The Study of the Resolved Radio Supernova Remnant SN2008iz hosted in the M82 Galaxy

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ABSTRACT

SN2008iz is a radio-loud supernova located in the nearby starburst galaxy Messier 82 (M82), a galaxy characterized by intense star formation and heavy obscuration by dust and gas. It was discovered in 2009 using the Karl G. Jansky Very Large Array (VLA) at 22 GHz, although radio observations indicate that the explosion likely occurred earlier, around mid-February 2008. The supernova has not been detected in optical or X-ray wavelengths due to the dense environment of its host galaxy. Since no Type Ia supernova in M82 has been observed in radio wavelengths, SN 2008iz is believed to be a core-collapse supernova. High-resolution observations using Very Long Baseline Interferometry (VLBI) revealed a ring-like expanding shell structure, which is characteristic of radio supernova remnants. Long-term monitoring with VLBI and the VLA also detected unusual flux density flares between approximately 1300 and 1600 days after the explosion.

This research investigates the radio evolution of SN 2008iz using VLBA observations collected over multiple epochs. The data will be reduced, calibrated, imaged, and aligned consistently using the Astronomical Image Processing System (AIPS). Radio light curves will be constructed to characterize the timing, strength, and radial positions of the observed re-brightening events. Spectral index analysis will be performed to study the evolution of the relativistic electron population responsible for the synchrotron emission. By examining frequency-dependent absorption in the radio light curves, the density of the circumstellar medium (CSM) will be estimated and the progenitor star's mass-loss rate will be derived. This integrated analysis aims to clarify the physical processes driving the remnant's spectral evolution, shock–CSM interaction, and progenitor mass loss. The results are expected to provide valuable insights into stellar death processes, supernova dynamics, and the feedback mechanisms influencing the interstellar medium in dense starburst environments

Aims and Objectives

Aim

- To study the resolved radio supernova remnant SN 2008iz in M82 using high-resolution VLBI.

Objectives

- To study the evolution of the SNR spectral index evolution
- To model the re-brightening event of the SNR
- To analyze the timing and radial location of the re-brightening events using radio light curves
- To Estimate the CSM density and Mass-Loss Rate from Radio Absorption

Summary

The study investigates the evolution of the resolved radio supernova remnant SN 2008iz in the starburst galaxy M82 using high-resolution Very Long Baseline Interferometry (VLBI) observations. It focuses on analysing the radio emission properties of the remnant, particularly the radio light curve, spectral index evolution, and expansion behaviour, to understand how the expanding supernova shock interacts with the surrounding circumstellar medium (CSM). By constructing radio light curves from multi-epoch VLBA data, the research aims to examine the late-time re-brightening observed in SN 2008iz, determine the timing and radial location of these events, and investigate whether they result from interactions between the shock wave and dense structures in the circumstellar environment produced by the progenitor star's mass loss. The study further estimates the CSM density and the progenitor's mass-loss rate using absorption features in the radio emission. Overall, the research seeks to improve understanding of shock–medium interactions, particle acceleration, and the late-time evolution of radio supernova remnants in heavily obscured starburst galaxies

Methodology

- The research will utilize VLBA archival data from the NRAO database under observation codes BB277, BB293, and BB301.
- The raw VLBA data will be imported and processed using AIPS
- An initial CLEAN image of SN2008iz will be generated
- Images from all observing epochs will be obtained
- Flux densities, spectral indices, and expansion parameters will be derived.
- Integrated flux from CLEAN components or model fits will be used to construct radio light curves across different epochs.
- Uncertainties will be estimated by considering calibration errors and model-fitting uncertainties.
- The resulting radio light curves and spectral indices will be analysed

Data Analysis and Results

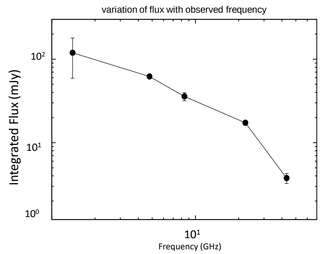
Spectral index

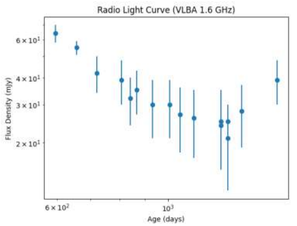
$S \propto \nu^{\alpha}$

For two frequencies

$$\alpha = \frac{logv2 - logv1}{logS2 - logS1}$$

- Integrated flux decreases with increasing frequency.
- Energy losses cause weaker emission at higher frequencies
- This implies a negative spectral index





- General decline from about 64 mJy at ~580 days to ~25 mJy at ~1200 day.
- Indication a decaying trend over time
- Apparent increase in flux at later epochs (~1300–1600 days), suggesting a possible re-brightening event.
- This could be due to interaction with a dense circumstellar medium.
- clear decay in 1.6 GHz flux over ~1200 days, followed by a re-brightening
- Interaction with the dense circumstellar medium or additional energy input at late times.

SN2008iz in M82

Fig. 1.1:M82 Galaxy

Fg.1.2:Supernovas in M82

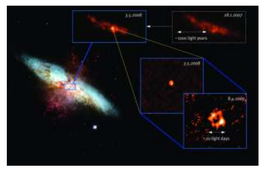


Fig. 1.3: SN2008iz

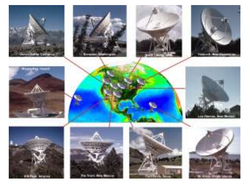


Fig. 1.4: VLBA

References

Brunthaler, A., et al. (2010). SN 2008iz: A radio supernova in M82. *Astronomy & Astrophysics, 516*, A27

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