RCW 86 as the remnant of a calcium-rich core-collapse supernova explosion

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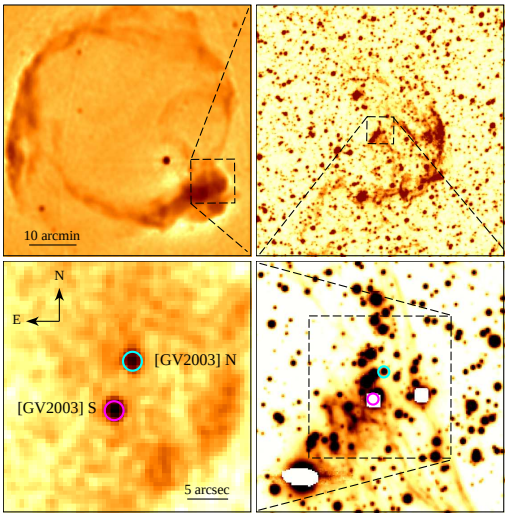

Figure 1: From the upper left clockwise: MOST 843 MHz image of RCW 86, DSS-II red band image of an arc-like optical nebula in the south-west corner of RCW 86, and VLT/FORS2 and *Chandra* images of two point sources, [GV2003] N and [GV2003] S, in the centre of the optical arc (marked, respectively, by blue and magenta circles). The orientation of the images is the same. At the distance of RCW 86 of 2.3 kpc, 10 arcmin and 5 arcsec correspond to ≈6.6 and 0.05 pc, respectively.

The pyriform appearance of the supernova remnant (SNR) RCW 86 (Fig. 1) can be explained as the result of a supernova (SN) explosion near the edge of a bubble blown by the wind of a moving massive star. This interpretation implies that the SN exploded near the centre of the arc-like optical nebula in the south-west of RCW 86. Using *Chandra* data we discovered two sources in the expected position of the SN progenitor (Fig.1), one of which, [GV2003] S, turns out to be a foreground late-type active star, while the second one, [GV2003] N, was interpreted as a candidate neutron star [1]. Using the 7-channel imager GROND we detected a G-type star at the position of [GV2003] N. Follow-up VLT/FORS2 spectroscopy of this star revealed clear radial velocity variations, indicative of a close, eccentric binary, and showed that the star is strongly polluted with calcium and other elements [2]. Our findings mean that [GV2003] N is a post-SN binary system, which lost most of its initial mass due to common-envelope evolution shortly before core collapse, and that the SN explosion that formed RCW 86 might belong to the class of Ca-rich SNe – faint and fast transients, whose origin is strongly debated. The short orbital period of [GV2003] N indicates that this binary system will evolve into a low-mass X-ray binary (LMXB) within its nuclear time scale ($\sim 10^{10}$ yr), providing the first definite example of a pre-LMXB located within a SNR.

References

[1] V. V. Gvaramadze & A. A. Vikhlinin, *A&A* 401, 625 (2003)

[2] V. V. Gvaramadze et al., *preprint*, arXiv:1702.00936 (2017)

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