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V2540 Oph (Nova Oph 2002): LARGE-AMPLITUDE SLOW NOVA WITH STRONG POST-OUTBURST OSCILLATIONS

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V2540 Oph (Nova Oph 2002) was independently discovered by Katsumi Haseda and Yuji Nakamura at magnitude 9.0 on 2002 January 24 (Haseda et al. 2002). Retter et al. (2002) detected emission lines of hydrogen and Fe II, indicating that the object is an Fe II class nova caught in the early decline stage. Later examination of photographs revealed that the nova was already at magnitude 8.9 on 2002 January 19 (Seki et al. 2002).

Since the detection of the outburst, the nova has been intensively monitored by a number of observers. Figure 1 shows the light curve constructed from visual, CCD V-band and photovisual observations reported to the VSNET Collaboration.[1] The nova showed strong post-maximum oscillations up to 1 mag. The large-amplitude early stage oscillations resemble those observed in V1178 Sco = Nova Sco 2001 and V4361 Sgr = Nova Sgr 1996 (Kato, Fujii 2001). The light curve of V2540 Oph also resembles that of V2214 Oph = Nova Oph 1988 (Lynch et al. 1989), which has been later suggested to be a magnetic nova (Baptista et al. 1993).

Superimposed on these oscillations, the nova showed a steady fade at 0.033 mag d^{-1}. [This rate was determined using the data between 2452294 and 2452341, during which the general trend of the fading can be approximated by a single decline rate. The last part of the light curve, when the nova underwent a long-lasting brightening, was not used in this analysis. If we incorporate the last part of the light curve, the average decline rate becomes 0.013 mag d^{-1}, which may more severely constrain the following discussion]. By applying the recently calibrated relation (Downes, Duerbeck 2000) of absolute maximum magnitude vs rate-of-decline (MMRD) in classical novae, we obtain the expected absolute V-band maximum magnitude of $M_{\rm V}=-6.8\pm0.6$. We performed the accurate astrometry with the images obtained by Kyoto 0.30-m telescope taken on Mar. 8.23 UT, which revealed the position of the nova as: R.A. = $17^{\rm h}\ 37^{\rm m}\ 34^{\rm s}.385 \pm 0^{\rm s}.017$, Decl. = $-16^\circ\ 23'\ 18''.19 \pm 0''.18$ (equinox 2000.0, using 59 UCAC1 reference stars). This position is marginally consistent of the reported position by K. Kadota, who measured Haseda's discovery films (Haseda et al. 2002). No corresponding object was found on DSS and 2MASS scans within $2''.5$ of the nova, setting an upper limit of the prenova magnitude of $\sim$21 (Figure 2; a wider field map together with the outburst image is shown in Figure 3).

