Resolving X-ray Sources from B-Stars Spectroscopically

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Motivation

- Isolated late type B stars are NOT supposed to emit X-rays
- Nevertheless, many have been detected in the X-rays (Einstein, ROSAT, Chandra)
- which raises the companion hypothesis, or standard stellar theory would be questioned
- Challenge for Observers: Find an unseen companion
  - X-ray and IR Imaging (Hubrig et al. '01, Stelzer et al. '03)
  - X-RAY GRATING SPECTROSCOPY
- … and to identify it
- Interestingly, many of these targets are CP stars

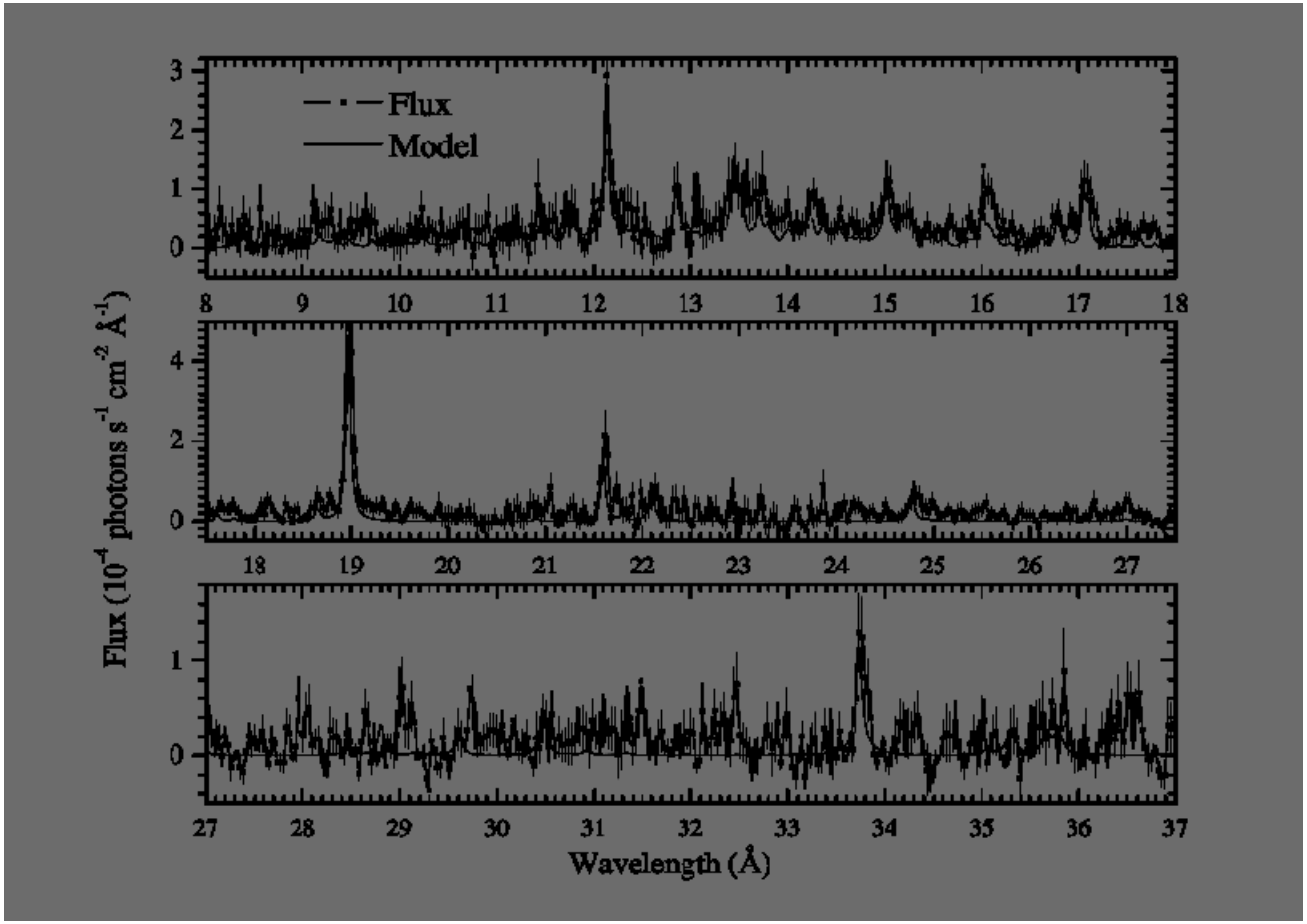
Methods

- Spectroscopic
  - UV quenching of forbidden lines
  - Peculiar Elements
- Traditional
  - Astrometry
  - Timing

