M31N 2017-01e: Still No Evidence for a Surrounding Nova Super-remnant

Draft version March 12, 2026
Typeset using LaTeX **default** style in AASTeX7.0.1

M31N 2017-01e: still no evidence for a surrounding nova super-remnant

M.J. Darnley[1] and M.W. Healy-Kalesh[1]

[1]*Astrophysics Research Institute, Liverpool John Moores University, IC2 Liverpool Science Park, Liverpool, L3 5RF, UK*

Submitted to RNAAS

ABSTRACT

The recurrent nova M31N 2017-01e, with an inter-eruption period of just 2.5 years, is the second most active nova yet discovered. As such, one might expect it to be surrounded by a visible nova super-remnant akin to the one discovered around M31N 2008-12a, or to those around selected Galactic and Magellanic Cloud recurrent novae. Here, we report that the deepest Hα observations of M31N 2017-01e yet collected still show no evidence for a surrounding nova super-remnant. We outline some potential explanations and consequences.

Keywords: Recurrent novae (1366) — Stellar remnants (1627) — Interstellar medium (847)

Nova super-remnants (NSRs) form from the eventual interaction between nova shells from successive eruptions of classical and recurrent novae (RNe). They are predicted to exist around all novae that have experienced at least two eruptions (M. W. Healy-Kalesh et al. 2023). Following the discovery of the first, and still brightest, NSR around the 1-year RN M31N 2008-12a (hereafter '12a'; M. J. Darnley et al. 2019), four more have been identified each surrounding known RNe: RS Ophiuchi, T Coronae Borealis, KT Eridani, and LMCN 1971-08a (see M. W. Healy-Kalesh et al. 2024a; M. M. Shara et al. 2024a,b; M. W. Healy-Kalesh et al. 2025, respectively).

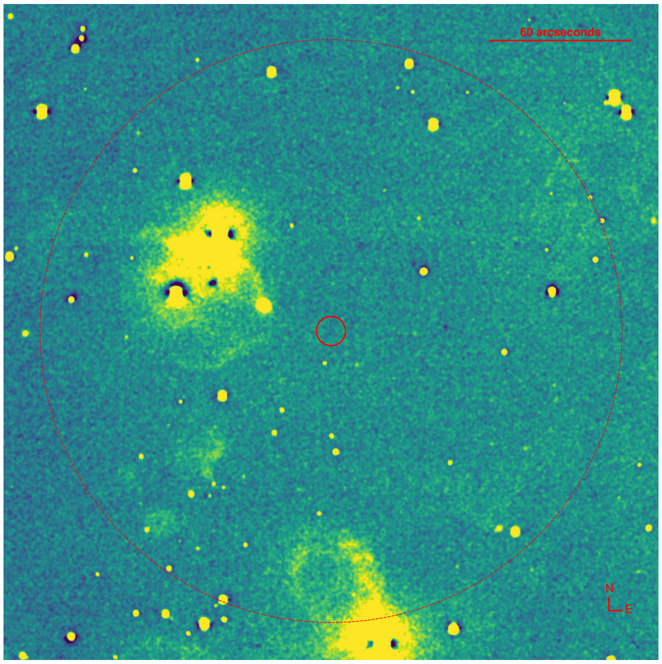
M. W. Healy-Kalesh et al. (2024b) undertook a systematic search for NSRs in M31 and the LMC using archival Hα observations of M31 and new LCOGT imaging of the LMC. That survey only recovered the already known NSR around 12a. Those authors concluded that the data were not deep enough to see any other NSRs due to the correlation between increasing NSR luminosity and decreasing recurrent period proposed by M. W. Healy-Kalesh et al. (2023). In practice, that survey did not recover the LMCN 1971-08a NSR as that example turned out to be larger than the originally observed field.

With a recurrence period of just 2.5 ± 0.1 years (S. Chamoli et al. 2025), M31N 2017-01e (hereafter '01e') is the second fastest RN known. Therefore, following M. W. Healy-Kalesh et al. (2023), if this system contains a CO-WD that has grown to (almost) the Chandrasekhar mass, we might expect 01e to host a bright NSR akin to the one surrounding 12a. However, M. W. Healy-Kalesh et al. (2024b) found no evidence for a NSR around 01e.

