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Research Note

The Status of Nova Orionis 1667

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Abstract. Images taken in 1.3″ seeing show that a claimed hibernating nova, Candidate 5 in a Newswire item in *Sky & Telescope,* is a visual binary, with a 1.1″ separation between components. Spectra reveal the components to be emission-line M0 and K7 stars.

Key words: stars: individual: V529 Ori=Nova Ori 1667 – novae, cataclysmic variables – binaries: visual – stars: late-type

1. Introduction

The hypothesis that novae hibernate in the millenia between outbursts predicts that very old novae should be much less luminous than those seen in the 20th century, because mass transfer in these systems has diminished or stopped entirely (Shara et al. 1986). Nova hibernation theory has a serious drawback, though: not one old nova has ever clearly been shown to be hibernating (Naylor et al. 1992; Mukai & Naylor 1995; Somers et al. 1996, 1997). To test the theory, it is therefore essential to recover novae as old as possible. Among the oldest novae listed in the catalog of Duerbeck (1987) is V529 Ori, or Nova Ori 1667.

Our knowledge of V529 Ori has a complex history. It was discovered at m_{vis} = 6 by J. Hevelius during a lunar occultation. Although claimed several times to be a recurrent nova, it probably is not one: all but the first account have been discredited as duplications of the original observation (Ashbrook 1963; Duerbeck 1987; Webbink et al. 1987). Details surrounding the original observation, such as the date of observation, have also been called into question (Ashworth 1981): it should be 1678, not 1667.

Recently, a Newswire item in *Sky & Telescope* magazine reported that this nova had been recovered, and was in deep hibernation. This Newswire item was originally uncredited, but it was written by R. T. Fienberg (1996, private communication) and so will be referenced here as Fienberg (1995). It was based on a poster paper by Wagner et al. (1994), although Nova Ori 1667 is not mentioned in the proceedings abstract.

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2. Imaging

We took three I-band images and one Hα image of the field of V529 Ori on 1993 August 15 and 16 UT with the 1.0-m Jacobus Kapteyn Telescope at La Palma. All images were taken in in 1.3″ seeing. An EEV CCD was used at the f/15 Cassegrain focus, which yielded a pixel scale of 0.31″ pixel^{-1}. A median of three bias frames was subtracted from each image, and the data were then flat-fielded using images of the twilight sky. We combined the I-band exposures into one image representing a total exposure of 1800 s. The Hα image was a 1000-s exposure.

The resulting images are shown in Fig. 1. Star 5, using the numbers in the image of Fienberg (1995), was reported by this author to be the hibernating nova. Our images clearly show there are two components. Astrometry with the Guide Star Catalog (Russell et al. 1990) showed the 1950.0 positions, to within 0.4″ absolute and 0.1″ relative, of component A to be α 05 55 15.574 δ +20 15 55.88, and of component B to be α 05 55 15.638 δ +20 15 55.22.

3. Spectra

Spectra of both components were taken on 1995 February 8, beginning at 1:56 and 2:29 UT, with the ISIS spectrograph of the 4.2-m William Herschel Telescope at La Palma. The R158R and R158B gratings were used with TEK CCDs. The slit was 0.73″ wide on the sky, and was set to a position angle of 26.0 degrees, perpendicular to the line intersecting the centers of both stars. The parallactic angle at the time varied from 68.5 to 67.5 degrees. Seeing was 0.9 – 1.0″, and weather was photometric. The dispersion was 2.9 Å pixel^{-1}, and the exposure times for both sets of red and blue exposures was 1800 s. A standard reduction

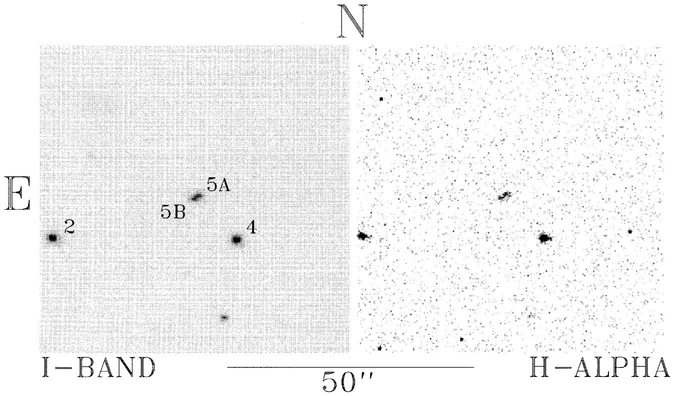

Fig. 1. Images in I and Hα of the field of Nova Ori 1667. The stars are labeled with the numbers of Fienberg (1995). The visual binary in the center of the field is Candidate 5, the claimed hibernating nova.

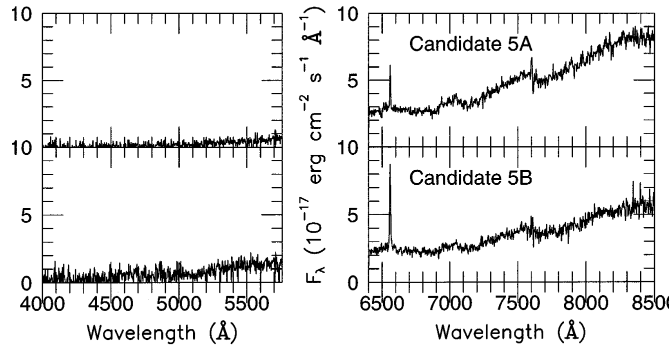

Fig. 2. Spectra of components A and B of Candidate 5. Telluric absorption bands were mapped and removed from these sky-subtracted spectra. The TiO $\lambda\lambda$ 7165 and 7665 Å bands are evident in both red spectra, as is Hα in emission.

was carried out, in which the frames were debiased, flat-fielded with exposures of tungsten lamps, wavelength-calibrated using Cu-Ne and Cu-Ar lamps, sky-subtracted, and flux-calibrated with the spectrum of the standard Feige 34 (Stone 1977). The spectrum of a nearby F8 star, SAO 077760, was also taken, to map the telluric absorption bands to allow their removal.

