

New radio observations of the Type II_n Supernova 1978K

Stuart D. Ryder¹, Erik C. Kool^{2,1} and Rubina Kotak³

¹Australian Astronomical Observatory, Sydney NSW 1670, Australia
email: sdr@aaoo.gov.au

²Dept. of Physics & Astronomy, Macquarie University, Sydney NSW 2109, Australia

³Astrophysics Research Centre, Queens University Belfast, United Kingdom

Abstract. SN 1978K is the oldest-known Type II_n supernova, and one of the closest. We report new radio observations at high frequency and spatial resolution. SN 1978K has been detected at 34 and 94 GHz with the Australia Telescope Compact Array, while Very Long Baseline Interferometry at 8.4 GHz has allowed us to derive the past average expansion velocity, which indicates significant deceleration as the blast wave interacts with the dense circumstellar medium.

Keywords. supernovae: general – supernovae: individual: SN 1978K – galaxies: individual: NGC 1313

Summary

At just 4.6 Mpc away, SN 1978K in the late-type barred spiral galaxy NGC 1313 is the second-closest example (after SN 1996cr in the Circinus Galaxy) of a Type II_n supernova, in which the Balmer optical emission lines show a narrow (few hundred km s⁻¹) emission peak atop a broader (several thousand km s⁻¹) profile. These characteristics are thought to be associated with a dense circumstellar medium arising from significant mass-loss by the progenitor star prior to explosion.

SN 1978K was observed with the Australia Telescope Compact Array at 34 GHz and at 94 GHz in Sep 2014, yielding fluxes of 2.9 ± 0.2 mJy and 1.2 ± 0.3 mJy, respectively. SN 1978K is only the third evolved extragalactic supernova (after SN 1987A and SN 1996cr) to be detected at these frequencies, but is $>400\times$ brighter than SN 1987A.

We observed SN 1978K with the Australian Long Baseline Array at 8.4 GHz on 29 March 2015. After deconvolving the resultant image by the 3 milli-arcsec beam, we find the current diameter of the remnant of SN 1978K is <5 milli-arcsec (0.1 pc), giving a past average expansion velocity $<1\,500$ km s⁻¹.

Our radio light curve fitting constrains the remnant radial expansion to have $R \sim t^{0.78}$, which implies significant deceleration of the ejecta by a substantial circumstellar medium, and predicts a current expansion velocity $\sim 1\,000$ km s⁻¹. Recent optical spectroscopy of SN 1978K by Kuncarayakti *et al.* (2016) shows remarkable similarities with SN 1987A, and line-widths indicating a current expansion velocity ~ 500 – 600 km s⁻¹, within a factor of 2 of that predicted by this model for SN 1978K.

Full details of the results outlined here can be found in Ryder *et al.* (2016).

References

- Kuncarayakti, H., Maeda, K., Anderson, J., Hamuy, M., Nomoto, K., Galbany, L., & Doi, M. 2016, *MNRAS*, 458, 2063
Ryder, S., Kotak, R., Smith, I., Tingay, S., Kool, E., & Polshaw, J. 2016, *A&A*, 595, L9