

INTEGRAL Observations of the Tycho SNR

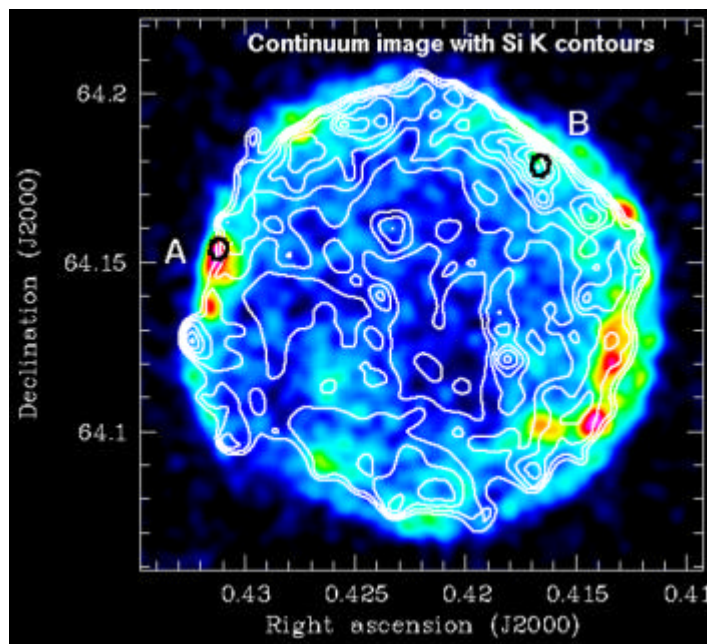
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Outline

- Overview of Tycho SNR
- Analysis of 1.5 Ms A0-1 -> Tycho (P.I. : A. Decourchelle) & Cas A (P.I. : J. Vink)
 - JEM-X :
 - image : detection up to 13 keV ?
 - spectrum
 - ISGRI :
 - detection up to 50 keV
 - search for ^{44}Ti lines : sub-Chandrasekhar models excluded
- Conclusion

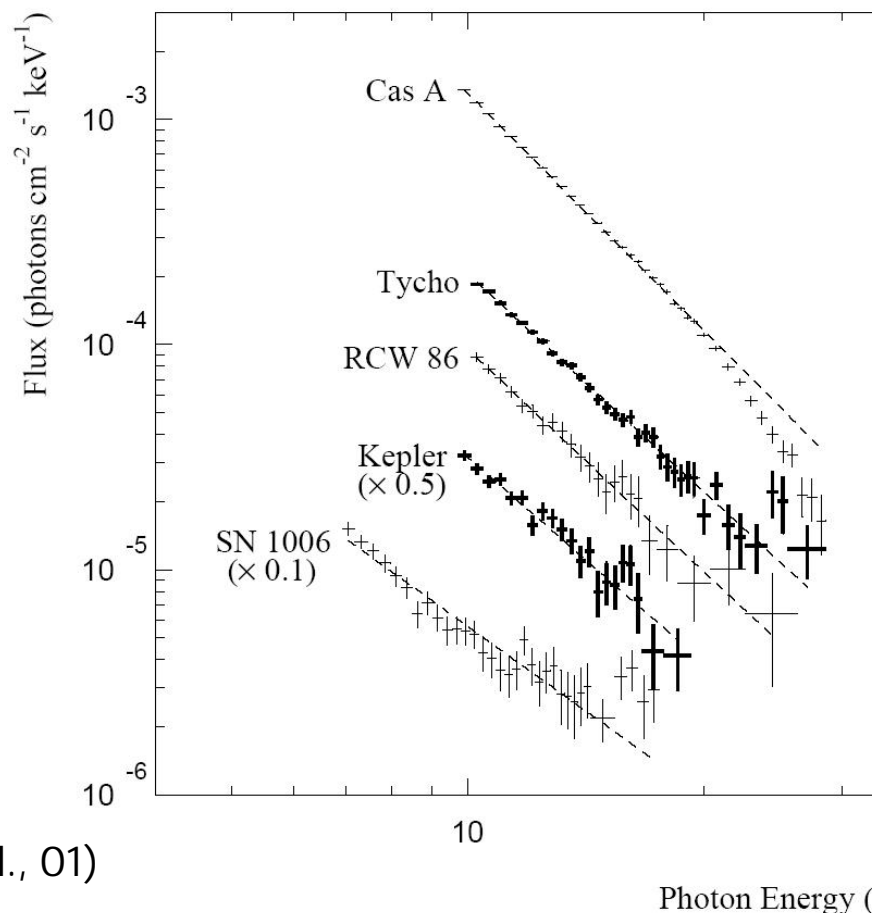
Overview of Tycho SNR

- Prototype of type Ia SNR
- age : 432 y , d : 2.3 ± 0.5 kpc
- shell-like structure, $F \sim 8'$



