Asymmetric Type-Ia supernova origin of W49B

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How do we type a middle-aged supernova remnant?

	Normal core-collapse	Type-Ia	W49B
Pulsar wind nebula	Maybe	No	no
Neutron star	Yes	No	?
Ejecta	Intermediate-element rich	Iron-group rich	Iron-group rich
Other direct method?			

Wind bubble and asymmetries cannot be taken as direct methods, as both Type-Ia and core-collapse (CC) SNRs may be inside wind bubbles and both can have asymmetrical morphology

The metal abundances/masses in W49B support a Type-Ia origin

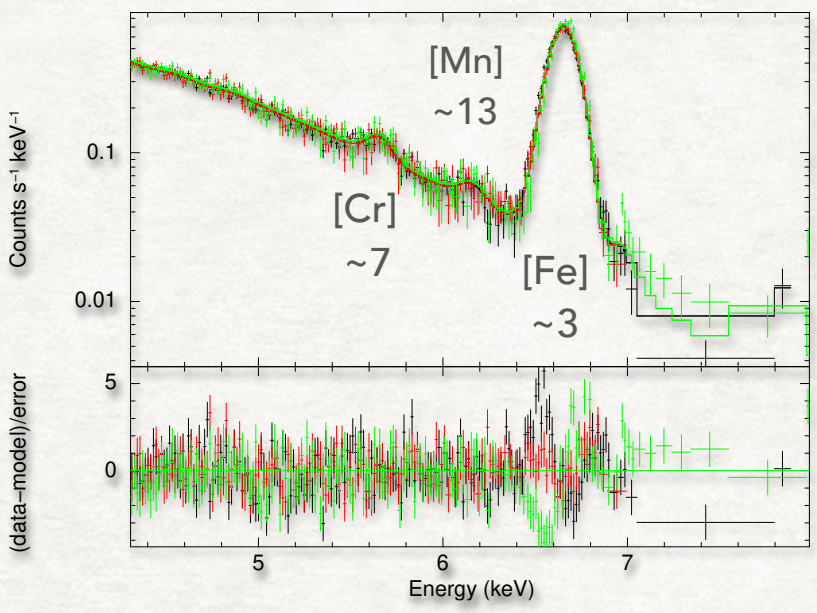

Fig. 1. Global spectra of W49B fitted with a recombining plasma model vvrnei

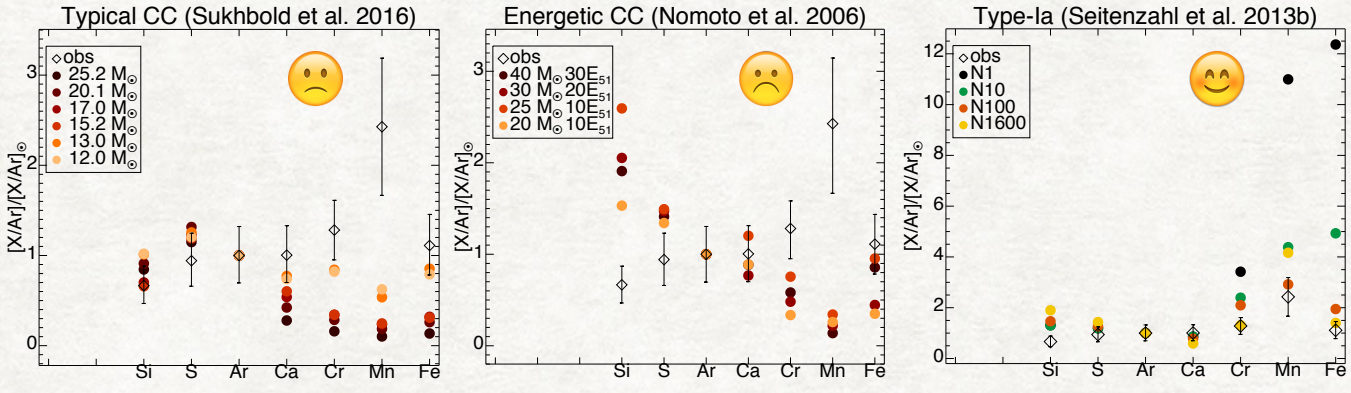

Fig. 2. Abundance ratios compared with the predictions of SN nucleosynthesis models

