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THE RAPID FADING OF V1647 ORIONIS: THE SUDDEN END OF A FUOR-TYPE ERUPTION?

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V1647 Orionis ($\alpha_{2000} = 05^{\rm h}46^{\rm m}13\overset{\rm s}{.}13$, $\delta_{2000} = -00°06'04\overset{''}{.}8$) is a young eruptive star, which went into outburst in November–December 2003. The star brightened by about 4 mag in the I_C band in 4 months, suggesting that we witness either an FU Orionis-type (FUor) or an EX Lupi-type (EXor) outburst. Since then, the object has been gradually fading at both optical (BVRI) and near-infrared (JHK) wavelengths with a rate typical of FUors (see photometric measurements of Briceño et al. 2004, Maheswar & Bhatt 2004, Masi et al. 2004, McGehee et al. 2004, Ojha et al. 2004, Semkov 2004, and Walter et al. 2004).

In this paper we present observations of V1647 Ori using the 1m RCC telescope of the Konkoly Observatory (Hungary) equipped with Cousins $V(RI)_C$ filters and a Princeton VersArray:1300B CCD camera (image scale: $0\overset{''}{.}3$, field of view: $6\overset{'}{.}8 \times 6\overset{'}{.}6$). Integration time was selected so that the comparison stars would not be saturated. This resulted in integration times between 180 and 600 s. With each filter, 3–10 frames were taken. All frames were bias-subtracted and flat-fielded and were corrected for cosmic rays. In the case of V and R_C filters, the images were shifted and co-added, and photometry was done in the single co-added image. In the case of I_C filter, photometry was done on each individual frame, and the resulting magnitudes were averaged.

Photometry was performed using IRAF in the following way: on each (co-added in V and R_C, individual in I_C) frame, 4 to 6 isolated, non-saturated stars were selected to build the PSF. Then, PSF-photometry was obtained for V1647 Ori and for 4 comparison stars (denoted as 'A', 'B', 'C' and 'G' by Semkov 2004). Instrumental magnitude differences between V1647 Ori and the comparison stars were transformed to the standard Cousins-system, using the standard magnitudes of comparison stars given by Semkov (2004), and Henden (2004). The resulting magnitudes are presented in Table 1. In the case of V and R_C filters, the errors come from the uncertainties of the standard transformation and from the formal errors of the photometry given by IRAF, while in the case of I_C filter, errors are dominated by uncertainties of the standard transformation and the scatter of the individual magnitudes.

In Fig. 1 we plotted the I_C light curve of V1647 Ori in October–November 2005 complemented with some of our measurements from February–March 2004 (these data were taken with the same instrument and reduced with the same method as in October–November

Table 1. Photometry of V1647 Ori in October–November 2005.

Date	JD − 2,453,000	V	R_C	I_C
04 Oct 2005	648.54	20.45 ± 0.10	18.70 ± 0.10	16.31 ± 0.08
05 Oct 2005	649.53	20.48 ± 0.10	18.55 ± 0.04	16.21 ± 0.07
09 Oct 2005	653.64	–	–	16.42 ± 0.07
10 Oct 2005	654.64	–	–	16.20 ± 0.10
15 Oct 2005	659.65	–	–	16.33 ± 0.02
19 Oct 2005	663.59	–	–	16.36 ± 0.05
28 Oct 2005	672.55	21.34 ± 0.20	19.51 ± 0.10	17.13 ± 0.10
30 Oct 2005	674.58	21.55 ± 0.15	19.68 ± 0.05	17.25 ± 0.08
31 Oct 2005	675.57	21.74 ± 0.10	19.83 ± 0.04	17.44 ± 0.07
17 Nov 2005	692.49	–	–	17.67 ± 0.08
19 Nov 2005	694.60	–	–	17.80 ± 0.10

2005, and belong to a more comprehensive study, Acosta-Pulido et al., in prep.) We also plotted data points from Briceño et al. (2004), who measured the brightening of the star. The overlapping points (in February-March 2004) show that although magnitudes were calculated differently (Briceño et al. used aperture photometry, we used PSF-photometry), the values agree well, thus the comparison of the two datasets is justifiable.