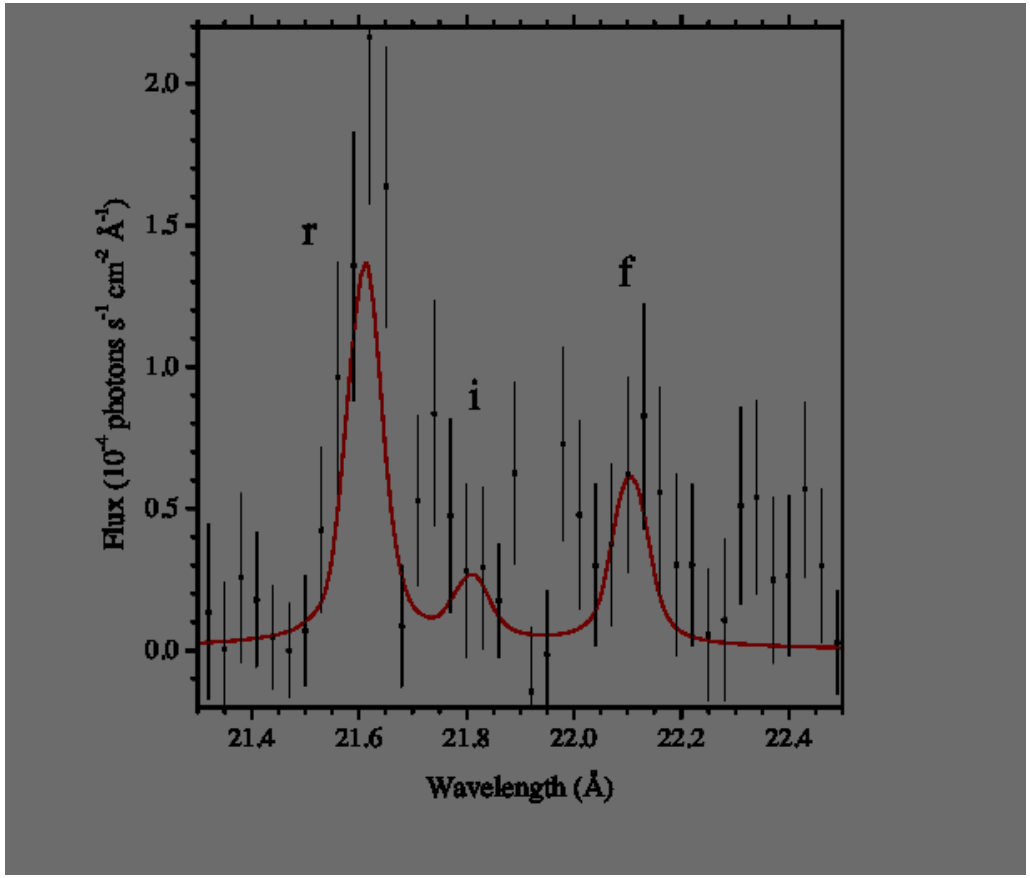
Choice of Target: The case for μ Lep

- "Isolated" B9 non-magnetic HgMn star
  - also known as HR 1702 & HD 33904
- Nearby: 56.5 pc
- Detected by ROSAT (Berghöfer et al. '96)
- Companion was searched for but not found
  - (Hubrig et al. '01)
- *XMM-Newton* & *Chandra*/LETGS
  - guest observation

