

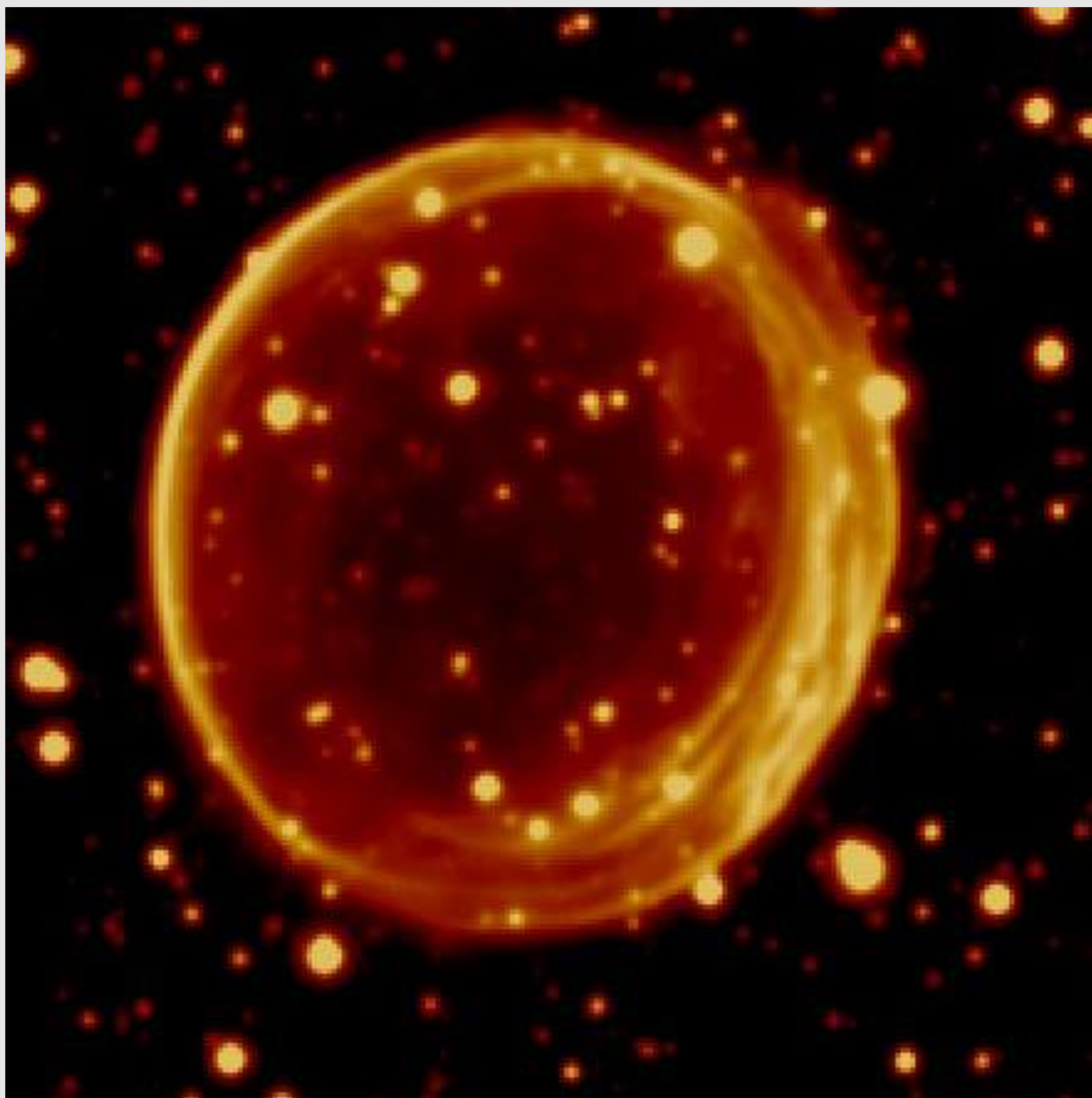


Observational Study of the Reversed Shocked Ejecta in SNR 0509-67.5

By Priyam Das (Supervisors: Dr Ivo Seitenzahl, Dr Ashley Ruitter)



UNSW
CANBERRA



H α (Forward Shock) of SNR 0509-67.5

Location : Large Magellanic Cloud
Type : Type Ia (1991T-like)
Age : 450 ± 120 years

