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ABSOLUTE SPECTROPHOTOMETRY AND BVR$_C$I$_C$ PHOTOMETRIC EVOLUTION OF THE FAST NOVA OPHIUCHI 2010 N.2 (V2674 Oph)

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Nova Ophiuchi 2010 N.2 (= V2674 Oph) was discovered by H. Nishimura on UT 18.85 Feb 2010 (cf. Nakano, 2010) and confirmed spectroscopically on UT 19.85 Feb 2010 by Imamura, Tanabe and Fujii (2010) as a Fe II class nova.

We obtained BVR_CI_C photometry of Nova Ophiuchi 2010 N.2 with a 0.30-m Meade RCX-400 f/8 Schmidt-Cassegrain telescope equipped with a SBIG ST-9 CCD camera. The photometry was accurately corrected for color equations using nightly calibrations on Landolt (1992, 2009) standard stars. The data are presented in Table 1, and plotted in Figure 1. The combined Poissonian + transformation errors were always less than 0.025 mag. The zero points of the photometry were scaled on the nearby star HD 157866, for which we adopted: V= 9.849, $B-V$=+0.004, $V-R_C$=+0.158 and $V-I_C$=+0.327. The B and V were obtained from Tycho-2 photometry transformed to Johnson system following Bessell (2000), and the R_C and I_C were derived combining B, V with J, H, K from 2MASS following the recipes of Caldwell et al. (1993).

Our light-curve in Figure 1 indicates a very smooth evolution for Nova Oph 2010 N.2. The time of maximum brightness seems coincident with that of our first observation. This is supported by the zoomed view in the V-band panel of Figure 1 where our early observations are compared to those collected by VSNET (`http://www.kusastro.kyoto-u.ac.jp/vsnet/`). In spite to their much larger dispersion, interpolations of VSNET observations following different statistical criteria consistently indicate that our Feb 21.2 UT observation (HJD 2455248.7) marks the actual maximum V band brightness, from which time is counted in Figure 1 and in the rest of this paper.

The decline times are

$$t_2^V = 18 \qquad t_3^V = 31 \text{ days} \tag{1}$$

which are the times taken by the nova to decline, in the V band, by two and three magnitudes, respectively, from maximum brightness. The t_3^V/t_2^V ratio for Nova Oph 2010 N.2 is somewhat smaller than observed in other novae. In fact, given t_2^V, the Warner (1995) relation would predict t_3^V=35, while Munari et al. (2008) relation would give t_3^V=38. According to the classification of Warner (1995, his Table 5.4), t_2^V = 10 days qualifies Nova Oph 2010 N.2 to be classed among the *fast* novae.

Van den Bergh and Younger (1987) derived a mean intrinsic color $(B-V)_\circ$=+0.23±0.06 for novae at the time of maximum, and $(B-V)_\circ$=-0.02 ± 0.04 at t_2. Comparing with $B-V$=+1.07 at maximum and $B-V$=+0.57 at t_2 from Figure 1, the reddening affecting Nova Oph 2010 N.2 is $E_{B-V} = 0.7 \pm 0.1$, and the extinction (assuming a standard R_V=3.1 interstellar law) is therefore A_V=2.2 mag.