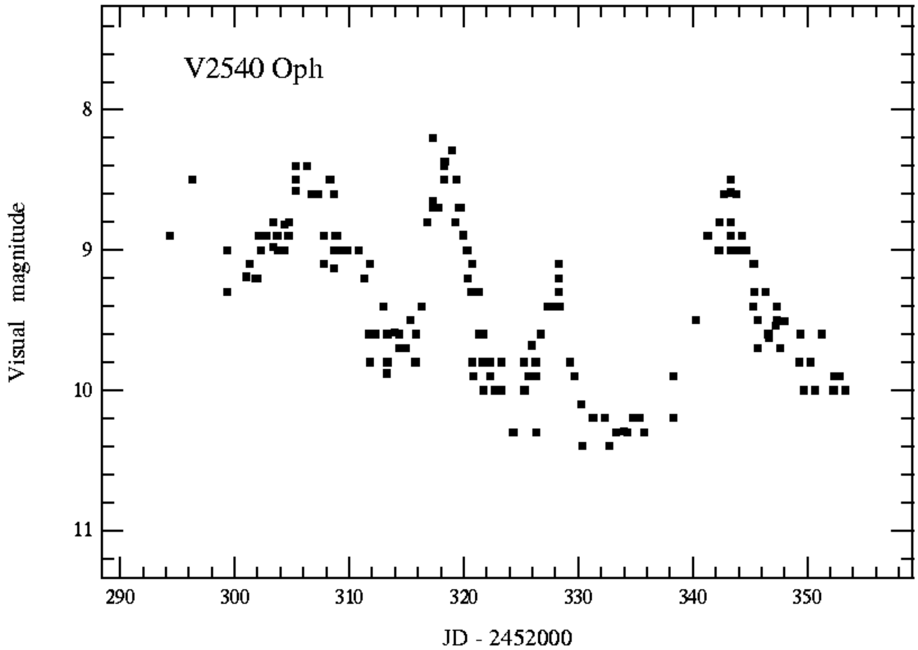

Figure 1. Light curve of V2540 Oph (Nova Oph 2002) constructed from visual, CCD V-band and photovisual observations reported to the VSNET Collaboration.

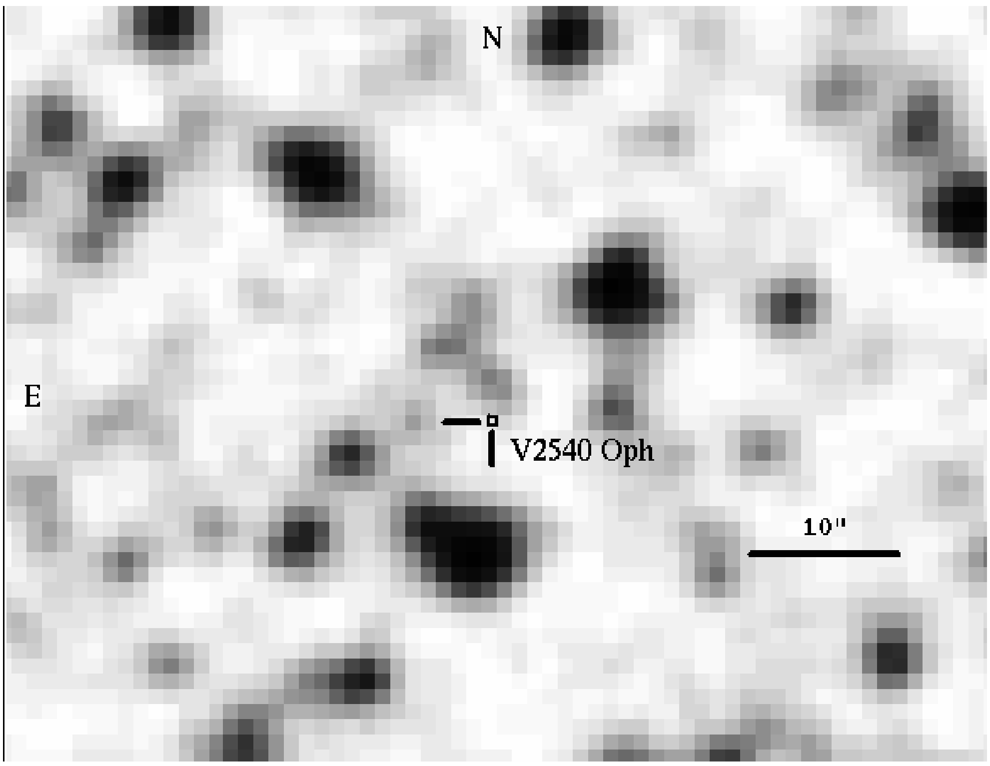

Figure 2. The position of V2540 Oph (square) on DSS2 red image. No prenova can be found to the image limit (mag ~21). The north is up, and the east is left.

