Isolated Neutron Stars

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Constellation X/ GSFC, May 5, 2004

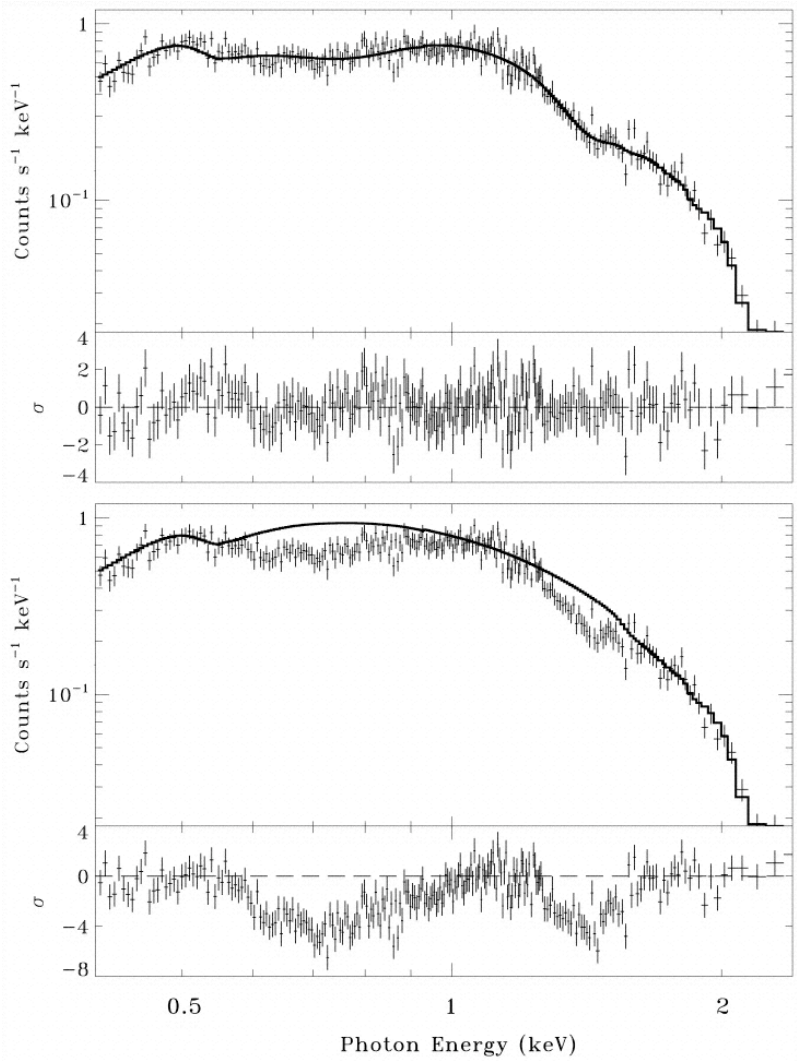
‘Isolated Neutron Stars’: heterogeneous collection of objects:

- *bona fide* radio pulsars (*e.g*. PSR B0656; Crab)
- ms pulsars, gamma-ray pulsars (RX J0437-4715, Geminga)
- radio quiet objects (*e.g*. RX J1856.35-3754)
- central objects in SNR (*e.g*. 1E1207.4-5209)
- …

Motivation to study derives from detection of optically thick, soft X-ray emission (photospheric emission)

- prior to *Chandra*, XMM-*Newton*: detection, crude characterization (‘blackbody’)
- detailed study of photospheric spectrum only possible with spectrometers on *Chandra*, XMM-*Newton*

‘Blackbodies are Boring’ - but spectral features now seen in at least a few objects:



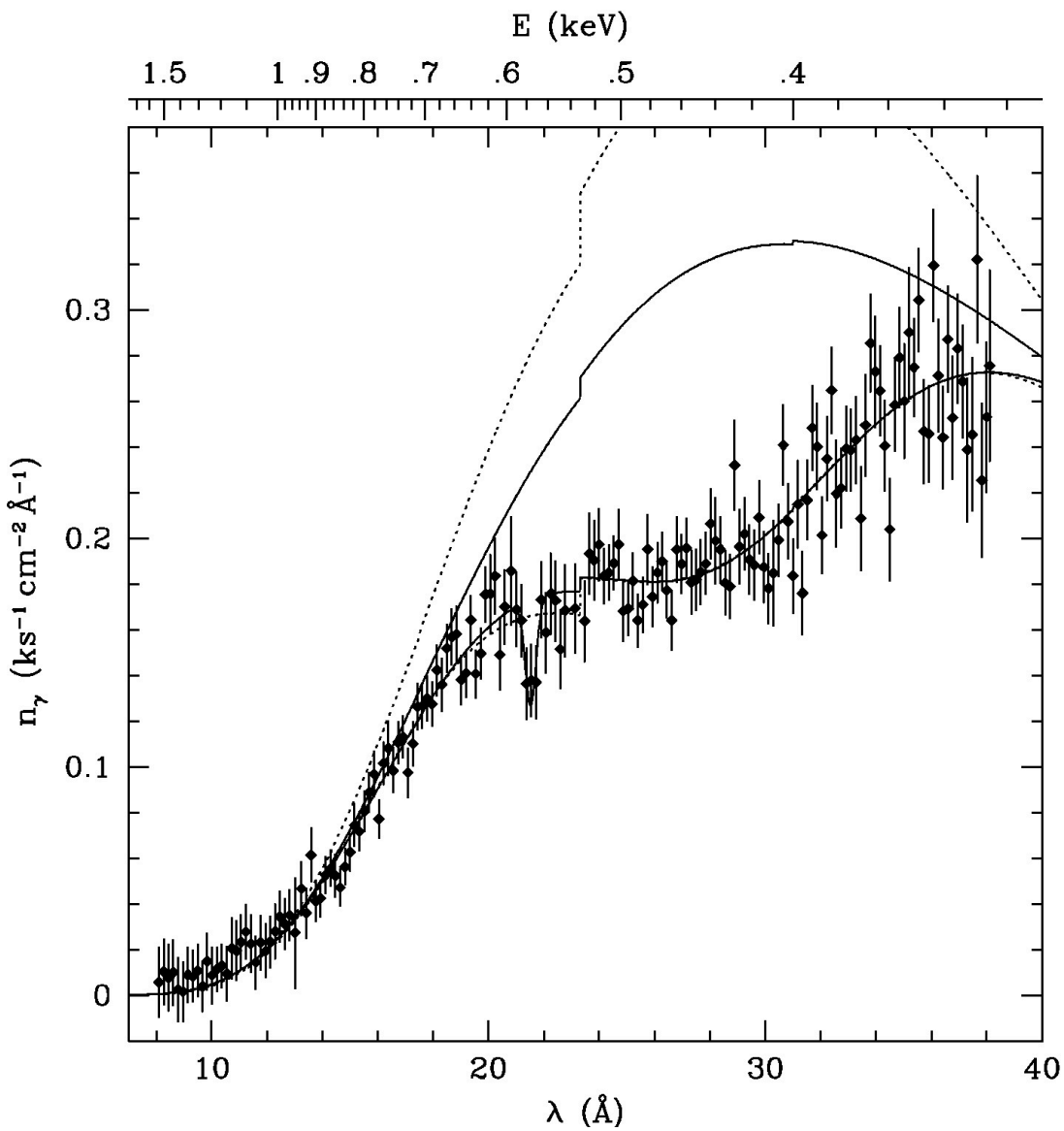
Chandra ACIS observation of 1E1207;
Sanwal et al., 2002, *Ap. J.*, **574**, L61

? Cyclotron resonances or atomic features?

Anyway: low spectral resolution!

RX J1605.3+3249: XMM-Newton RGS + PN

Van Kerkwijk et al., **astro-ph/0402418**



(Isolated) Neutron Stars: Primary Astrophysics Goals

- bulk properties of n-degenerate matter (EOS, nucleon dissociation phase transitions? Superfluidity? Superconductivity? …)
- origin of neutron stars; surface composition, fallback, …
- evolution of neutron stars ($L(t)$; evolution of $\boldsymbol{B}$; evolution of surface composition; …

This list is familiar…but clearly, photospheric spectroscopy holds the key to providing the detailed physical information

Obviously, without a much clearer physical rationale motivated by recent observational discoveries, the previous slide should not be taken to provide requirements on the capabilities of any future X-ray observatory…

We need efficient high resolution (about the XMM/RGS, or ~ 2 eV at O K), time-resolved spectroscopy of known point sources: FOV, angular resolution not a consideration-cryogenic spectrometer meets the requirements; largest possible aperture.