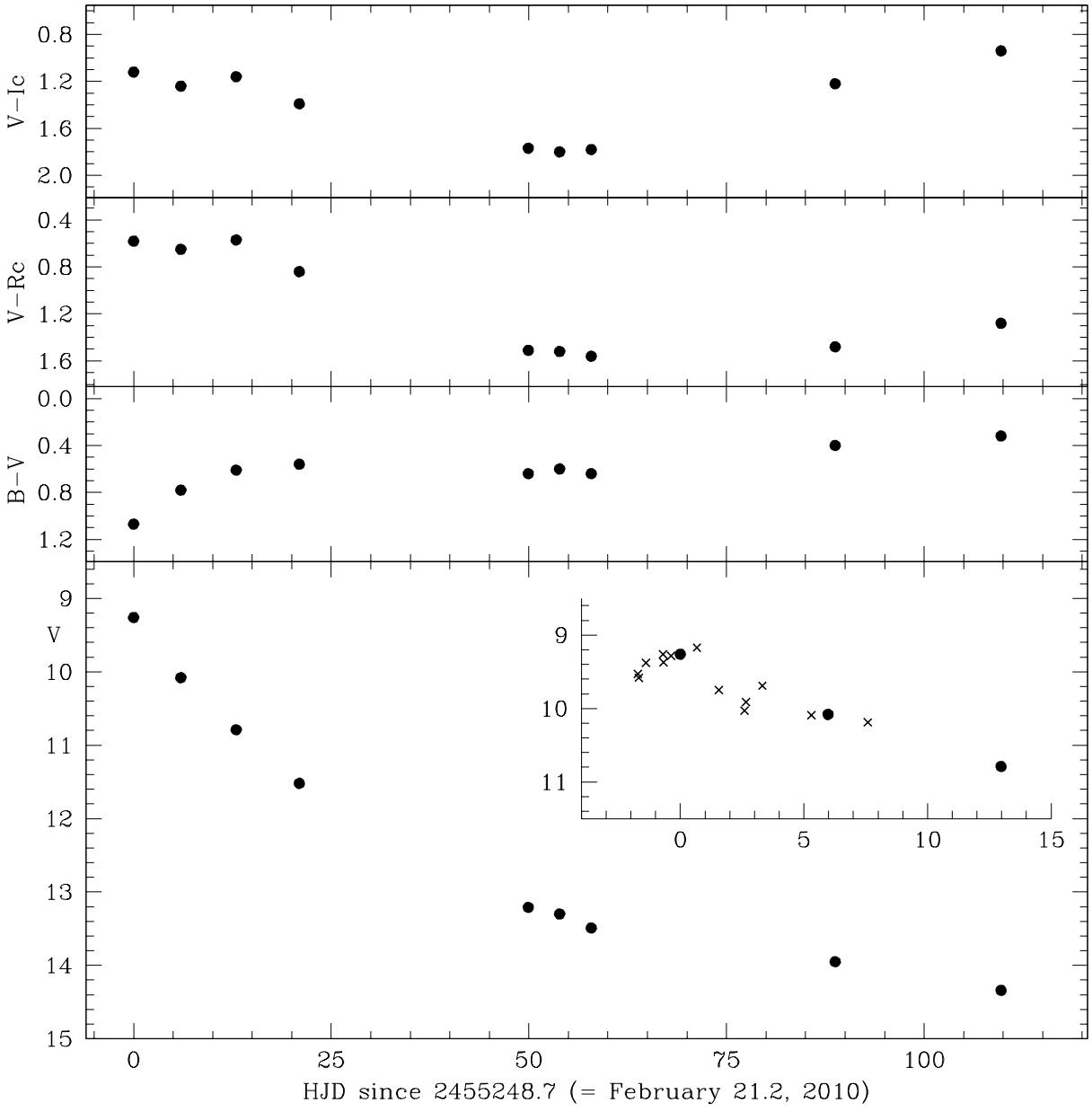

Figure 1. BVR_CI_C photometric evolution of the outburst of Nova Ophiuchi 2010 N.2. The dots represent the data in Table 1. The insert zooms on the earliest evolution of the outburst in the V band, where the crosses are VSNET V estimates.

Table 1. Our $BVR_{\rm C}I_{\rm C}$ of Nova Oph 2010 N.2

HJD	V	B-V	V-R$_C$	V-I$_C$	HJD	V	B-V	V-R$_C$	V-I$_C$
2455248.7012	9.26	1.07	0.58	1.12	2455302.5948	13.30	0.60	1.52	1.80
2455254.6787	10.08	0.78	0.65	1.24	2455306.5942	13.49	0.64	1.56	1.78
2455261.6759	10.79	0.61	0.57	1.16	2455337.4588	13.95	0.40	1.48	1.22
2455269.6603	11.52	0.56	0.84	1.39	2455358.4332	14.34	0.32	1.28	0.94
2455298.6337	13.21	0.64	1.51	1.77					