4.5-5.8 keV XMM image (Decourchelle et al., 01)

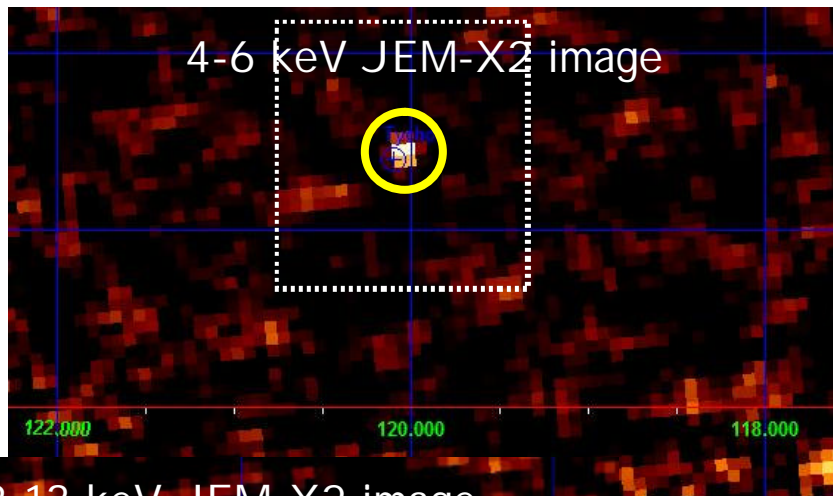
RXTE/PCA spectra (Allen et al., 99)



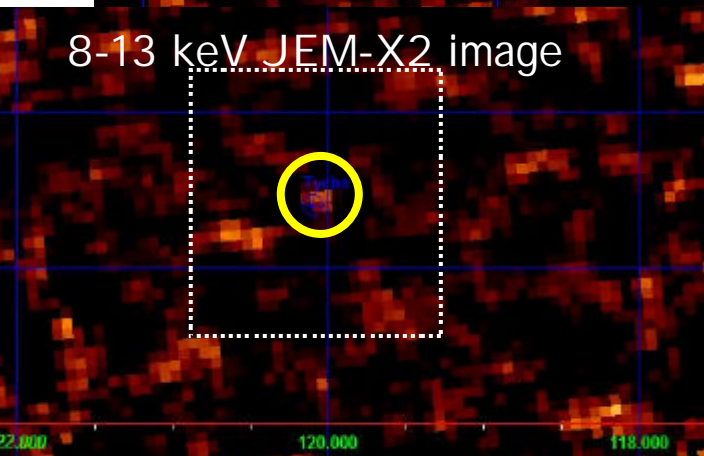
Analysis of JEM-X/I SGRI data : images

- JEM-X2

exposure time ~ 300 ksec (12/03)

