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DISCOVERY OF THE CV ROTSE3 J015118.59–022300.1

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On October 11, 2001, the first ROTSE-III automated telescope began observations in Los Alamos, NM, USA. ROTSE-IIIa is an 0.45 m telescope with a 1.85 degree field-of-view, carrying an unfiltered, thinned CCD. Although the primary task of this telescope is to rapidly respond to satellite detections of Gamma-Ray Bursts, most of the observing time is used to perform automated sky patrols. Pairs of images are taken for each of ~ 100 patrol fields twice a night.

Analysis of the first ROTSE-IIIa dark run has uncovered an interesting transient event, which we identify as a nova and designate ROTSE3 J015118.59–022300.1. This object is absent in images taken on October 11, 2001, to limiting aperture magnitudes of $m_{\rm ROTSE3} \sim 17\overset{\rm m}{.}9$. It is also absent from skyview images, scanned SERC plates from the USNO PMM archive, and the USNO A2.0 catalog. On October 13, 2001, however, the object appears at $m_{\rm ROTSE3} = 14\overset{\rm m}{.}00 \pm 0\overset{\rm m}{.}06$ (weather conditions prohibited observations on Oct 12), after which it fades rapidly, falling by more than 2 magnitudes over the next 13 d (Fig. 1). Assuming an onset time of 1.0 d before the first detection, the best-fit decay index for the light curve is $\alpha \sim 0.9$ ($m \propto t^{-\alpha}$), although even the early light curve in Figure 1 is clearly inconsistent with a single power law.

On 2001 Nov 20.129 and Dec 14.235 the source was observed at BVR_cI_c using the USNO, Flagstaff Station 1.0m telescope with a SITe/Tektronix 1024×1024 CCD camera (Henden 2001). Figure 2 shows the V-band image from the Nov 20 dataset. The nova was found to be at $V = 20\overset{\rm m}{.}70 \pm 0\overset{\rm m}{.}07$ and $20\overset{\rm m}{.}90 \pm 0\overset{\rm m}{.}05$ in the two observations, respectively, indicating the system may have returned to its quiescent state. This brightness, however, is still well above the POSS-II blue plate limit; there may still be some residual activity from the disc, and the quiescent spectrum may be extremely red. The four-color photometry for these two observations is reported in Table 1. The USNO images along with USNO-A2.0 provide the following coordinates for the object: R.A.$=01^{\rm h}51^{\rm m}18\overset{\rm s}{.}60 \pm 0.01$ and Decl.$= -2^\circ 23' 0\overset{''}{.}42 \pm 0.09$ (J2000.0). The ROTSE-IIIa position is consistent with this location to within its errors ($0\overset{\rm s}{.}06$ R.A., $0\overset{''}{.}8$ Decl.). The ROTSE astrometric accuracy has been calibrated against the USNO A2.0 catalog (Smith et al. 2002).

We used the first V-band image to set a photometric zero-point for the unfiltered ROTSE-III images and estimate the V magnitude for the source. Using 46 bright stars ($m_{\rm ROTSE3} < 16^{\rm m}$) that show no evidence for variations in intensity ($\sigma_m < 0.2$ mag) during the 56 ROTSE-III observations, we found the median offset between the ROTSE aperture magnitudes and the USNO V-band magnitudes to be $V - m_{\rm ROTSE3} = +0\overset{\rm m}{.}71$. The offset for any given object is of course dependent on its spectral energy distribution, and we show the offset as a function of color for three different colors in Figure 3. Since the spectrum of the nova during the outburst is unknown, this necessarily introduces undetermined systematic errors into the magnitude estimates.

Figure 1 shows as diamonds the ROTSE V-magnitude estimates for ROTSE3 $J015118.59-022300.1$. Also plotted as triangles, late in the light curve, are the USNO V-band measurements. Arrows indicate the mean limiting magnitude for a pair of ROTSE images in which the nova was not detected. Error bars on the ROTSE magnitudes include an estimate of the known systematic errors (as measured through our relative photometry procedure) added in quadrature to the statistical uncertainty.

