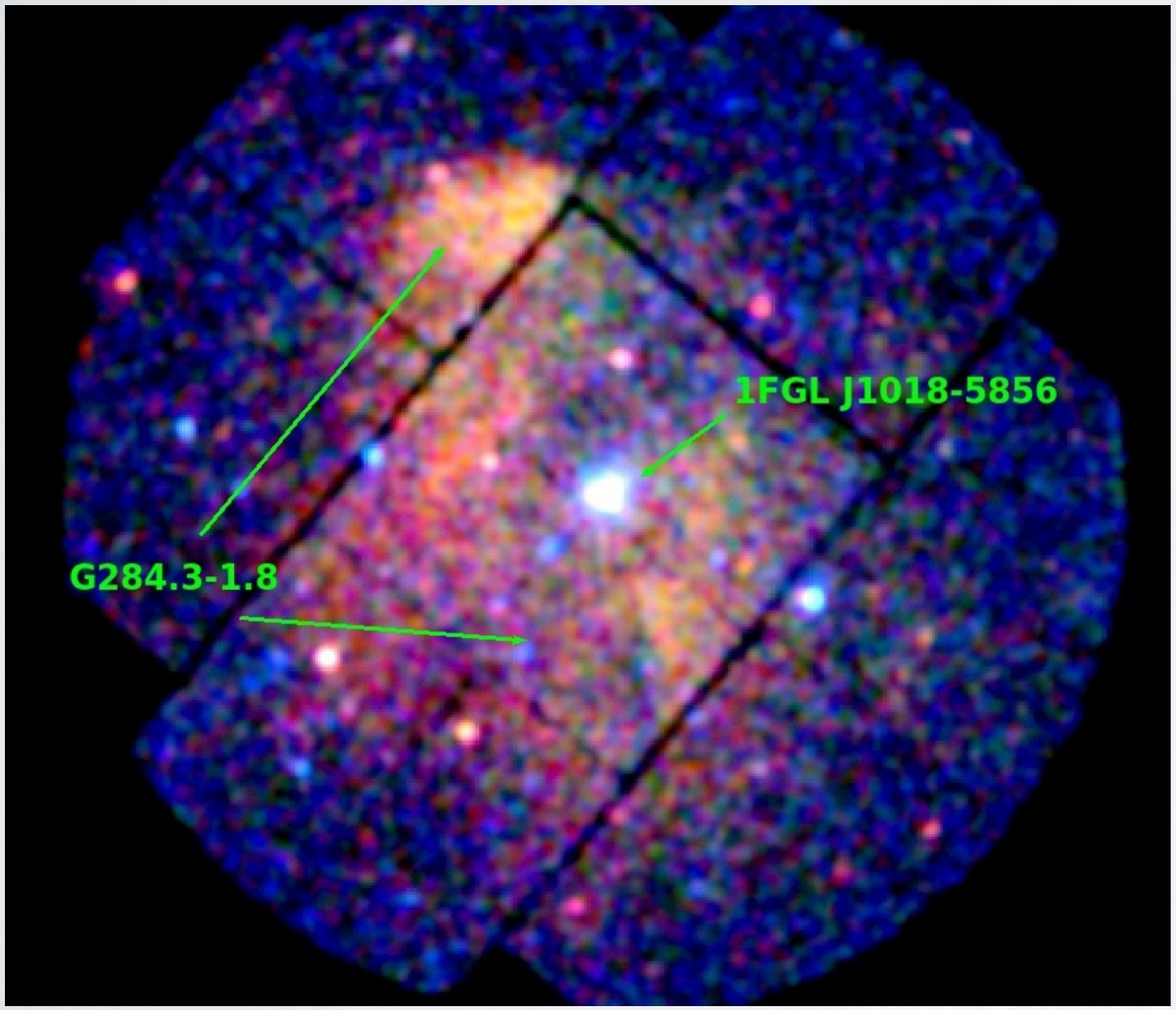
MAGNESIUM-RICH EJECTA IN SNR G284.3-1.8 AROUND 1FGL J1018.6-5856



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This talk is based on new Chandra and archival XMM-Newton observations