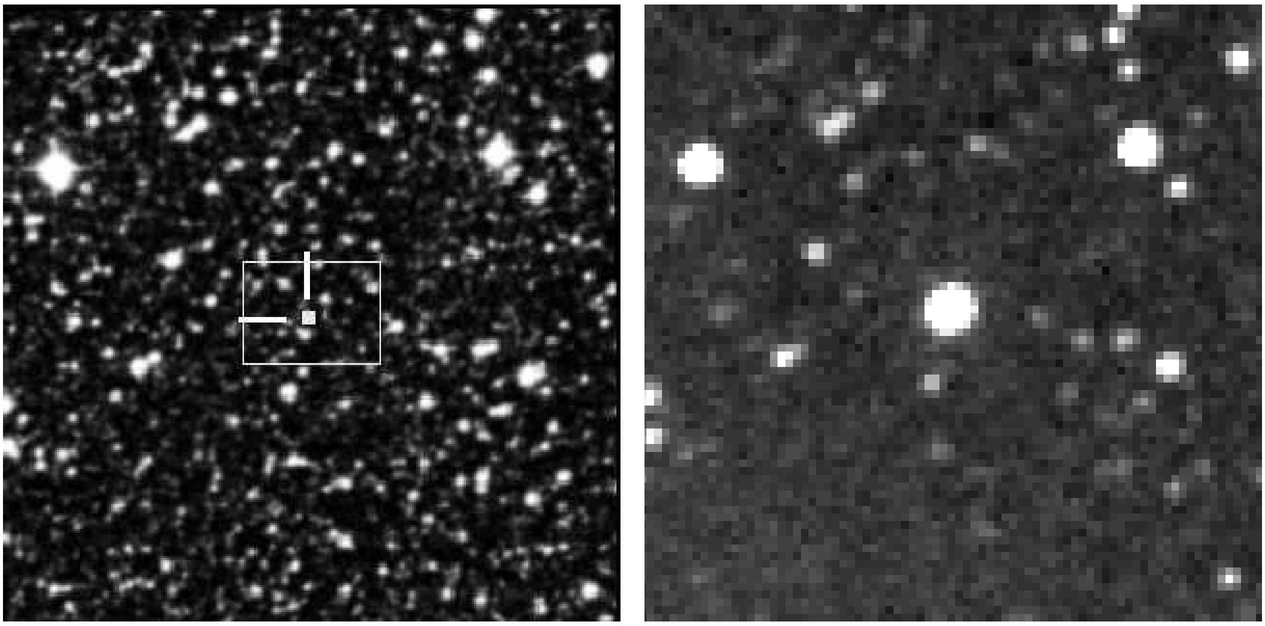

Figure 3. Field map of V2540 Oph. Each panel shows 5 arcminutes square, north is up, east is left. (Left) DSS image. A thick small square with a hair shows the position of V2540 Oph (see Fig. 2), and a thin box shows the field of Fig. 2. (Right) Kyoto image taken on 2002 Mar 8.23.

This indicates that the lower limit of the outburst amplitude is ~12.5 (by adopting the observed maximum magnitude of 8.5), which is unusually large for a slow nova with a decay rate of 0.033 mag d^{-1}. By using the above expected absolute V-band maximum magnitude, we can set an upper limit of M_V~5.7 for the nova progenitor. This magnitude is extremely faint for known prenova magnitudes and other novalike cataclysmic variables (Warner 1986, 1987). [Available observations suggest that the true maximum of the nova must have been missed. By considering this, both the decline rate and the outburst amplitude could be larger than the values in this discussion. However, we consider this effect will not severely affect the conclusion, because 1) the MMRD-relation (della Valle, Livio 1995, Downes, Duerbeck 2000) is known to be relatively flat (i.e. little depends on the decline rate) around the decline rate in question; a brighter maximum will therefore tend to pose a more stringent upper limit for the prenova), and 2) the reported spectrum (Retter et al. 2002) suggests that the object was caught during an early decay stage.]

Such a faint prenova magnitude would require a small mass-transfer rate, a small dimension of the disk, or a high inclination. Because V2540 Oph is a slow nova, the low mass-transfer rate is a rather unlikely explanation. We propose that the nova should have either a short orbital period or a high inclination. Among the well-observed classical novae, V2540 Oph most resembles the presumed magnetic nova V2214 Oph in many aspects: large outburst amplitude, slow rate of decline, and the presence of prominent oscillations. Since the characteristic double-wave orbital modulations were already present during the decay stage of V2214 Oph (Baptista et al. 1993), we strongly encourage observers to detect orbital signatures in V2540 Oph.

[1] http://www.kusastro.kyoto-u.ac.jp/vsnet/

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