

Global and Rapid Deceleration of X-Ray Knots and Rims of RCW 103

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1. INTRODUCTION:

Supernova remnant RCW 103 (G332.4-0.4; Fig. 1)

- Age: 2–4 kyr (Braun et al. 2019)
- Distance: 3.1 kpc (Reynoso et al. 2004)
- Magnetar with 6.67 hr periodicity, 1E 161348–5055 is associated
- Origin of this peculiar magnetar? — Metal abundances and kinematics provide important information
- Only upper limits on movements of X-ray knots reported (Braun et al. 2019)
- We aimed to obtain meaningful constraints on proper motions using 3-epoch Chandra data

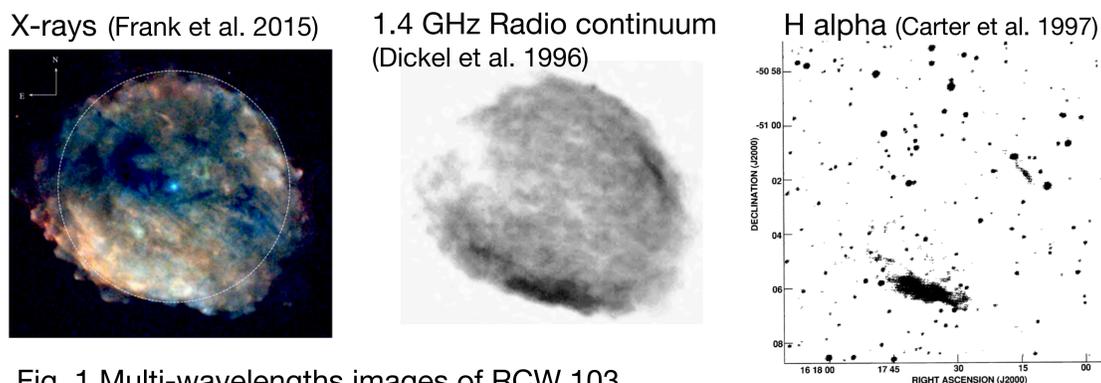


Fig. 1 Multi-wavelength images of RCW 103

2. OBSERVATIONS & DATA REDUCTION

- All the Chandra observations used
- 13 ks (1999), 80 ks (2010), 39 ks (2016) after standard reprocessing
- Astrometry correction for images: two methods
 - match 6–9 X-ray point sources
 - catalog match for 4–6 sources
 - resulted in 0.05–0.30 arcsec residuals left after correction

3. ANALYSIS & RESULTS

3.1 X-ray knots & rims

- Extracted 1D Flux profiles from 12 knots and rims (Fig. 2 left)
- Calculated velocities with the least χ^2 method for two profiles in different years
- Measured proper motions are outward with ~ 1000 km/s in 1999–2010, but changed to inward with $< \sim 2500$ km/s in 2010–2016
- This rapid deceleration is seen both in the north and south
 - effect of systematics insignificant
- An example comparison of flux profiles from different years shown in Fig. 3
- No clear spectral change in time (Fig. 4)

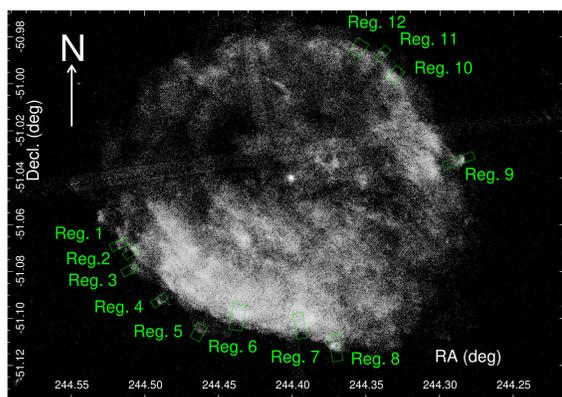


Fig. 2 Profile extraction regions (top) and measured proper motion velocities (bottom)

