

Post-outburst phase of LDN 1415 nebula (IRAS 04376+5413)

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Abstract. LDN 1415 nebula was first detected by Stecklum (2006) in early April 2006 in the vicinity of IRAS 04376+5413. In this paper, we present a study of the post-outburst phase of LDN 1415 nebula using optical (V, R, I) and near-infrared (J, H, K) photometric and low-resolution optical spectroscopic observations.

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(LDN 1415 nebula)

1. Observations

Optical (V, R, I) and near-infrared (NIR) (J, H, K) photometric and low-resolution optical spectroscopic observations were carried out with the Hanle Faint Object Spectrograph Camera (HFOSC), NIR camera (NIRCAM) and IUCAA Faint Object Spectrograph Camera (IFOSC) on the 2-m Himalayan *Chandra* Telescope, Hanle and 2-m IUCAA optical and NIR telescope, Pune, during the period 2006 October - 2009 March.

2. Results and Discussion

We have defined eruptive source plus reflected nebula as L1415-Neb since the associated outburst source is too faint to detect separately. The VRI light

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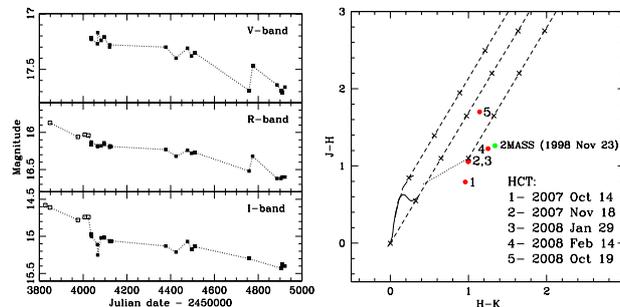


Figure 1. (*left*) The optical light curve of L1415-Neb in *VRI* bands. The filled boxes show our HFOSC and IFOSC measurements (2006 October – 2009 March). The empty boxes show the photometric measurements from Stecklum et al. (2007). (*right*) *J-H/H-K* CC diagram showing the location of L1415-Neb as observed with 2MASS (filled circle, green in colour) on 1998 November 23; with HCT (filled circles, red in colour) on 2007 October 14, 2007 November 18, 2008 January 29, 2008 February 14 and 2008 October 19.

curves are shown in Fig. 1 (*left*) alongwith the measurements from Stecklum et al. (2007). Comparing the pre-outburst *I*-band magnitude from POSS II (epoch 1996 December) and the KISO (2001 January) quoted in Stecklum et al. (2007), with our first post-outburst data point, shows an enhancement of 3.4 mags. Following this, a general decline in the brightness is seen in all three (*VRI*) optical light curves. This is consistent with the young and eruptive nature of this class of objects. Fig. 1 (*right*) shows the *J-H/H-K* colour-colour (CC) diagram of L1415-Neb. This plot displays the change in the pre- and post-outburst NIR colours. The pre-outburst 2MASS colours suggest an IR excess in the source. There is a movement along the reddening vector towards the tip and beyond the locus of the T-Tauri stars (see Fig. 1). Our first sampled NIR data point of 2007 October 14 seems to have the NIR colours of a reddened Herbig AeBe star. The movement downwards along the reddening line suggests that circumstellar matter of $A_V \sim 5$ mag has possibly been cleared during the present eruption. Therefore, our long-term, post-outburst optical and NIR photometric and optical spectroscopic monitoring of L1415-Neb and its associated outburst source dating from 2006 October to 2009 March, suggests an EXor or FUor event, possibly by the least luminous member of the known sample of FUor and EXor objects (Stecklum et al. 2007).

References

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