At time 02:32:41 (UT) on Nov 11, 2001, a spectrum of the source was recorded in a 20-minute exposure with the Boller and Chivens Spectrograph on the 6.5 m Walter Baade Magellan project telescope (Fig. 4). The spectrum shows a continuum with broad but relatively weak Balmer emission lines: H_γ, H_δ, H_ϵ and H_8. The lines are about 3000 km s^{-1} wide and have a “square” profile (steep sides and flat top), characteristic of accretion disc systems. The intensity of the line emission is about half that of the continuum. The radial velocity is less than a few hundred km s^{-1}.

We therefore identify ROTSE3 J015118.59–022300.1 as a galactic cataclysmic variable. While the high galactic latitude ($b = -40\overset{\circ}{.}74$) of this object is unusual, it is not unprecedented (Downes, Webbink & Shara 1997). If we classify this event as a fast nova, the scaling relations in Duerbeck (1981) would predict a peak absolute magnitude around V$\sim -8\overset{\rm m}{.}5$. An extrapolation of the decaying light curve predicts a peak apparent maximum of V$\sim 14\overset{\rm m}{.}5$ at one day before the first detection, which implies a distance modulus (DM) of $\sim$ 23, or 420 kpc. If our conversion to V-band overestimates V, the resulting distance could be as low as 320 kpc. At this latitude, extinction cannot explain this unreasonably large distance. If it is a fast nova, it is an unusually dim one. With the large increase in brightness, it is unlikely that the source is a dwarf nova (Osaki 1996). Also, its absence in the plates scanned by the USNO PMM machine (12 epochs from 1953-1997) requires a low duty cycle. If this is a dwarf nova, it may be akin to WZ Sge. It may be a recurrent nova: a diverse class known to recur on timescales of decades (Cordova 1994). Further observations are necessary to reliably classify this system.

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Table 1. The USNO Four-Color Intensity Measurements for ROTSE3 J015118.59–022300.1

UTD	B	V	R_C	I_C
011121.129	20.74 ± 0.05	20.70 ± 0.07	20.25 ± 0.06	19.80 ± 0.08
011214.235	20.91 ± 0.03	20.90 ± 0.05	20.76 ± 0.07	20.29 ± 0.10

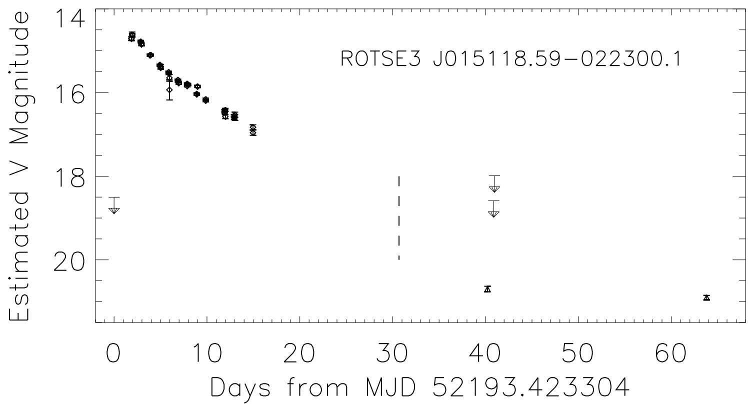

Figure 1. Light curve for a transient nova discovered by ROTSE-IIIa. The ROTSE-IIIa unfiltered magnitudes have been corrected by $+0\overset{\mathrm{m}}{.}71$ to estimate the source's V-band magnitude. Arrows indicate the mean limiting magnitudes of pairs of images in which the source was not detected. V-band observations with the USNO Flagstaff Station 1.0m telescope are indicated by the triangles at 40 and 64 days. The vertical dashed line indicates when a spectrum of the source was taken with Magellan.