Importance of type Ia supernovae

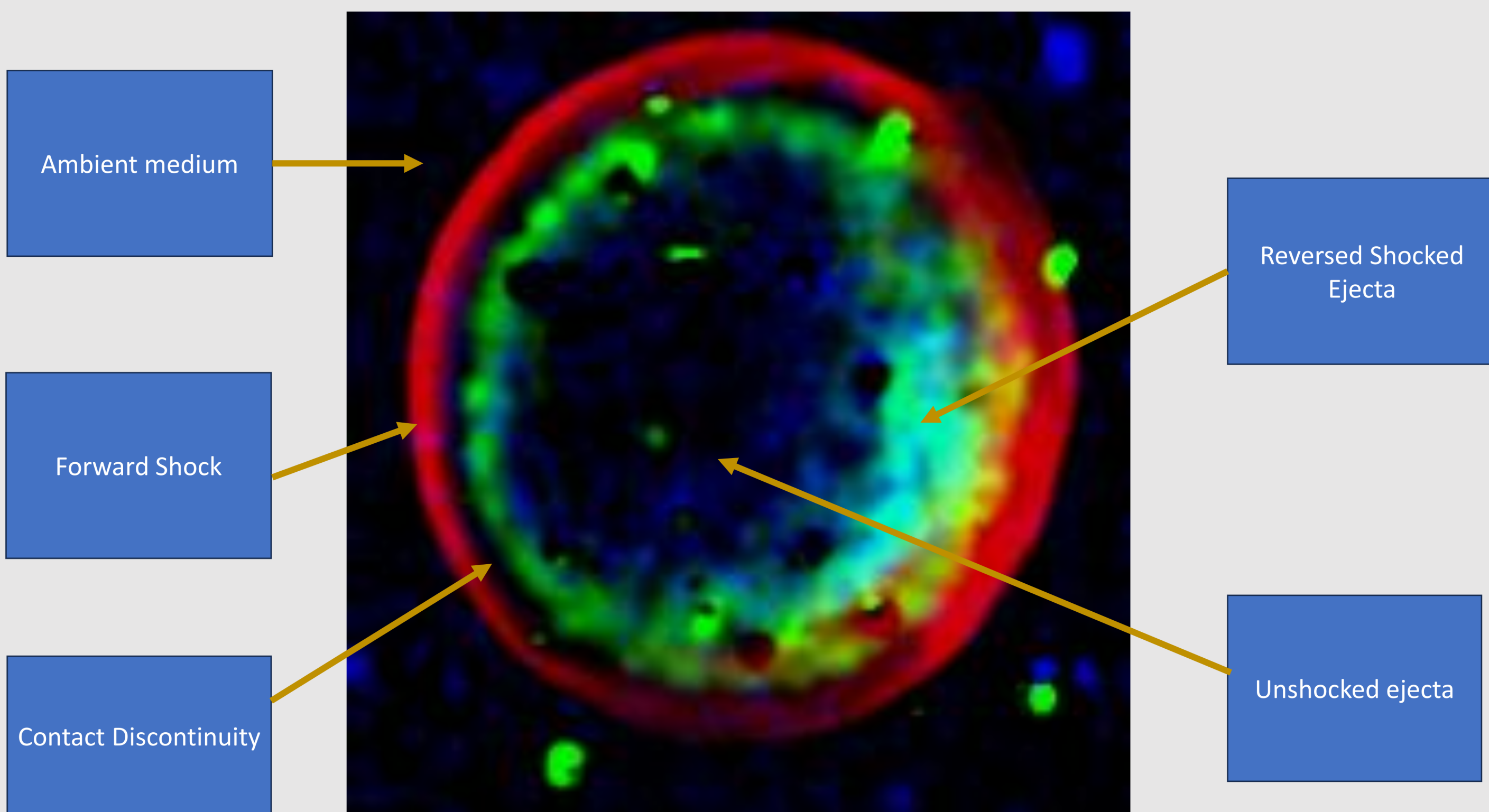
- Used as standardizable candles to measure the expansion of the Universe.
- Important site for nucleosynthesis.
 - Primary source of Iron in the Universe.
 - Key production site of intermediate-mass elements.
- Acceleration site of high energy cosmic rays.

The Big Question!

What is the explosion mechanism of a type Ia Supernova?

Methods:

- SNR 0509-67.5 was observed by MUSE and the final data is a combination of 39 exposures of 2700s each.
- Emission lines fitting with a Gaussian curve to obtain parameters like fwhm, peak, central wavelength, etc.
- Studying the reverse shock can give us insight into its explosion mechanism and progenitor model.
- Analysis of the ejecta and its spectrum through continuum and spatial integration, respectively.