Williams et al. (2015), ApJ, submitted

A Talk in Three Acts

Act I: Spectral/spatial analysis of J1018

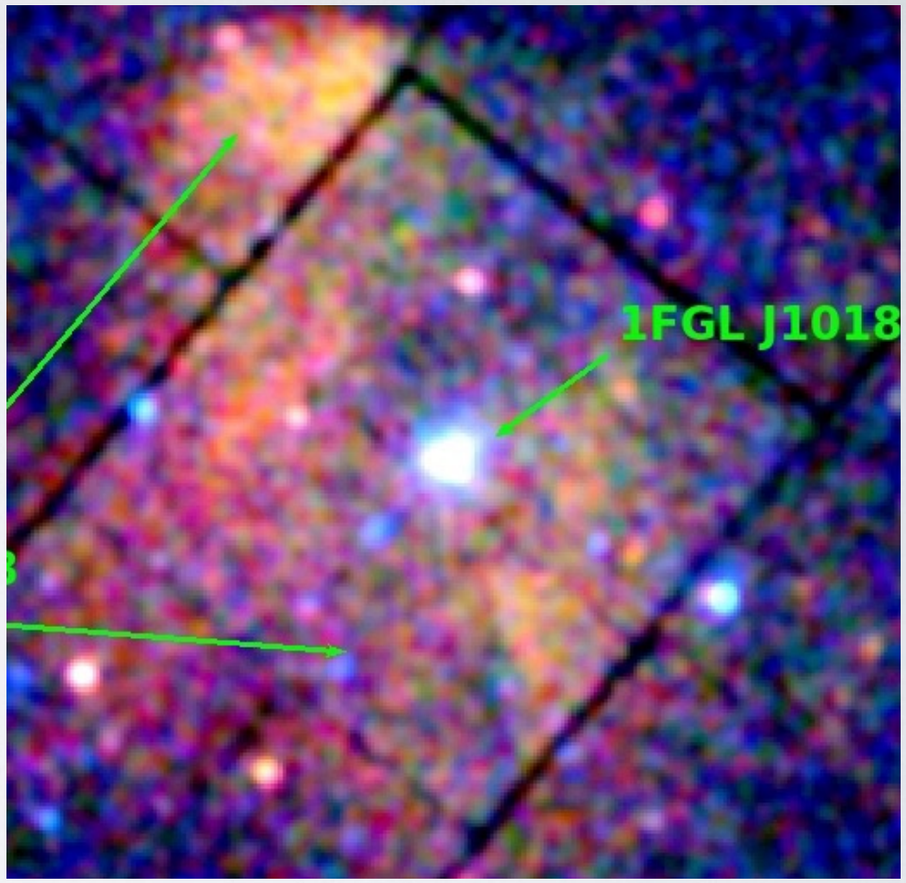
Act II: Binary evolution modeling

Act III: Spectral analysis of G284.3-1.8

Encore: Conclusions

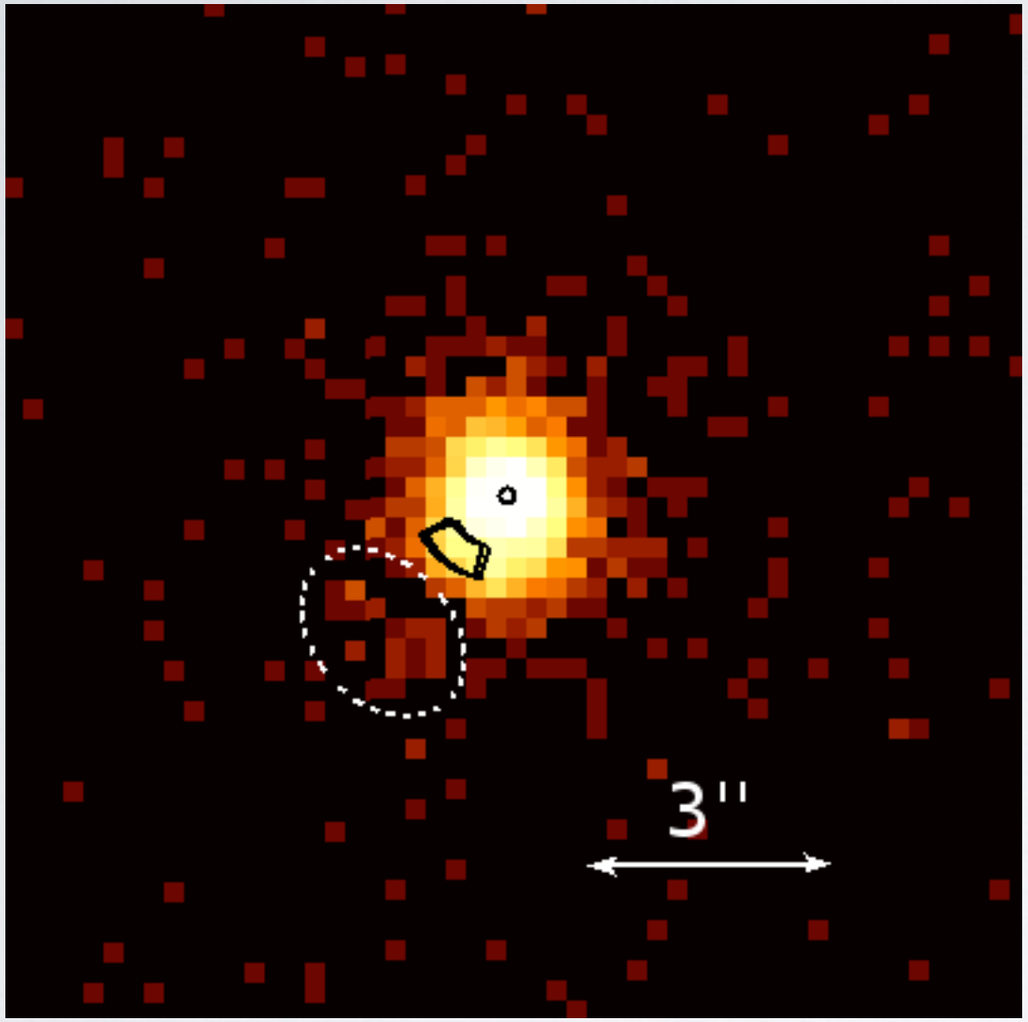
Meet 1FGL J1018.6-5856…

- X-ray point source… or is it? Check w/Chandra
- Power-law spectrum:
  - $N_H = 8 \times 10^{21}$ cm^{-2}
  - Γ phase-dependent: 1.0-1.8
- It's a binary! ~16.6 d period identified in both γ-rays (Corbet+ 2011, Ackermann+ 2012) and X-rays (An+ 2013, 2015, Tanaka+ 2014)
- Optical counterpart identified: 30 $M_\odot$ O6V((f)) star (Napoli+ 2011)
- One of only *two* high-mass γ-ray binaries inside an SNR (SS 433 in W50)