Fe-group yields	M_{Cr} (M_{sun})	M_{Mn} (M_{sun})	M_{Fe} (M_{sun})
W49B (observed value in the hot gas phase)	~5E-03	~7E-03	~0.32
normal SN from a 25M_{sun} star	6.4E-04	3.2E-04	0.048
10^{52} erg SN from a 25M_{sun} star	1E-03	3.5E-04	~0.1

Conclusion:

1. Metal abundance ratios are consistent with a Type-Ia SN model (see Fig. 2)
2. Metal masses of Fe-group elements (especially Mn) cannot be produced by a CCSN (see the table above)
3. W49B results from a near-Chandrasekhar mass white dwarf <— The large amount of Mn and high Mn/Fe ratio indicate a large central density of the white dwarf (massive white dwarf)
4. Normal explosion energy of ~10^{51} erg, an age of 5—6 kyr
5. Fe abundance is highly enhanced in the east (see Fig.3) —> the type-Ia SN explosion could be highly asymmetrical
6. The bar-like X-ray morphology is mainly due to a density enhancement in the center (see Fig.3.)

Most detailed parameter distributions from spatially resolved X-ray spectroscopy

- Gradient of temperature (kT) and recombination timescale (Tau)
- Asymmetric Fe distribution
- Density enhanced along the E-W bar

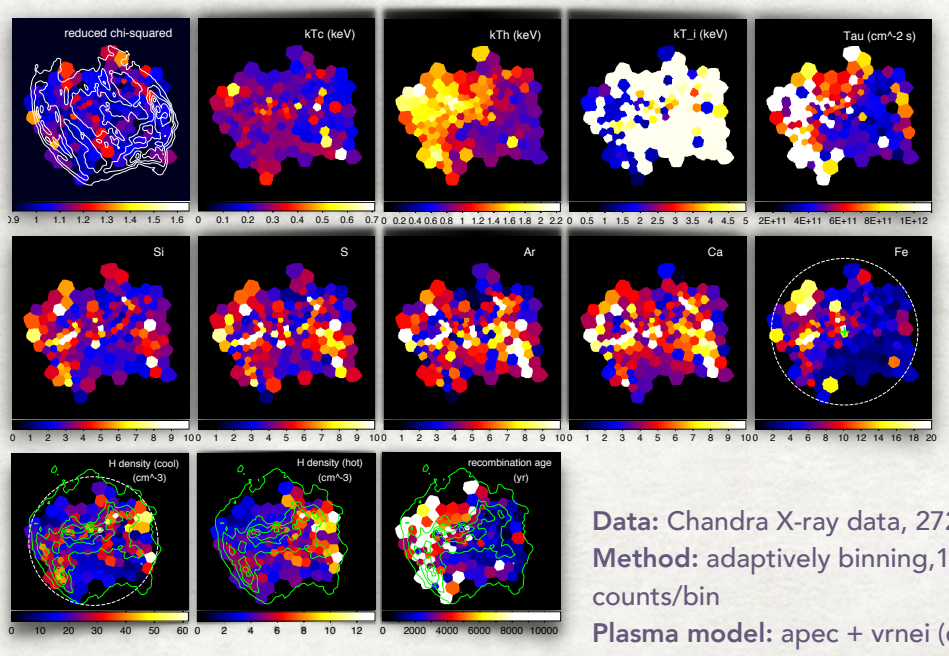

Fig. 3. parameter distribution

Data: Chandra X-ray data, 272 ks
Method: adaptively binning,177 bins,~6000 counts/bin
Plasma model: apec + vrnei (collisional ionization equilibrium plasma + recombining plasma)

Please check our paper and references therein:
Zhou & Vink 2018, A&A, 615, A150