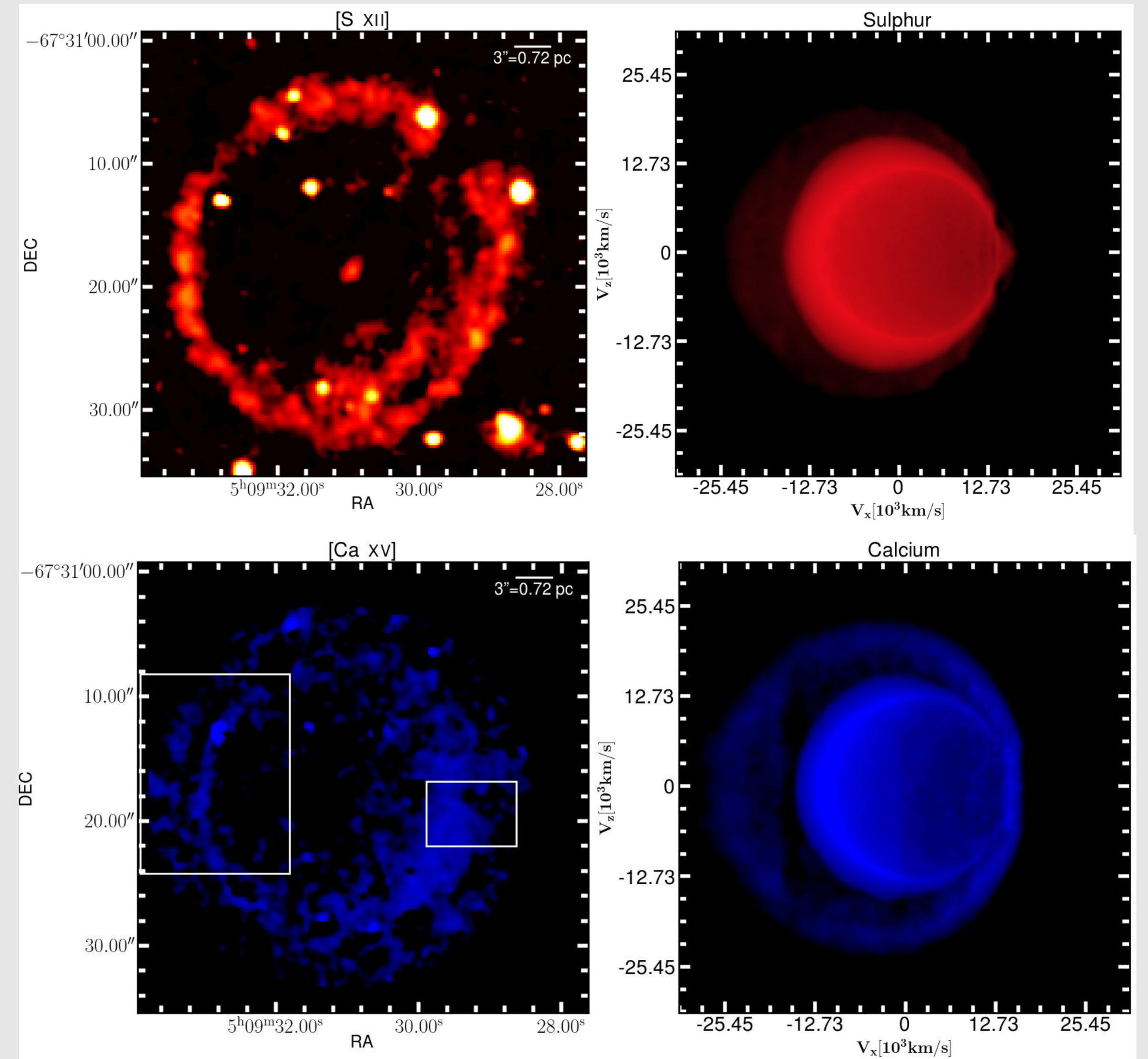
Morphology of a type Ia Supernova remnant.

SNR 0509-67.5 observations and modeling of Seitenzahl et al. (2019) suggest a **double detonation explosion**.

Double detonation is an explosion scenario for type Ia Supernova.