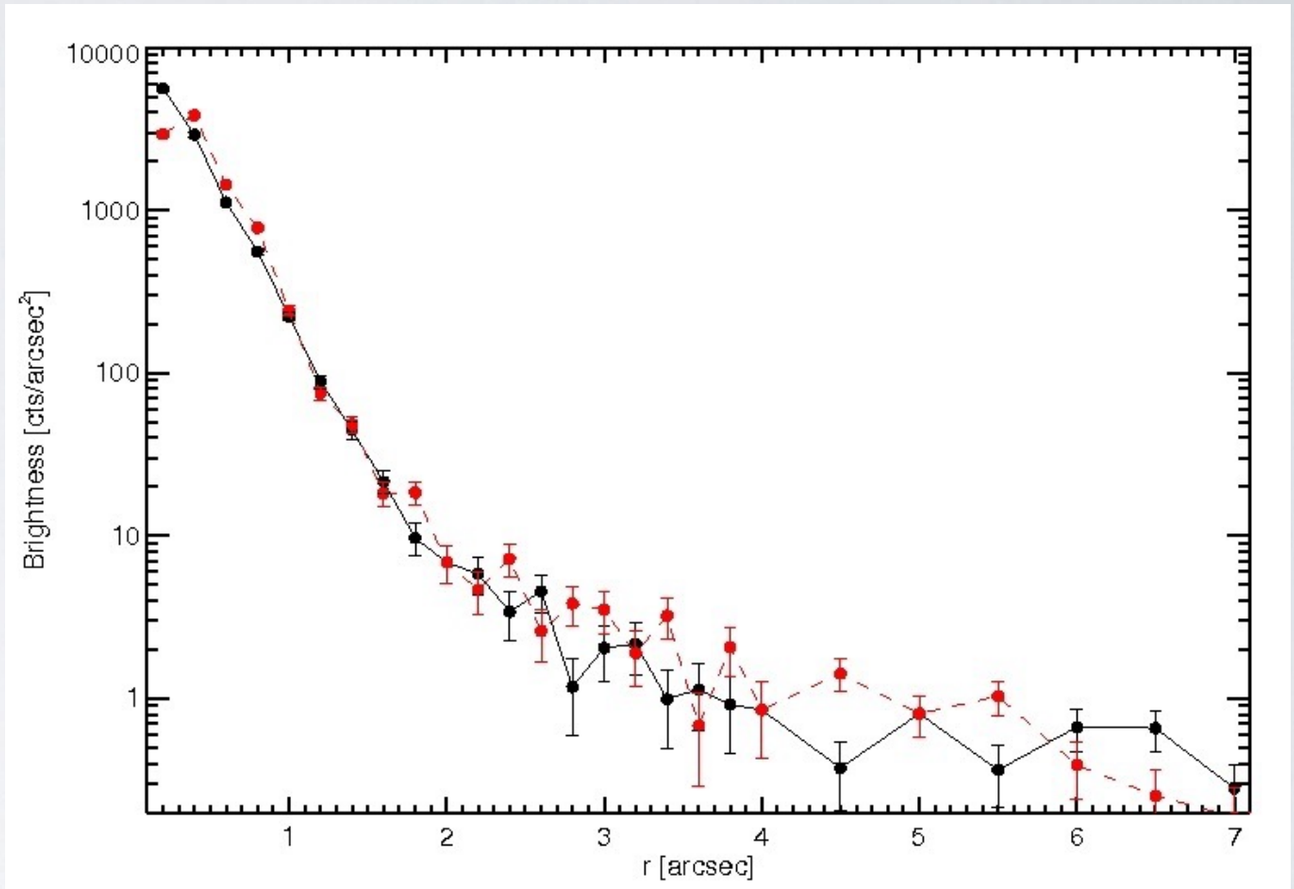


XMM image

Is it really a point source?



Chandra close-up

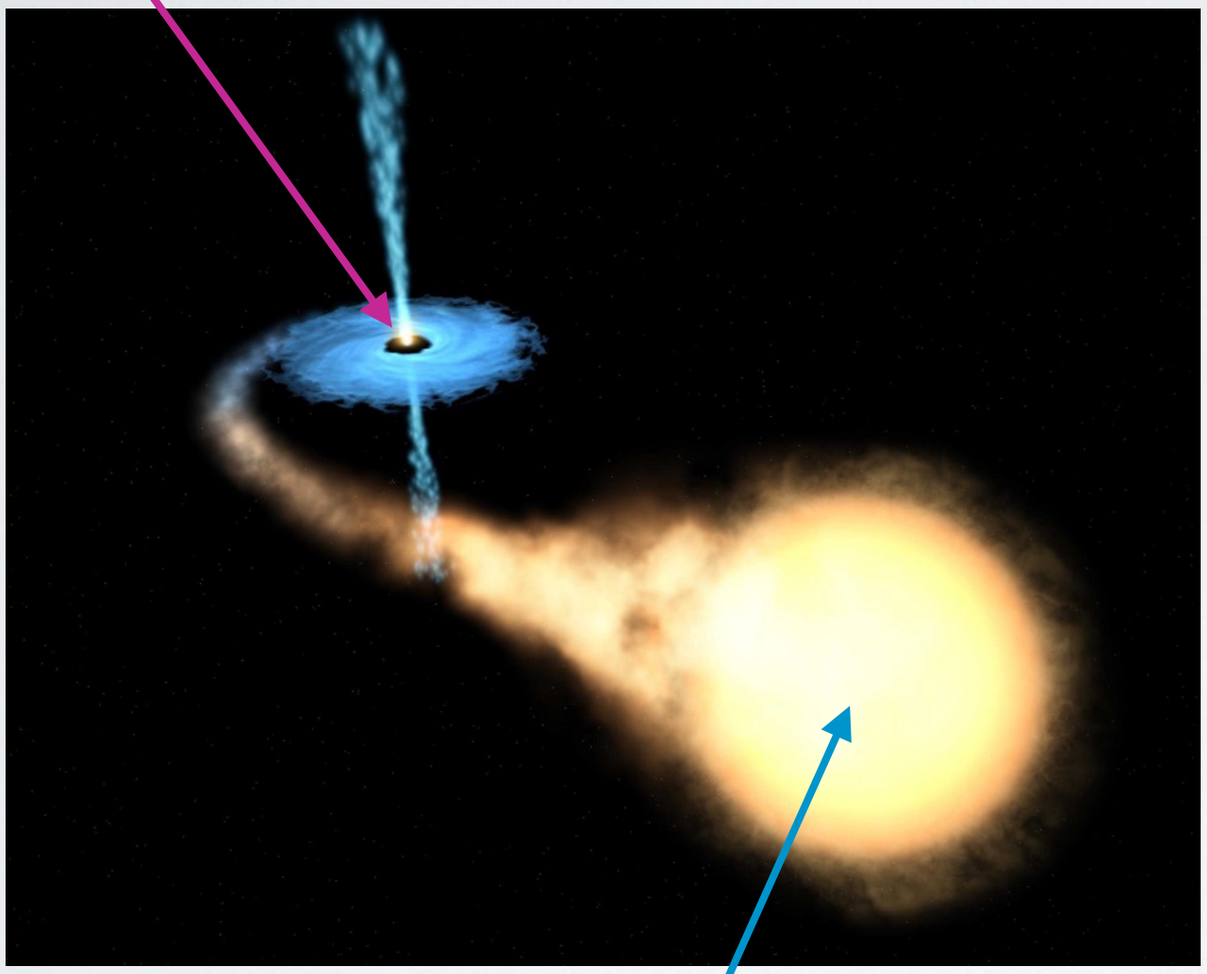


Profile vs. PSF model

Yes, but: a slight excess of photons in white ellipse…
matter ejected by the binary?!?