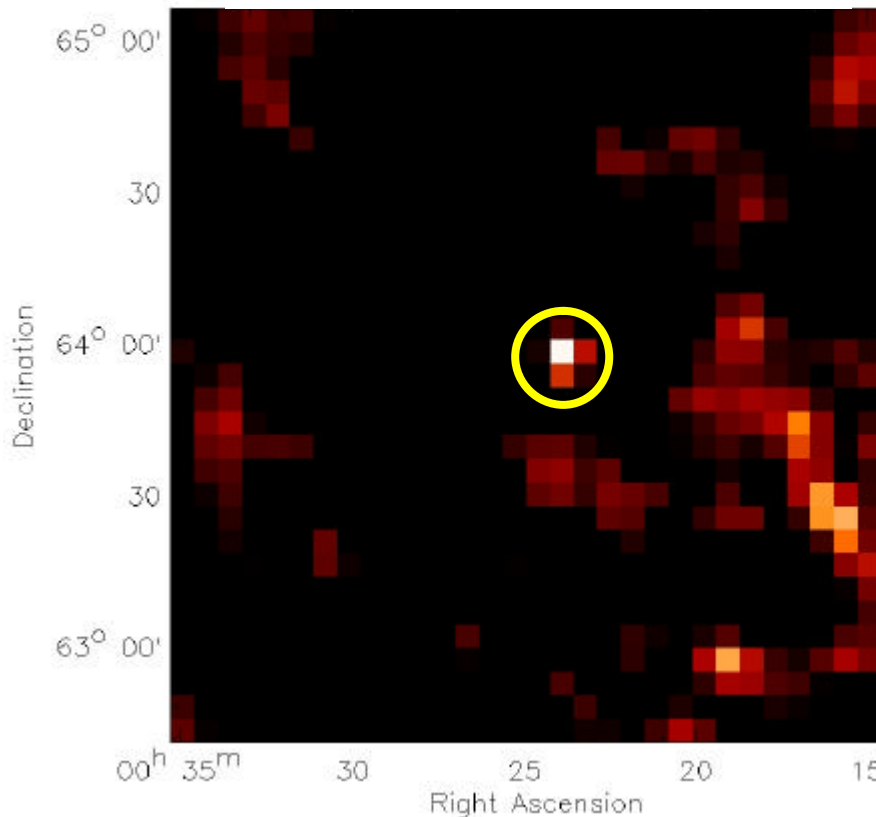


8-13 keV JEM-X2 image



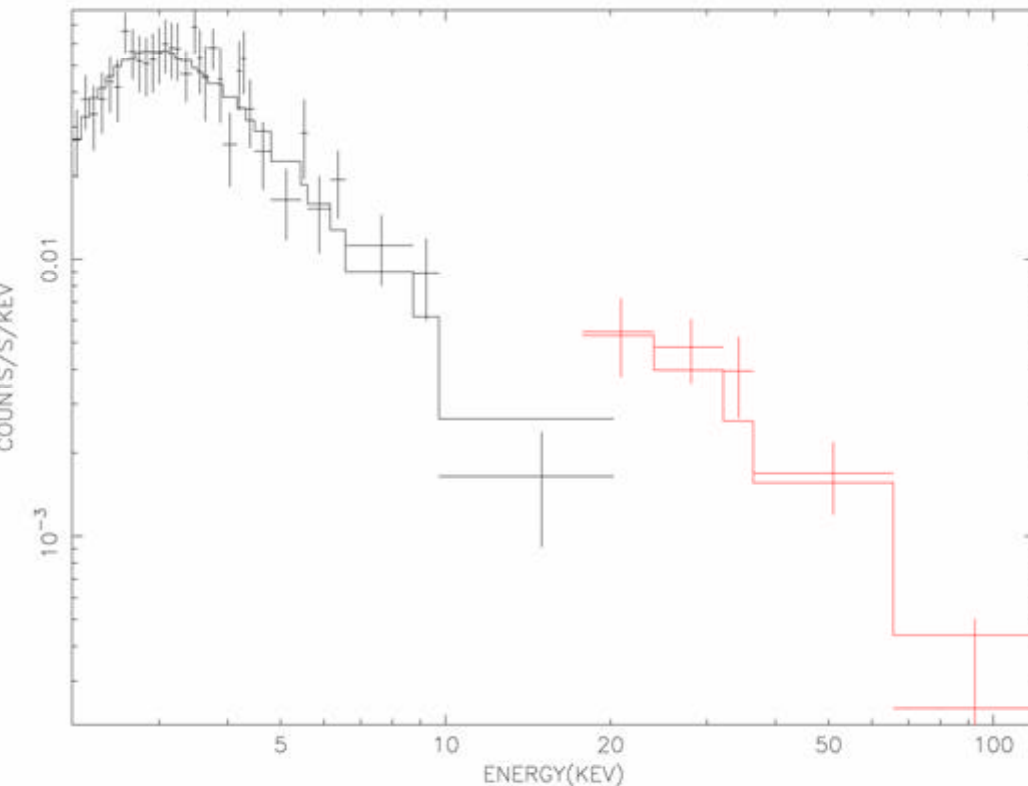
- I SGRI

exposure time ~ 1.5 Msec



Analysis of JEM-X/I SGRI data : spectra

- Standard spectral extractions (OSA 4.1 software)