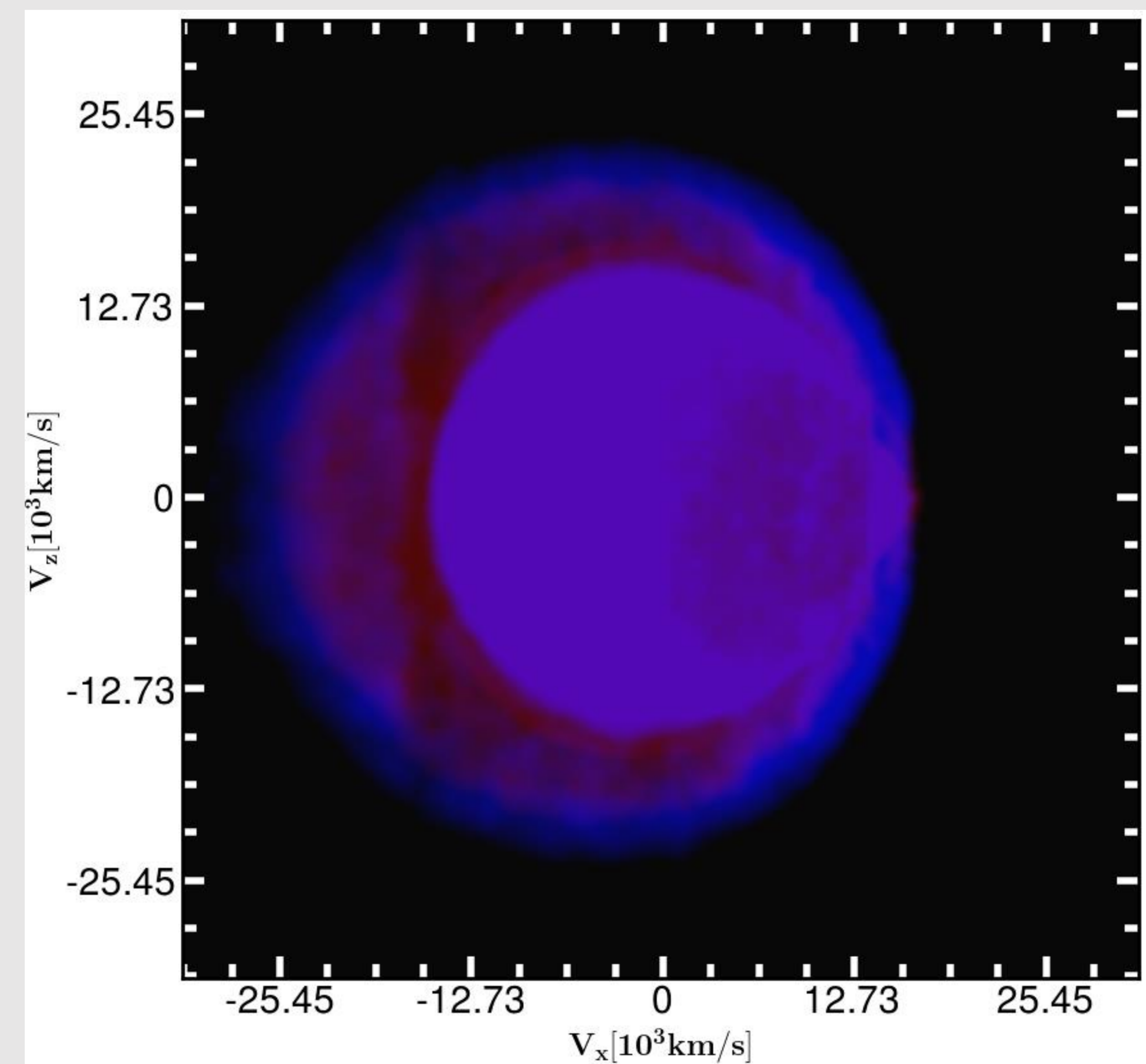
- Mass of the star- sub-Chandrasekhar ($\sim 1.0 M_{\odot}$)
- Accretes helium from a helium-rich donor through stable mass transfer and forms a He-shell ($\sim (0.01 M_{\odot} - 0.1 M_{\odot})$).
- Initial detonation takes place in the He-shell.
- Detonation wave from He-shell ignites carbon in the core leading to a thermonuclear runaway.

Single-shell sulphur and double-shell calcium.