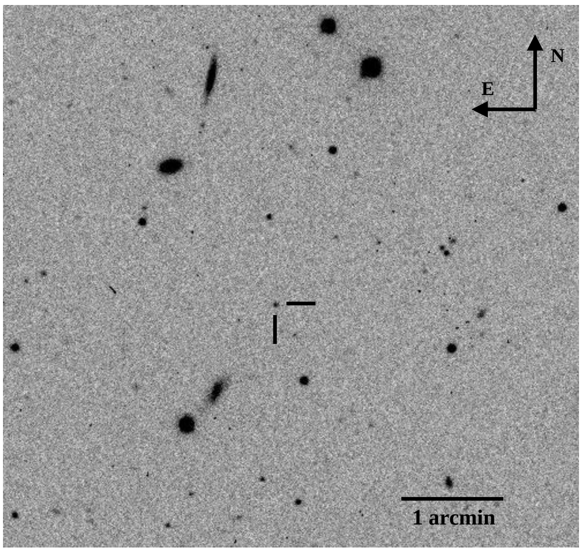

Figure 2. Image of the region around ROTSE3 J015118.59–022300.1, from the USNO Flagstaff Station 1.0m telescope at 2001 Nov 20.129 (UTC). The nova, at $V = 20\overset{\mathrm{m}}{.}70 \pm 0.07$, is indicated by crosshairs.

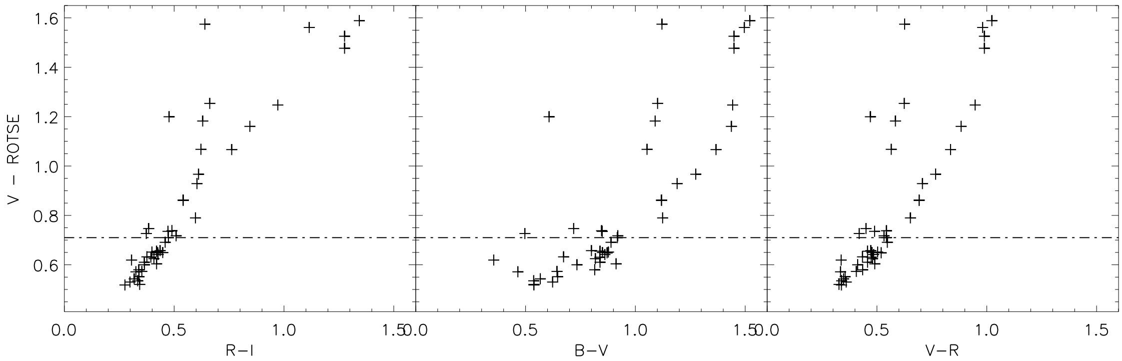

Figure 3. Offset between ROTSE magnitude and V magnitude versus the BVR_CI_C colors for 46 template stars of constant intensity. The broken line indicates the median value of this offset.

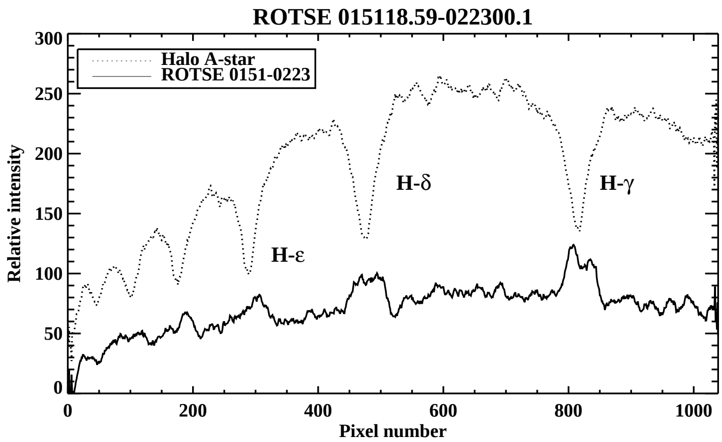

Figure 4. Spectrum of ROTSE3 J015118.59–022300.1, as compared with a nearby halo A-star, from a 20-minute exposure with the Boller and Chivens Spectrograph on the 6.5 m Walter Baade Magellan project telescope at 2001 Nov 11.1060 (UTC).

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