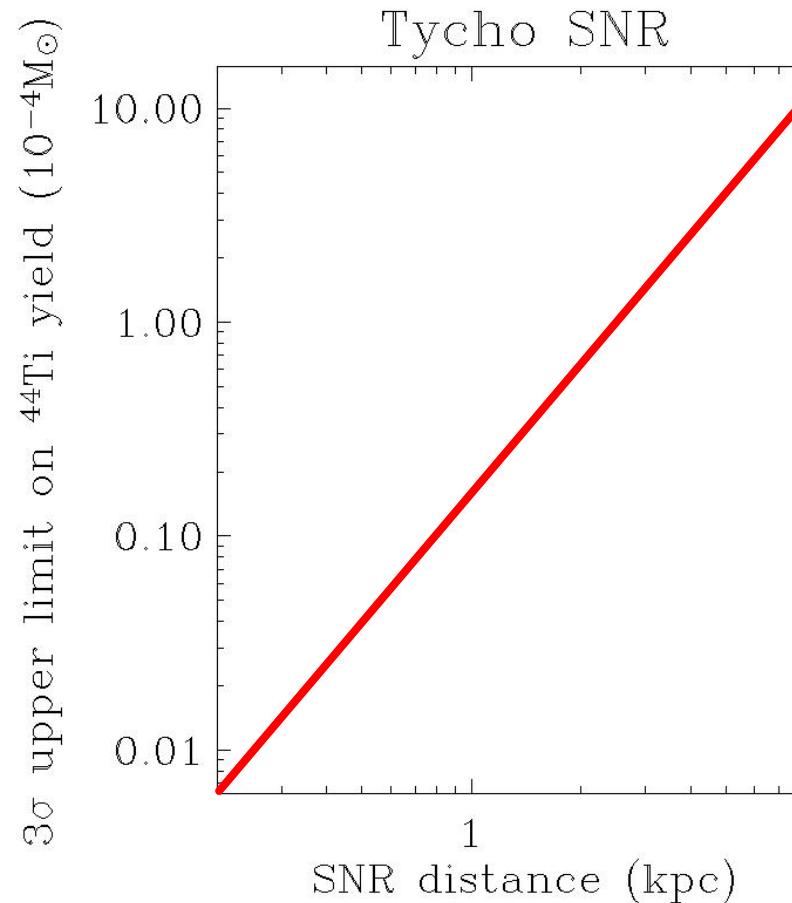


Fit with wabs*(bremss+PL)

- > $G \sim 3$ close to the value of RXTE/PCA
- > detection with I SGRI up to 50 keV

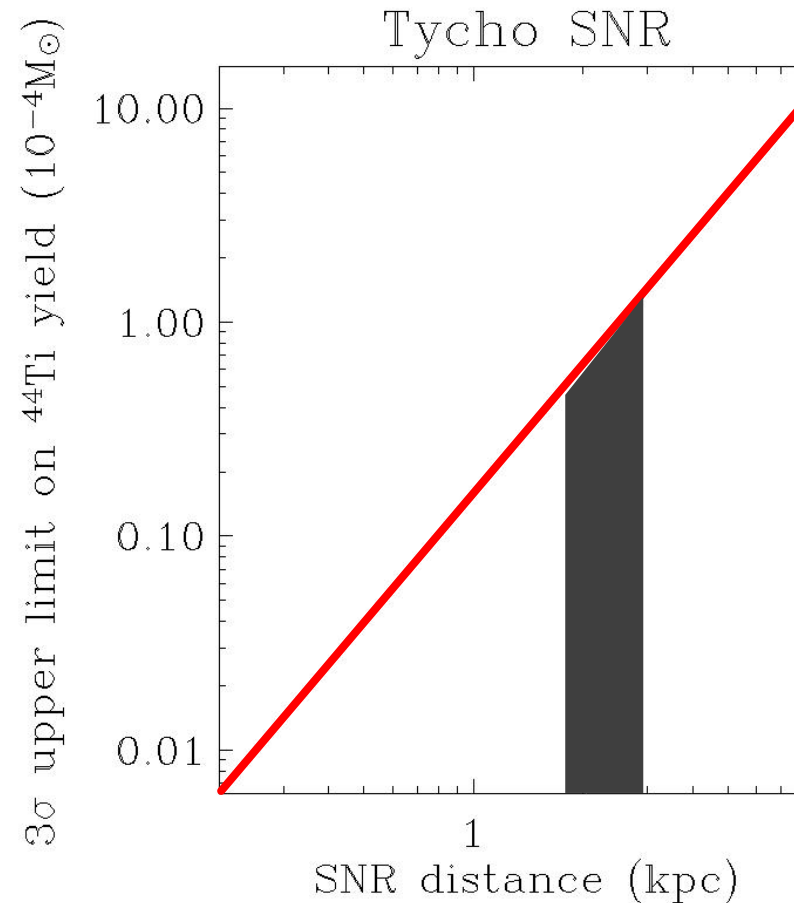
Analysis of JEM-X/I SGRI data : spectra

- No-detection of ^{44}Ti lines -> **3 σ upper limit $\sim 10^{-5} \text{ cm}^{-2} \text{ s}^{-1}$**