As part of a programme to detect and follow-up eruptions from 01e, the Liverpool Telescope (I. A. Steele et al. 2004) has been regularly observing the system since September 2021. These observations have been taken by the IO:O instrument through Hα and Sloan-r' filters with the express intention of utilising them to undertake a deeper search for any associated NSR.

A series of 175 Hα images and 105 r' band images were carefully aligned and combined to create a pair of single deep observations of the field around 01e. The stacked Hα and r' images had effective exposure times of 27,060 s (7.52 h) and 6,300 s (1.75 h), respectively. Even after accounting for the differences in telescope size, these observations are deeper than those utilised by M. W. Healy-Kalesh et al. (2024b): $\sim\times4.5$ and $\sim\times6.3$ in Hα and r', respectively. The stacked images were carefully photometrically matched and manipulated to produce a continuum subtracted Hα image. Following M. W. Healy-Kalesh et al. (2024b), a Hα radial flux profile around the position of 01e was produced. Both the Hα continuum subtracted image (left) and the Hα radial flux profile are shown in Figure 1.

Email: M.J.Darnley@ljmu.ac.uk



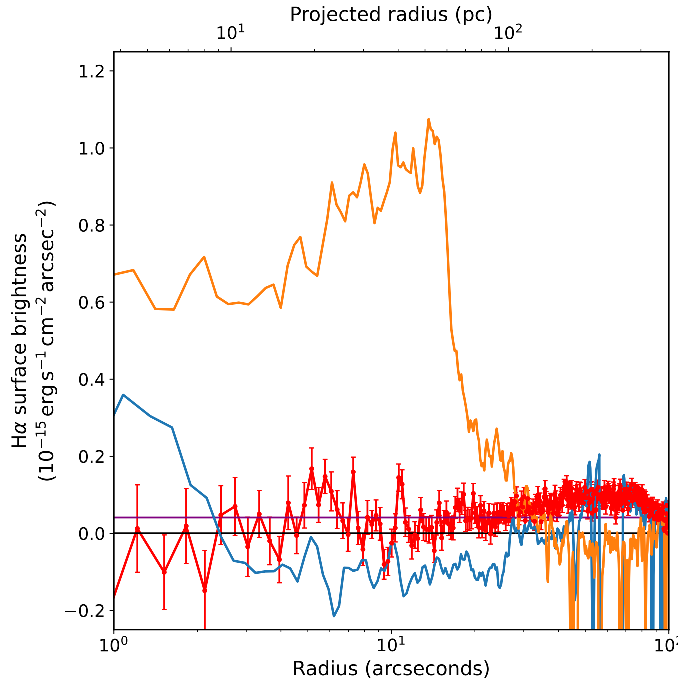


Figure 1. Left: Liverpool Telescope Hα continuum subtracted image showing the extended region around M31N 2017-01e. The image is approximately $5' \times 5'$. The position of M31N 2017-01e is indicated by the small red circle at the centre. The larger dashed red circle indicates the outer extent of the region over which the radial flux profile was computed. **Right:** The Hα radial flux profile around M31N 2017-01e (red line; this work), compared to the previous measurement (blue line; M. W. Healy-Kalesh et al. 2024b), the radial profile of the M31N 2008-12a nova super-remnant (orange line; M. W. Healy-Kalesh et al. 2024b), and the peak Hα surface brightnesses of the LMCN 1971-08a and KT Eri NSRs (purple line; the black horizontal line just below indicates zero excess flux).

The NSR surrounding 12a was originally discovered, by eye, due to its brightness in ground-based Hα images (M. J. Darnley et al. 2015). However, there is still no such ‘visible’ remnant in this deeper and continuum subtracted Hα image of 01e (see Figure 1 left). Although nearby and unrelated nebulosity can be clearly seen, e.g., from the known H II region just to the north-west and further to the south. The updated radial Hα flux profile (see Figure 1 right; red line) reveals no evidence for a Hα flux excess around 01e. Indeed, the measured flux excess is consistent with zero within $\sim 30''$ (~ 100 pc projected) of 01e. The flux rise beyond this is likely due to the unrelated nebulosity seen in the larger field.