Binary evolution models

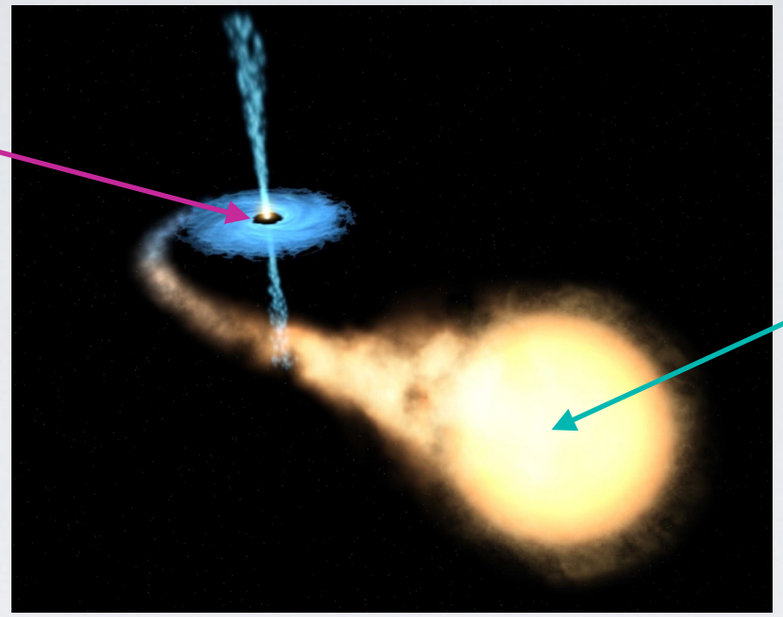
???



Massive O-type star

Constraints

- 30 $M_\odot$ companion
- 16.6 d period
- Compact star progenitor explodes first