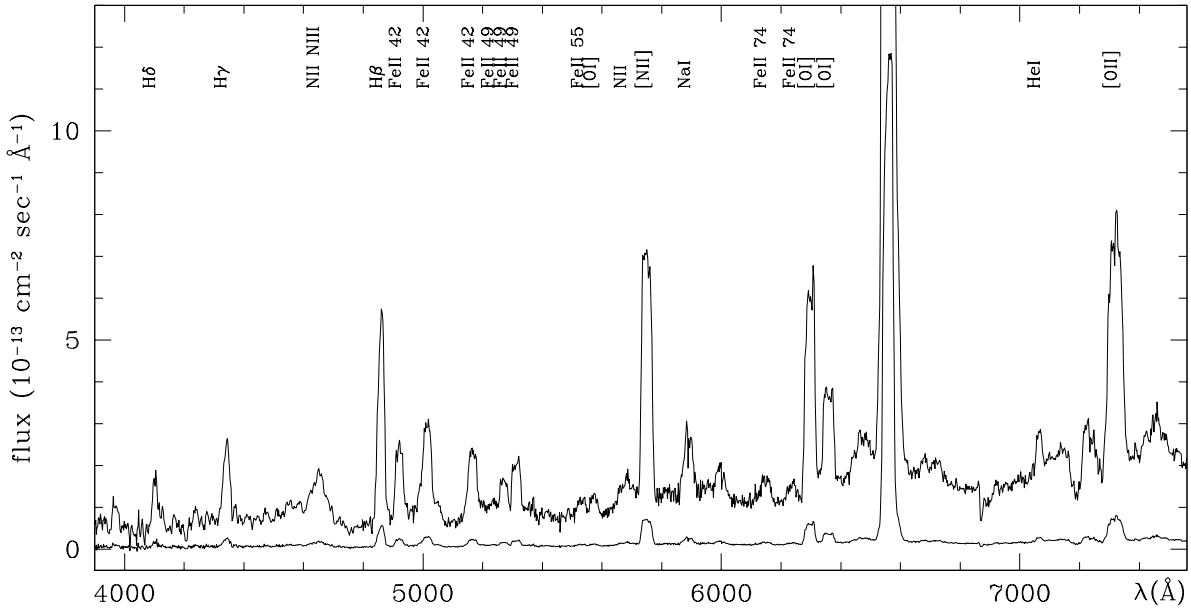

Figure 2. Absolute spectrophotometry of Nova Ophiuchi 2010 N.2 for 16.128 April 2010 UT. The spectrum is also plotted at 10× expanded scale to emphasize the visibility of weaker features.

Table 2. Integrated fluxes of the emission line (in erg cm^{-2} sec^{-1}) of Nova Oph 2010 N.2 on the spectrum of Figure 2 for 16.128 April 2010 UT

$\lambda_\circ$	ion	flux	$\lambda_\circ$	ion	flux	$\lambda_\circ$	ion	flux
4101	Hδ	3.21E-13	5276	FeII 49	2.29E-13	6148	FeII 74	2.57E-13
4340	Hγ	4.45E-13	5317	FeII 49	4.88E-13	6245	FeII 74	1.95E-13
4650	NII, NIII	5.69E-13	5535	FeII 55	1.80E-13	6300	[OI]	1.85E-12
4861	Hβ	1.53E-12	5577	[OI]	1.65E-13	6364	[OI]	9.73E-13
4924	FeII 42	6.01E-13	5679	NII	2.77E-13	6563	Hα	4.22E-11
5018	FeII 42	1.06E-12	5755	[NII]	2.31E-12	7065	HeI	1.89E-13
5169	FeII 42	6.00E-13	5893	NaI	6.17E-13	7323	[OII]	2.77E-12
5235	FeII 49	2.79E-13						

Published relations between the absolute magnitude and the rate of decline generally take the form $M_{\max} = \alpha_n \log t_n + \beta_n$. Using the Cohen (1988) V-t_2 relation, the distance to the nova is 8.8 kpc, and 9.2 kpc according to the Schmidt (1957) V-t_3 relation. Buscombe and de Vaucouleurs (1955) suggested that all novae have the same absolute magnitude 15 days after maximum light. The most recent calibrations for it are those of Capaccioli et al. (1989, on M31 novae) and Duerbeck and Downes (2000, on galactic novae), that give $M^V_{\max}$=5.69±0.14 and 6.05±0.44, respectively. The brightness of Nova Oph 2010 N.2 15 days after V maximum light was V_{15}=10.98, which corresponds the respective distances of 7.8 and 9.2 kpc. Taking the mean of these four determinations, the distance to Nova Oph 2010 N.1 is d=9 kpc. At a galactic latitude b=3.6 deg, it corresponds to an height over the Galactic equatorial plane of z=0.55 kpc, well within the range of heights reported by della Valle and Livio (1998) for novae of the Fe II type.

An absolutely fluxed, low resolution spectrum of Nova Oph 2010 N.2 was obtained on UT 16.128 April 2010 (day +53.9) with the B&C+CCD spectrograph attached to the Asiago 1.22m telescope. The spectrum is presented in Figure 1. At that time the nova was well past t^V_3, being 4.1 mag fainter than at maximum brightness, but the spectrum was still that of optically thick ejecta and consistent with a FeII classification. The integrated absolute flux of the strongest emission lines is given in Table 2.

The brightness decline in Figure 1 is well represented by a

$$F_\lambda \propto t^{-1.55} \tag{2}$$

power-law, which is significantly less steep than the dilution t^{-3} power-law that represents the continuum emission from optically thin gas in the advanced decline stages. This is nicely consistent with the optically thick characteristics of the spectrum in Figure 2. The stable $t^{-1.55}$ power-law could be used to speculate that the spectrum of Nova Oph 2010 N.2 was not yet optically thin at the time of the last photometric observations in Table 1.

The FWHM of Hα in the spectrum of Figure 2 is 1650 km/s, and 1570 for Hβ. [OI] and [NII] lines present a distinctive rectangular profile with a FWHM of 1800 and 1950 km/s, respectively. The expansion velocities they indicate nicely agree with the ∼850 km/s reported for the bulk velocity of P-Cyg absorption in the early spectra described by Imamura, Tanabe and Fujii (2010).

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