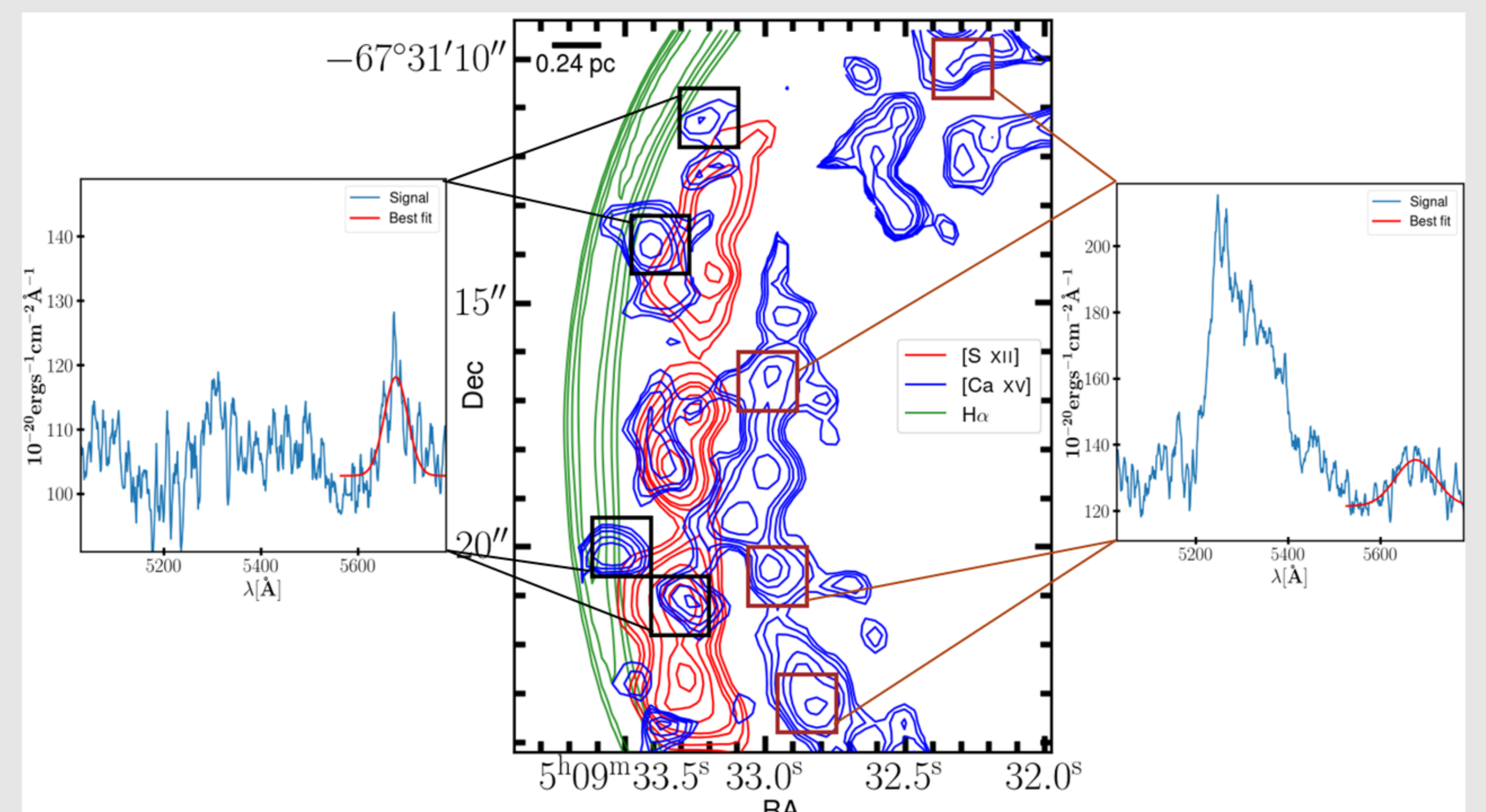


Column density of sulphur and calcium from the model (right) and observations with MUSE (left) show same shell structures.

Simulation of ejecta evolution for the first 100s in a double detonation scenario of a CO WD with a core mass of $1.0 M_{\odot}$ and helium shell mass of $0.03 M_{\odot}$ by Collins et al. (2022).



The position of sulphur (red) between the two shells of calcium (blue) in the double detonation model is the same as the observation.



Main Results :

- SNe 0509-67.5 which is 1991T-like, is the result of the double-detonation of a sub-Chandrasekhar mass WD.
- Studying the reversed shock ejecta is the key to understanding the explosion scenario and progenitor models.