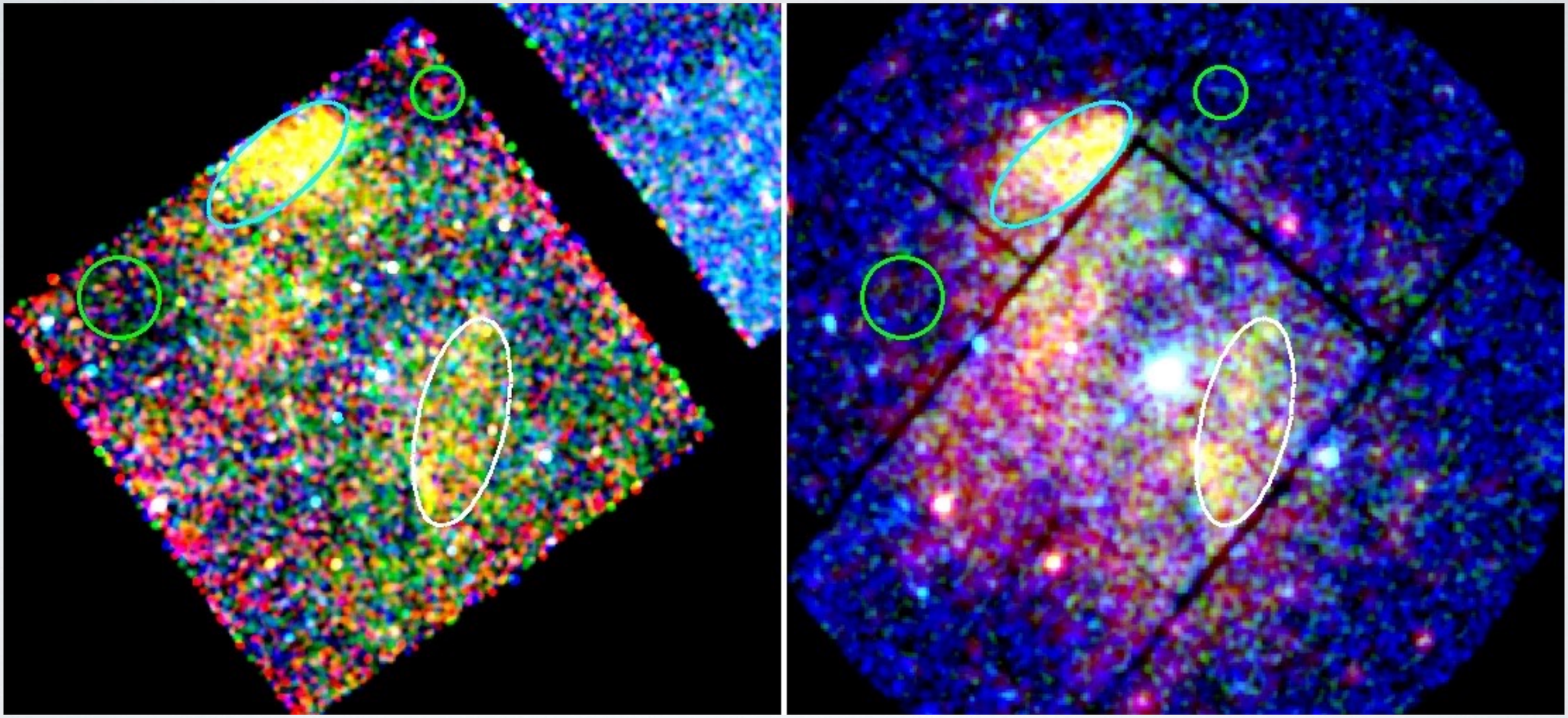
Detached binary

- Assume solar metallicity
- No mass transfer
- Use single-star evolution code (Hurley+ 2002)
- Result: compact object = black hole, but…
- No way to reproduce 16.6 d period

Binary with mass transfer

- Use binary star evolution codes (Hurley+ 2002)
- Grid of 80,000 simulations
- M_1 = 10-35 $M_\odot$, M_2 = 12-50 $M_\odot$, $M_2 > M_1$
- P = 5 - 50 d, e = 0 - 0.9
- Best-fit reproduction with M_1 = 13.4 $M_\odot$, M_2 = 26.7 $M_\odot$, P = 18 d
- **Results in 2.2 $M_\odot$ NS**