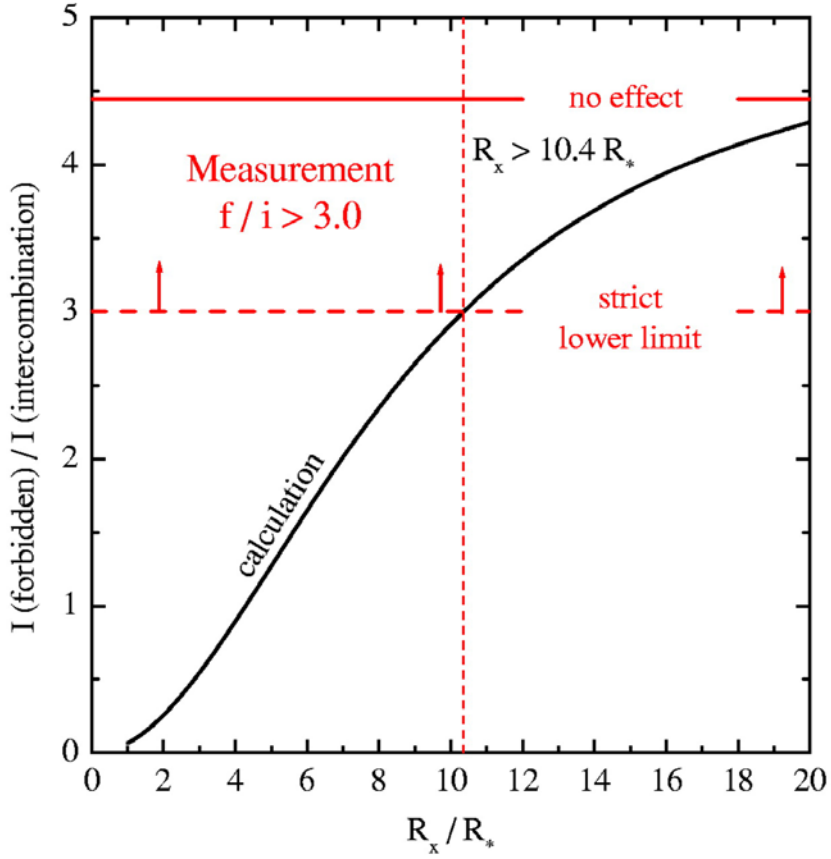
Looks Coronal *(RGS)*



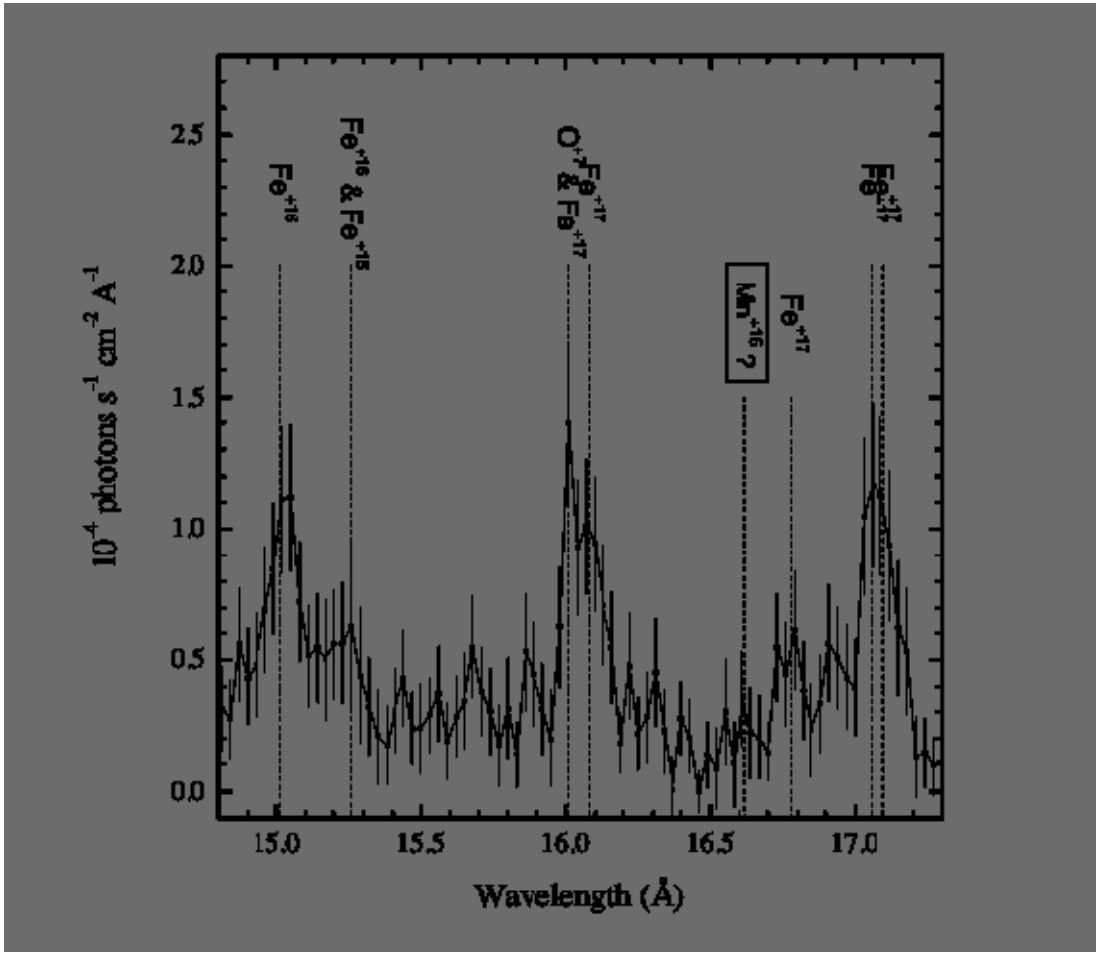