It may well be that 01e does still host a luminous NSR but that it is still faint enough to elude detection. The purple horizontal line shown in the right-hand panel of Figure 1 indicates the peak surface brightness of the NSRs detected around LMCN 1971-08a and KT Eri ($\sim 4 \times 10^{-17}$ erg s^{-1} cm^{-2} arcsec^{-2}; M. W. Healy-Kalesh et al. 2025; M. M. Shara et al. 2024b). The NSRs around LMCN 1971-08a and KT Eri are the most luminous after the 12a NSR but still ~ 25 times fainter. It is clear that those NSRs would not be detectable in these data. We can confidently conclude that any NSR around 01e cannot be substantially brighter than the ones found around RS Oph, T CrB, KT Eri, and LMCN 1971-08a. Larger-scale M31 structure and the unresolved stellar population that both contribute to ‘background’ Hα emission may simply dominate over any NSR emission associated with 01e.

It may be that 01e simply doesn’t host a large NSR, unlike many other RNe. M. W. Healy-Kalesh et al. (2023) demonstrated that NSRs are grown around novae hosting CO WDs as the WD slowly approaches the Chandrasekhar limit over many tens to hundreds of thousands of eruptions. But, M. W. Healy-Kalesh et al. (2023) also proposed that RNe with ONe WDs (which have a higher zero-age WD mass) would not support such large or luminous NSRs. Recently, S. Chamoli et al. (2025) proposed that 01e may be an ‘unusual’ nova powered by a Be star donor. Such a scenario may drive the high accretion rate necessary for such a short recurrence period without the requirement for a particularly high mass WD, and hence restrict both the growth and luminosity of any NSR.

In any event, our observations of this system are not yet extensive enough to draw any strong conclusions about the existence of an M31N 2017-01e nova super-remnant: further observations are still required.

ACKNOWLEDGMENTS

The Liverpool Telescope is operated on the island of La Palma by Liverpool John Moores University in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofisica de Canarias with financial support from the UK Science and Technology Facilities Council.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this manuscript.

Facilities: Liverpool:2m

REFERENCES

Chamoli, S., Basu, J., Barway, S., et al. 2025, ApJ, 991, 174, doi: 10.3847/1538-4357/adf843

Darnley, M. J., Henze, M., Steele, I. A., et al. 2015, A&A, 580, A45, doi: 10.1051/0004-6361/201526027

Darnley, M. J., Hounsell, R., O'Brien, T. J., et al. 2019, Nature, 565, 460, doi: 10.1038/s41586-018-0825-4

Healy-Kalesh, M. W., Darnley, M. J., Harvey, É. J., et al. 2023, MNRAS, 521, 3004, doi: 10.1093/mnras/stad617

Healy-Kalesh, M. W., Darnley, M. J., Harvey, É. J., & Newsam, A. M. 2024a, MNRAS, 529, L175, doi: 10.1093/mnrasl/slae016

Healy-Kalesh, M. W., Darnley, M. J., & Shara, M. M. 2024b, MNRAS, 528, 3531, doi: 10.1093/mnras/stae251

Healy-Kalesh, M. W., Sasaki, M., Points, S. D., et al. 2025, A&A, 702, L9, doi: 10.1051/0004-6361/202556670

Shara, M. M., Lanzetta, K. M., Masegian, A., et al. 2024a, ApJL, 977, L48, doi: 10.3847/2041-8213/ad991e

Shara, M. M., Lanzetta, K. M., Garland, J. T., et al. 2024b, MNRAS, 529, 224, doi: 10.1093/mnras/stad3612

Steele, I. A., Smith, R. J., Rees, P. C., et al. 2004, in Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, Vol. 5489, Ground-based Telescopes, ed. J. M. Oschmann, Jr., 679–692, doi: 10.1117/12.551456