searched several nuclear lines using SPIROS. Narrow lines (2.5 keV width) were assumed, MCM is used for estimating background. No detections with upper limits below (sensitivity limits!).

Line ID	Line Energy (keV)	3 flux upper limit phot cm-2 s-1
annihilation	511	6.8 E-5
56Co	847	5.2E-5
56Co	1238	3.7E-5
44Ti	78.4	5.0E-5
44Ti	1156	3.8E-5
26Al	1809	3.8E-5
56Ni	158	>6.1E-5
56Ni	812	6.0E-5

Positron annihilation studies



Predicted 511 keV line flux from SN1006 as a function of positron mean life. The filled circles represent lifetimes predicted by observed remnant electron densities. The open circles represent flux values if SNe 1a contribute all galactic positrons.

- Late optical light curves of Type Ia supernovae suggest that a fraction (as high as 5%) of positrons produced in 56Co decays escape the ejecta and annihilate on longer time scales (Milne, The & Leising, 1999).
- Based on inferred electron densities, one can calculate the positron lifetime, and a corresponding 511 keV and positronium continuum flux.
- F511 = 6.1 10^{-5} phot cm^{-2} s^{-1}
- F cont = 22 10^{-5} phot cm^{-2} s-1

Conclusions

- SN 1006 was observed for ~1000 ks with INTEGRAL with the main aim of detecting hard X-ray emission. It was not detected with ISGRI or SPI, but was detected with JEM-X.
- The ISGRI non-detection supports HESS non-detection of the source in TeV band, and disputes Cangoroo detection..
- None of the nuclear lines were detected with SPI, but we did not expect to detect those lines in 750 ks with the current sensitivity.
- With 2500 ks of extra data recently rewarded by TAC ♥ we will be able to detect the source in hard X-rays with ISGRI, with JEM-X above 10 keV, and most importantly, provide tight constraints on the escape fraction of positrons from SNe Type Ia, and contribution of this type of SNe to overall positron content of the Galaxy.