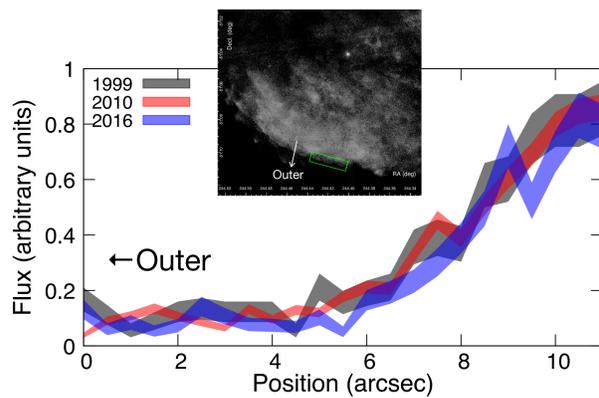


Fig. 3 Example X-ray flux profiles (extracted from a large region)

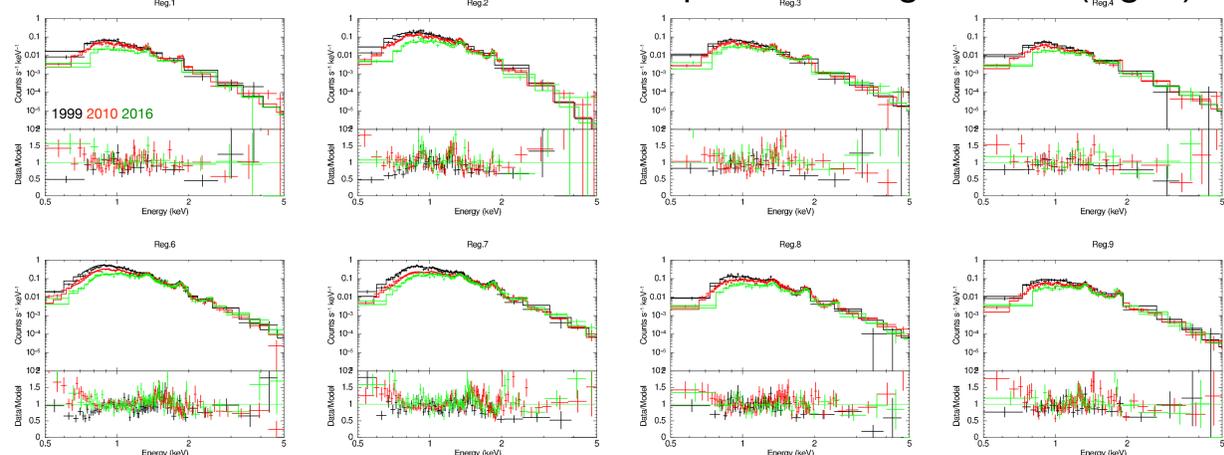


Fig. 4 X-ray spectra from several regions in different years

3.2 Associated Magnetar

- Proper motion of the associated magnetar was constrained as well (Fig. 5).
- Measured velocity, ~ 500 km/s, is typical among neutron stars

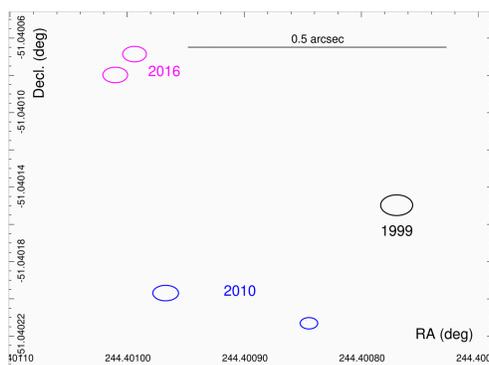


Fig. 5 Positions of the magnetar 1E 161348–5055 in different years

4. INTERPRETATION

- Both the north and south rims started interacting with dense medium within this ~ 20 yr, despite its age of 2–4 kyr
- Density jump of $\sim 36x$ can explain the rapid deceleration of $+1000$ km/s to -2000 km/s (Inoue et al. 2012)
- Spectral changes expected? — We are not yet quantitative.

5. CONCLUSION

- We studied proper motions of X-ray knots and rims of RCW 103 with 3-epoch data of Chandra
- We found global deceleration in this ~ 20 yr and even inward movements both in the north and south
- This can be interpreted as due to very recent & global interaction to dense medium