Analysis of JEM-X/I SGRI data : spectra

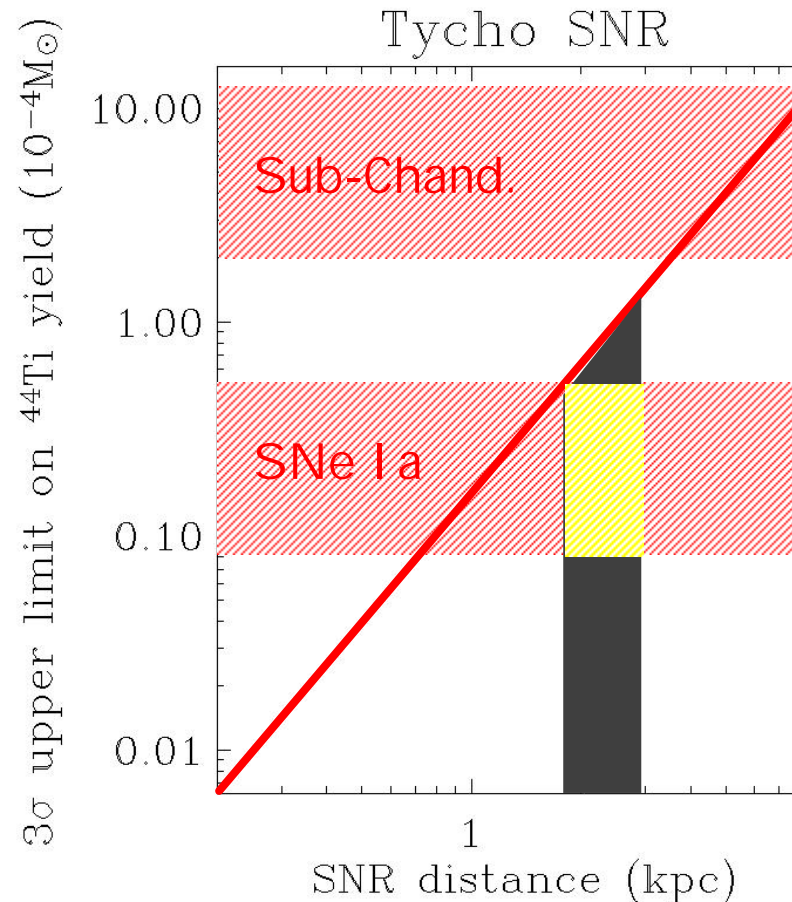
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- Tycho distance : $2.3 \pm 0.5 \text{ kpc}$



Analysis of JEM-X/I SGRI data : spectra

- No-detection of ^{44}Ti lines -> **3 σ upper limit $\sim 10^{-5} \text{ cm}^{-2} \text{ s}^{-1}$**
- Tycho distance : $2.3 \pm 0.5 \text{ kpc}$
- «standard» Ia SNe :
 $8 \cdot 10^{-6} M_{\odot} < Y_{44} < 5 \cdot 10^{-5} M_{\odot}$ (Iwamoto, 99)
- Sub-Chand. Ia SNe :
 $2 \cdot 10^{-4} M_{\odot} < Y_{44} < 4 \cdot 10^{-3} M_{\odot}$ (WW, 94)

=> sub-Chandrasekhar SNe Ia models **are ruled out ...**



Conclusion

- Non-detection of ^{44}Ti lines in Tycho SNR : upper limit **incompatible with sub-Chandrasekhar models**
- Continuum emission detected up to 50 keV
- I SGR1 pixel low-threshold correction is essential for obtaining a connexion with JEM-X spectrum
- Improved energy calibration needed
- Another 1.5 Msec will be analyzed soon -> constraints on standard SN Ia models ...
- AO-3 proposal to re-observe Cas A/Tycho for 2.5 Ms has been accepted ...