SNR G284

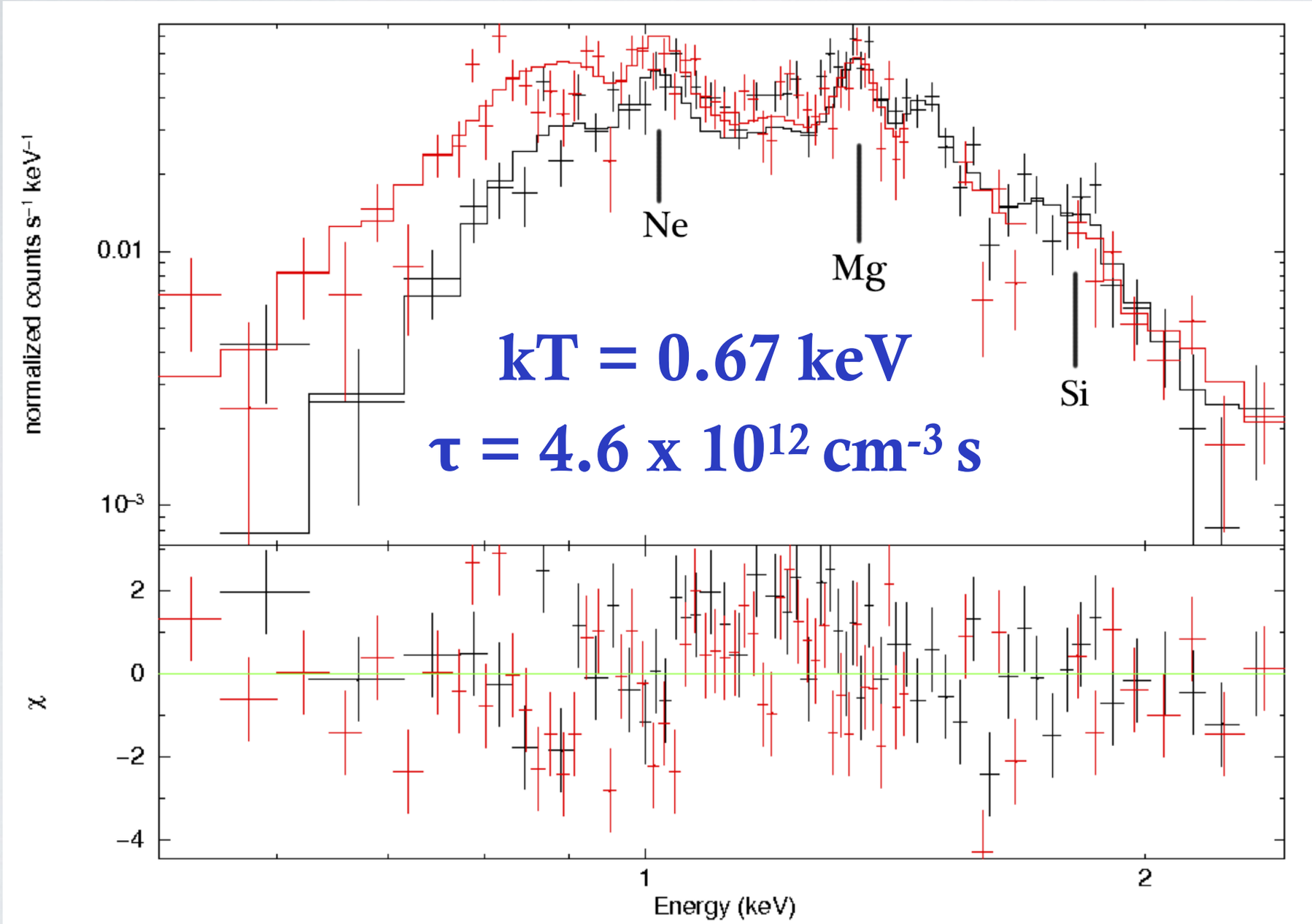


72 ks Chandra Obs. (ours)

105 ks XMM Obs. (PI: De Luca)

Selected two bright regions for analysis: **North & West**

North region spectrum



Model:
phabs x *vpshock*

Abundances:

O ≡ 1
Ne = 1.19
Mg = 1.06
Si = 0.19
Fe = 0.24

Chandra, XMM MOS 2

West region spectrum

Abundances:

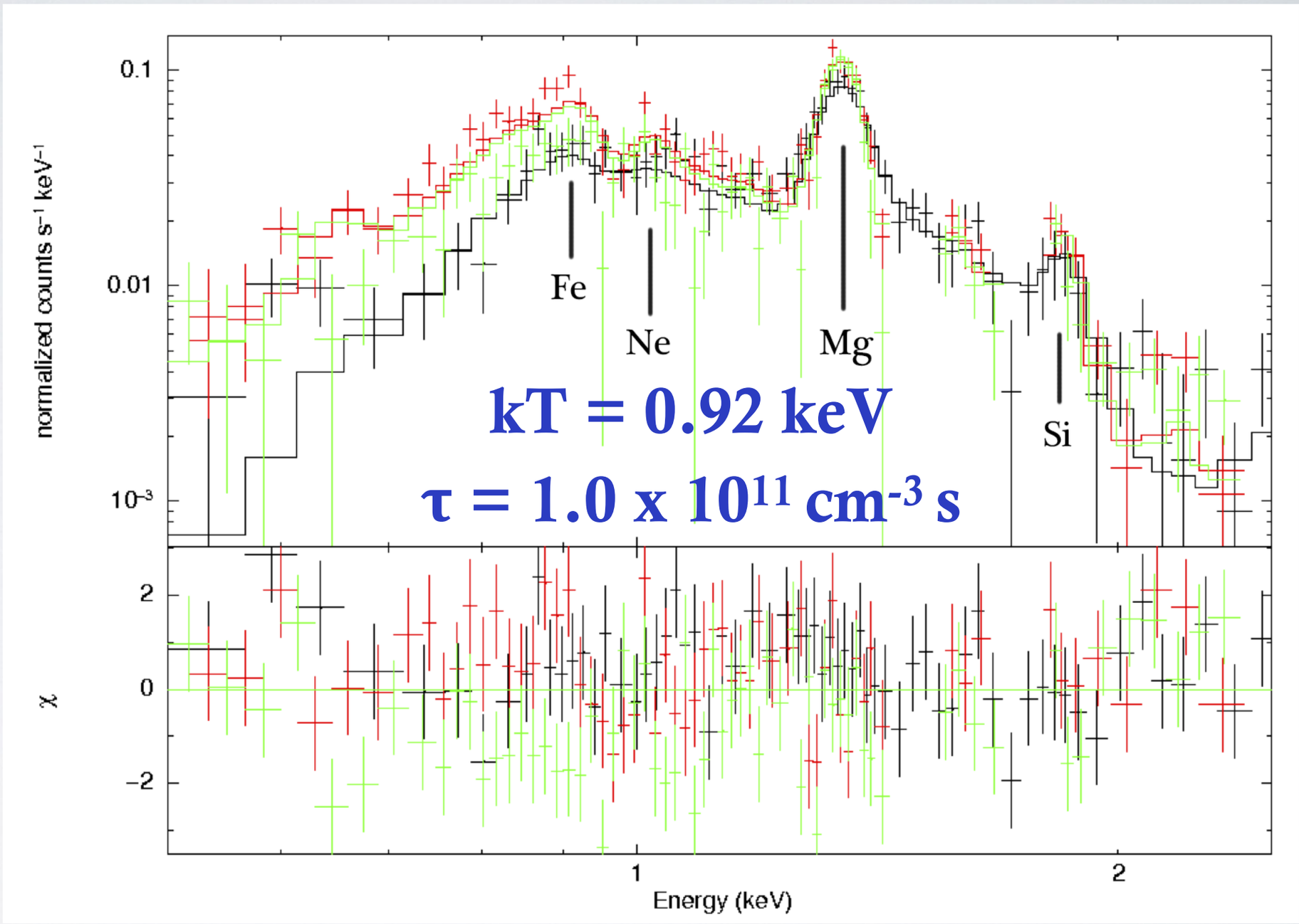
O ≡ 1

Ne = 1.30

Mg = 4.53

Si = 1.50

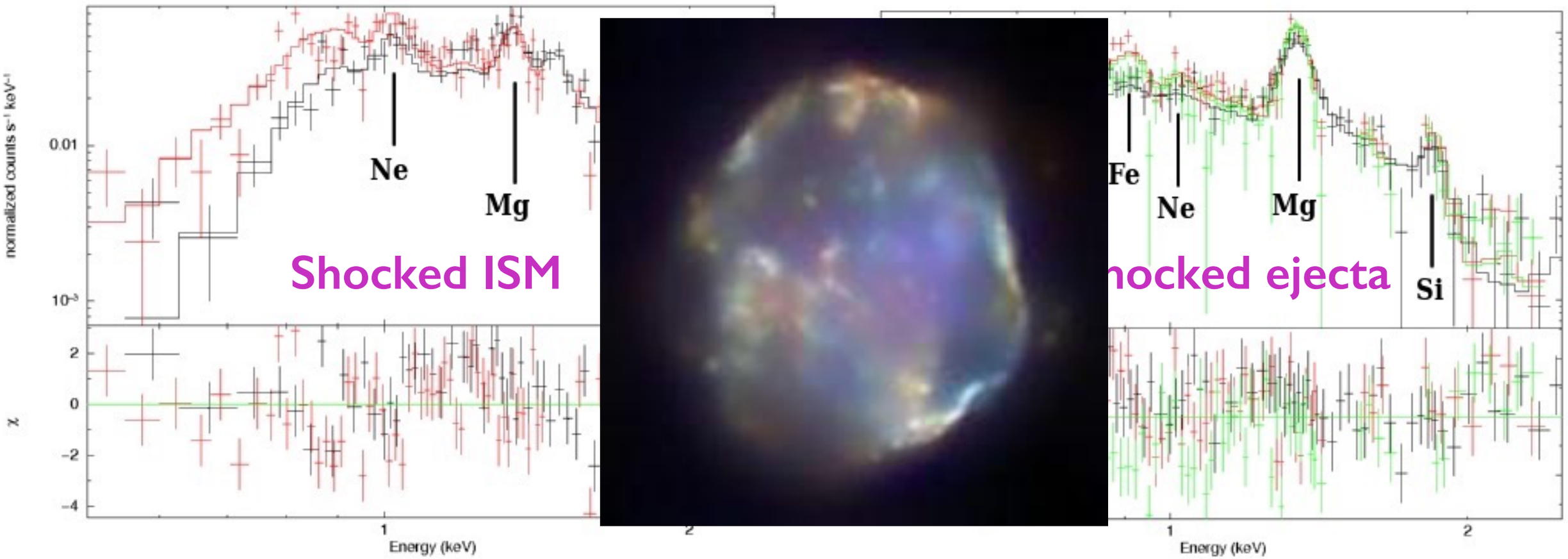
Fe = 0.97



Chandra, XMM MOS 1, XMM MOS 2

North

West



West region rich in Mg, spectra and abundances similar to N49B in LMC (Park et al. 2003), another SNR with Mg-rich ejecta

Nucleosynthesis models produce significant amounts of Mg in explosions of massive (> 25 $M_\odot$) (Thielemann+ 1996)

Conclusions

- **SNRs can reveal information about the progenitor system!**
- 1FGL J1018.6-5856 may have some extended emission a few arcseconds away… could be material from the binary?
- Binary evolution codes suggest a relatively tight binary where mass transfer must have taken place; SN progenitor ≃ 27 $M_\odot$
- Models most consistent with a heavy neutron star as compact object
- Ejecta in SNR appear Mg-rich, very similar to LMC SNR N49B
- Nucleosynthesis models favor massive stars > 25 $M_\odot$