V1647 Ori reached its peak brightness in February 2004, and faded by approximately 1.5 mag by October 2005. Then, between October and November 2005 the brightness of the star suddenly dropped by more than 1 mag. Due to this sudden, rapid fading, V1647 Ori now is only 1 mag above the pre-outburst level. This means that the present fading rate is 1 mag/month, as opposed to 0.1 mag/month in 2004 (calculated from the data of Semkov 2004 or Walter et al. 2004).

In order to check whether the fading is caused by increasing extinction, we plotted our measurements on a colour-colour diagram (Fig. 2). The standard reddening path (Cohen et al. 1981) is also shown. For comparison, we also plotted data points from McGehee et al. (2004) who measured V1647 Ori close to peak brightness in $V(RI)_C$, and performed PSF-photometry similarly to us. From Fig. 2 one can conclude that

- no significant colour change can be seen during the rapid fading in October-November 2005 (filled dots),
- there is a significant colour change between the new measurements (filled dots) and those close to peak brightness (open squares). This colour change cannot fully be explained by increasing extinction, since the colour variations do not follow the reddening path. Thus, the observed colour changes are at least partly intrinsic.

Supposing that the fading rate remains unchanged, the star will return to the pre-outburst state by mid-December 2005. If this prediction holds true, then the total duration of the outburst of V1647 Ori is 2 years, which makes it a unique (somewhat intermediate) object among FUors and EXors.

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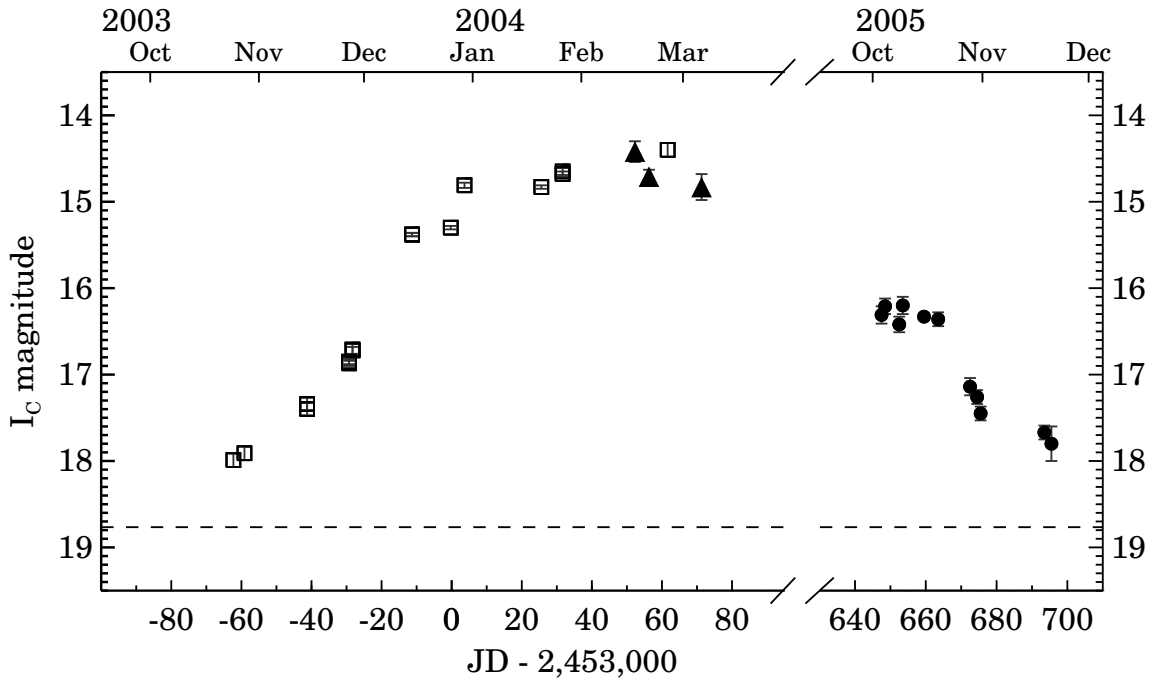

Figure 1. I_C light curve of V1647 Ori. Filled dots: photometry presented in this paper; filled triangles: photometry taken with the same instrument and reduced with the same method as the filled dots (Acosta-Pulido et al., in prep.); open squares: data from Briceño et al. 2004. Dashed line indicates pre-outburst brightness level.