Normal O VII Triplet



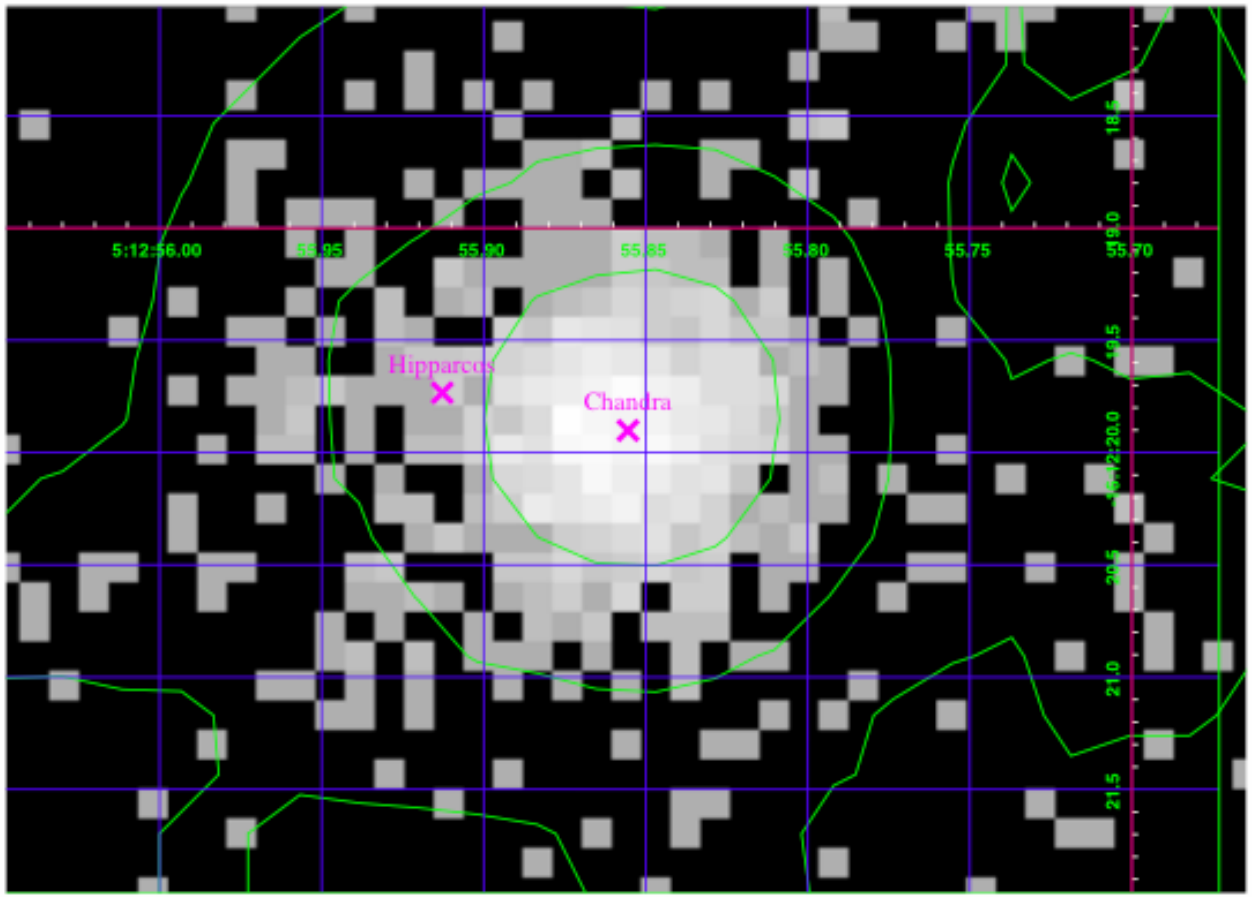
Pretty Far from B-Star (UV Sour.)



