Morphology and Metallicity: The Supernova Remnants of the Small Magellanic Cloud

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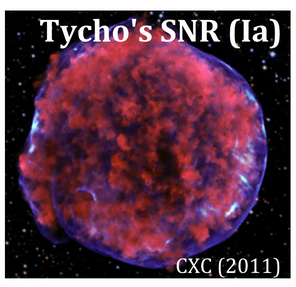
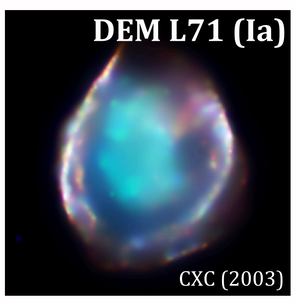
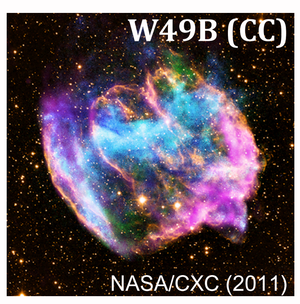
1.

Supernova Remnant (SNR) morphologies encode information about the nature of the SN explosion.

Type Ia SNRs are more spherical and mirror-symmetric than **Core-Collapse (CC) SNRs**.[1]







This is likely due to the distinct explosion mechanisms and the structure of the CSM.

2.

The Power Ratio Method

We can quantify the level of asymmetry of an SNR by using the Power Ratio Method (PRM).[2] [3]

The PRM calculates the powers (P_m) of the multipole moments (a_m and b_m) of the X-ray surface brightness.

$$P_{\mathrm{m}} = \begin{cases} (a_0 \ln(R_{ap}))^2, & m = 0 \\ \dfrac{1}{2m^2 R_{ap}^{2m}} (a_m^2 + b_m^2), & m > 0 \end{cases}$$

Each power describes the X-ray emission from an SNR on successively smaller scales.

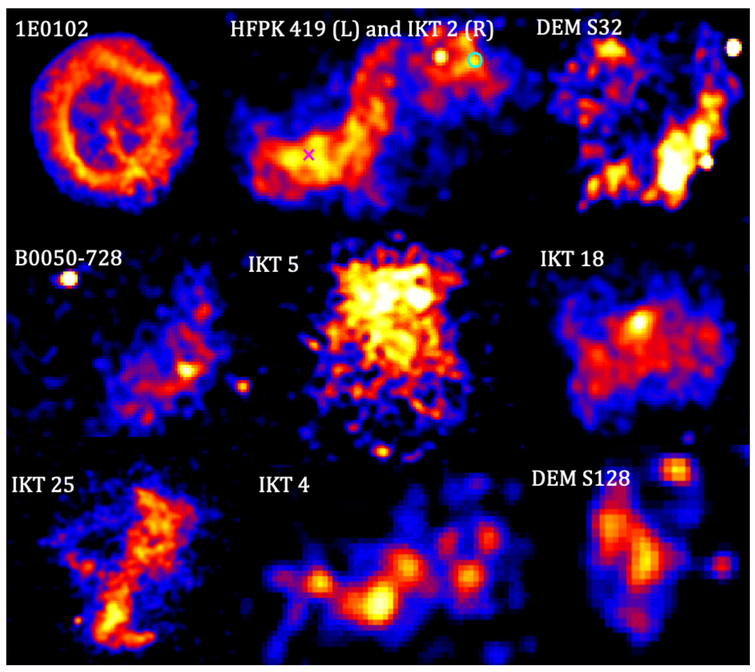
P_2 → Ellipticity

P_3 → Deviations from mirror symmetry

We normalise with respect to flux by computing the ratios P_m / P_0.

3.

Observations



A subset of the 15 archival *Chandra* observations of the Small Magellanic Cloud (SMC) SNRs.

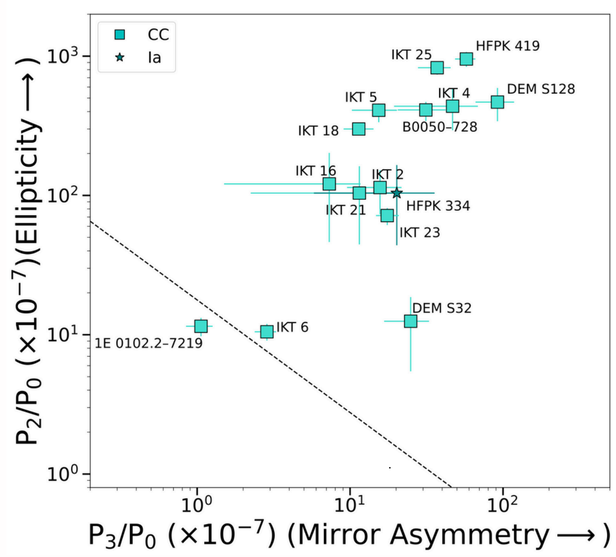
A Recipe for the Morphological Classification of SNRs:

1. Extract the soft X-ray emission (0.5 - 2.1 keV).
2. Quantify the ellipticity and mirror-asymmetry of each using the PRM.
3. Classify as either a CC or Type Ia remnant.

Voilà!

4.

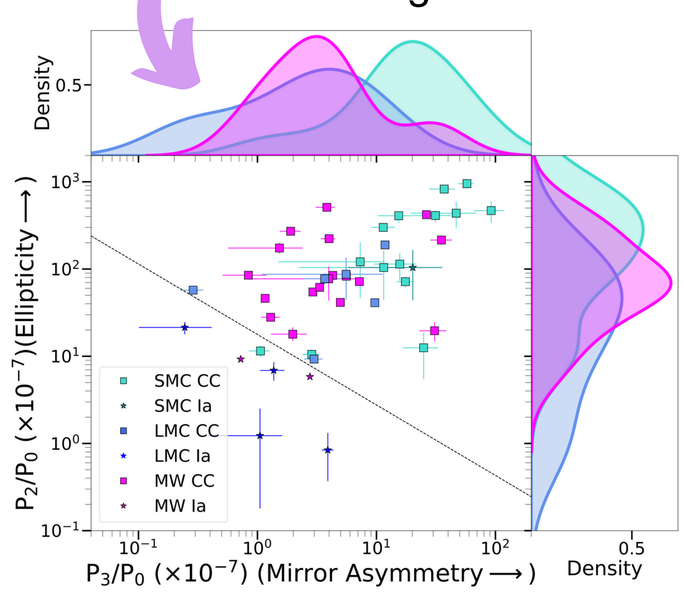
Preliminary Results



The dashed line is from [1], and separates Type Ia (below) and CC (above) morphologies. The markers indicate the suggested SN type from other methods.

The low-metallicity SMC exhibits enhanced asymmetry compared to the higher-metallicity Milky Way and LMC!

Comparison to other galaxies!



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References

[1] Lopez et al. (2011). ApJ. 732: 1-18.

[2] Buote & Tsai (1995). ApJ. 452: 522-537.

[3] Lopez et al. (2009). ApJ. 706: 106-109.