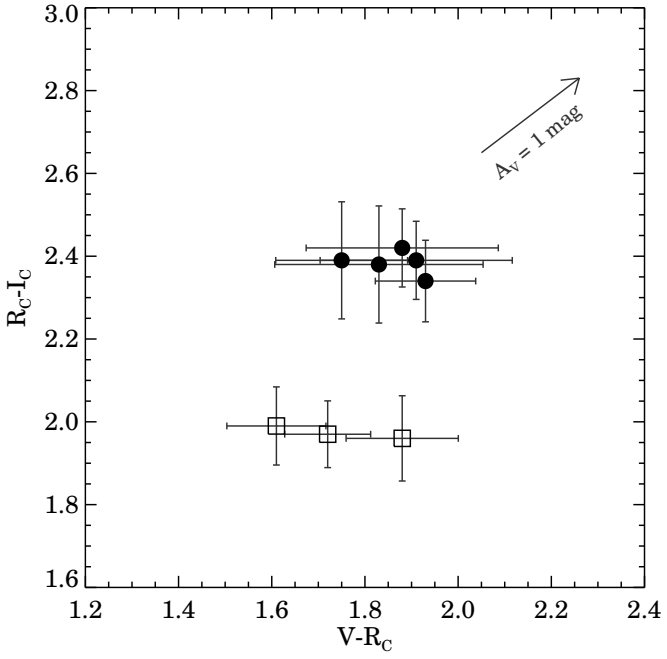

Figure 2. Colour-colour diagram of V1647 Ori. Filled dots: our measurements obtained between 4 October and 31 October 2005; open squares: data taken in February–April 2004 by McGehee et al. 2004. The line represents reddening path corresponding to $A_V = 1$.

References:

Acosta-Pulido, J., Kun, M., Ábrahám, P., Kóspál, Á., Csizmadia, Sz., Kiss, L.L., Moór, A., Szabados, L., Benkő, J., Charcos-Llorens, M., Eredics, M., Kiss, Z.T., Manchado, A., Rácz, M., Ramos Almeida, C., Székely, P., Vidal-Núñez, M.J., 2006, *in prep.*

Briceño, C., Vivas, A.K., Hernández, J., Calvet, N., Hartmann, L., Megeath, T., Berlind, P., Calkins, M., Hoyer, S, 2004, *ApJ*, **606**, L123

Cohen, J.G., Frogel, J.A., Persson, S.E., Elias, J.H., 1981, *ApJ*, **249**, 481

Henden, A., 2004, http://spiff.rit.edu/classes/phys440/lectures/new_star/mcneil.dat

Maheswar, G., Bhatt, H. C., 2004, *IAU Circ.*, **8295**, 3

Masi, G., Mallia, F., Hornoch, K., Croman, R., Halderman, M., di Cicco, D., Kreimer, E., 2004, *IAU Circ.*, **8290**, 2

McGehee, P.M., Smith, J.A., Henden, A.A., Richmond, M.W., Knapp, G.R., Finkbeiner, D.P., Ivezić, Ž., Brinkmann, J., 2004, *ApJ*, **616**, 1058

Ojha, D. K., Kusakabe, N., Tamura, M., 2004, *IAU Circ.*, **8306**, 2

Semkov, E. H., 2004, *IBVS*, 5578

Walter, F.M., Stringfellow, G.S., Sherry, W.H., Field-Pollatou, A., 2004, *AJ*, **128**, 1872