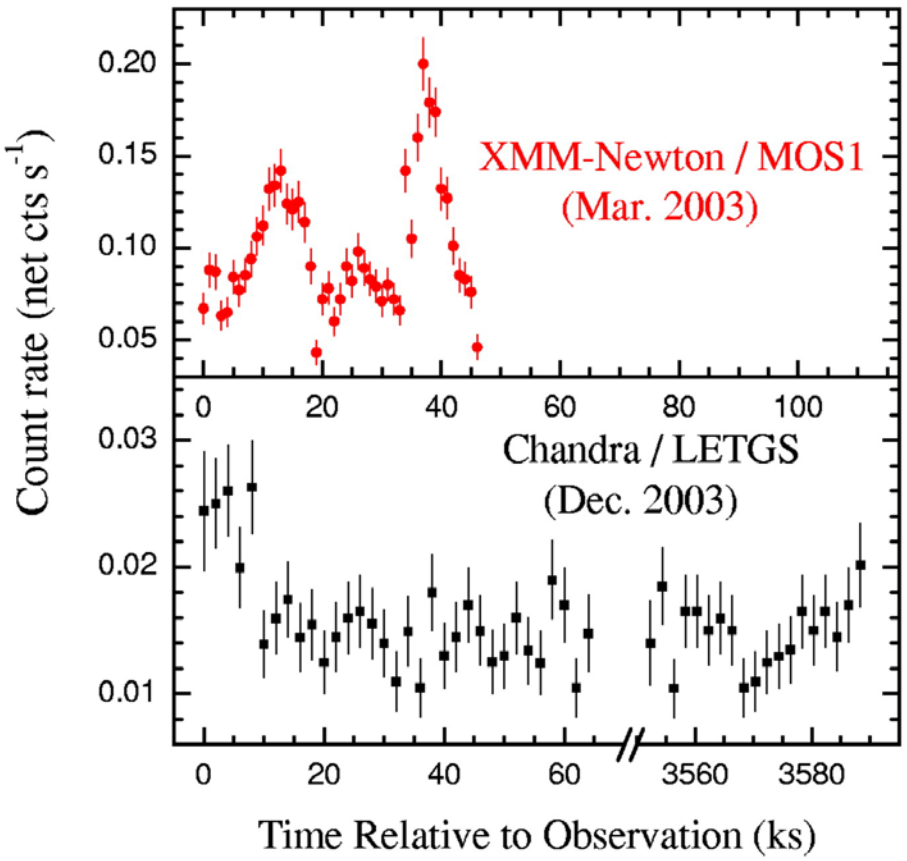
No Peculiar Elements



Chandra Imaging



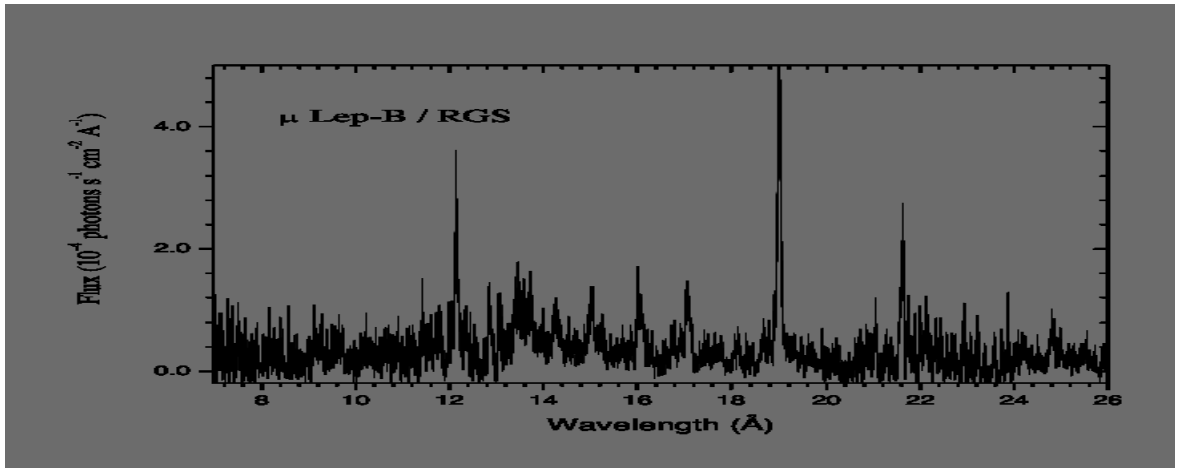
So, What is the Companion μ Lep-B?

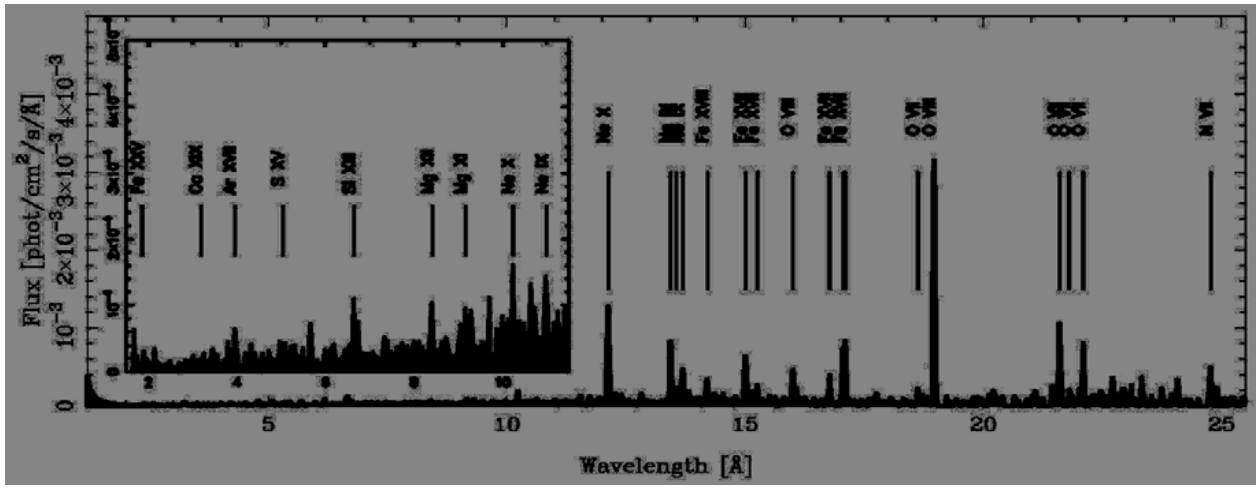


What is μ Lep-B? (cont.)

- Short duration flares
- $L_X = 4.4 \times 10^{29}$ erg s^{-1}
- vsin*i* (B star) < 10 km/s (Abt & Morrell '95)
- L_{bol} = ?
- Age (B star): 19 Myr (Schaller et al. '92)
- In short: Fits the ONC correlations for L_X with age and rotation (Feigelson et al. '03) and not those of MS stars

Looks like a (relatively cold, non-accreting, damn close) PMS star





HD 98800
(weak lined TTS)
Kastner et al. '04

Conclusions

- X-Ray spectroscopy is useful for testing the companion hypothesis of X-ray bright B stars
- An increasing number of examples seem to point at PMS companions being the actual X-ray sources
- This could be a method to find nearby PMS stars not easily detected by any other means