The resulting spectra of both components of Candidate 5 are shown in Fig. 2. The signal-to-noise ratios are about 20 near Hα in both red spectra and about 5 for star A and 10 for star B near Hβ in the blue spectra. The only features obvious in the red spectra are Hα, in emission, and the TiO absorption bands at $\lambda\lambda$ 7165 and 7665 Å. The blue spectra show only faint Mg b λ 5175 Å in star B. By comparison with Vilnius dwarf spectra (Sviderskiene 1988), we estimate spectral types of M0.5 $\pm$ 0.5 for star A and K7.5 $\pm$ 0.5 for star B. Hα has equivalent widths of 7.3 $\pm$ 0.5 Å and 22.8 $\pm$ 0.8 Å and full-widths at half-maxima of 290 $\pm$ 15 km s^{-1} and 400 $\pm$ 15 km s^{-1} in stars A and B, respectively. Since radial velocity standards were not taken, it is impossible to quote reliable absolute values for these stars' radial velocities, but the Hα lines show a difference of 46 $\pm$ 9 km s^{-1} between stars A and B.

Despite probable light losses through the slit, we deconvolved Johnson-Kron broad-band magnitudes from the spectra. The only bands completely covered were B and I. We found I = 18.1$\pm$0.1 for star A and I = 18.5$\pm$0.1 and $B-I$ = 4.5$\pm$0.2 for star B; low signal-to-noise in the blue prevented such a measurement for A. Assuming that star B is a K7 – M0 dwarf, its colors (Bessell 1991) and the extinction law of Howarth (1983) would imply $E(B-V)$ = 0.32 $\pm$ 0.05 and a distance between 1.5 and 1.9 kpc. Although star A is brighter, it is redder, although these spectra cannot distinguish its luminosity class.

4. Discussion

The component stars of most classical novae are K – M dwarfs orbiting white dwarfs. Warner (1995, Eq. 9.54) uses the calculations of Prialnik (1986) to find that $T_{eff} = 4.8 \times 10^5 [t/0.1]^{-0.28}$ K, where T_{eff} is the effective temperature and t is the time in years since eruption. This applies to a nova with a 1.25-$M_\odot$ white dwarf, and novae with massive white dwarfs should have much higher discovery probabilities (Ritter et al. 1990). The white dwarf in a 300-year-old nova should therefore have $T_{eff} \approx 50,000$ K. White dwarfs this hot are observed to have M_B = 8.8 (Wesemael, Green, & Liebert 1985) and $B-V = -0.3$ (Sion & Liebert 1977). In B and V, therefore, any white dwarf present should have absolute magnitudes comparable to or brighter than those of M0 or K7 dwarfs, with M_B = 10.27 and 9.55 and M_V = 8.86 and 8.23 (Bessell 1991), respectively. We see no obvious sign of a hot white dwarf in our red or blue spectra, however, nor of an accretion disk: if either Candidate 5a or 5b is the hibernating nova, it is in very deep hibernation indeed. Alternatively, these could just be M0 and K7 stars, and the nova has not yet been recovered. These stars' Hα equivalent widths seem high for M0 or K7 dwarfs, which more typically are near 2 Å (Linsky et al. 1982). However, T Tauri stars abound in Orion, and Hα emission from their accretion disks has equivalent widths ranging from < 10 to > 90 Å (Jaschek & Jaschek 1987). Radial velocity studies could demonstrate whether either Candidates 5a or 5b are close binary stars. Until then, however, or until a more convincing candidate has been found, this nova—if indeed it was a nova—should be considered unrecovered.

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References

Ashbrook J., 1963, Sky Telesc. 26, 80
Ashworth Jr. W. B., 1981, QJRAS 22, 22
Bessell M. S., 1991, AJ 101, 662
Duerbeck H. W., 1987, Space Sci. Rev. 45, 1
Fienberg R. T., 1995, Sky Telesc. 89, No.3, 11
Howarth I. D., 1983, MNRAS 203, 301

Jaschek C., Jaschek M. 1987, The Classification of Stars, Cambridge University Press, Cambridge, p. 309
Linsky J. L., Bornmann P. L., Carpenter K. G., Hege E. K., Wing R. F., Giampapa M. S., Worden S. P., ApJ, 260, 670
Mukai K., Naylor T., 1995, in: Cataclysmic Variables, eds. A. Bianchini, M. Della Valle, M. Orio, Kluwer, Dordrecht, p. 517
Naylor T., Charles P. A., Mukai K., Evans A., 1992, MNRAS 258, 449
Prialnik D., 1986, ApJ 310, 222
Ritter H., Politano M., Livio M., Webbink R. F., 1990, ApJ 376, 177
Russell J. L., Lasker B. M., McLean B. J., Sturch C. R., Jenkner H., 1990, AJ, 99, 2059
Shara M. M., Livio M., Moffat A. F. J., Orio M., 1986, ApJ 311, 163
Sion E. M., Liebert J., 1977, ApJ 213 468
Somers M. W., Mukai K., Naylor T., 1996, MNRAS 278, 845
Somers M. W., Ringwald F. A., Naylor T., 1997, MNRAS 284, 359
Stone R. P. S., 1977, ApJ 218, 767
Sviderskiene Z., 1988, Bull. Vilnius Obs., No. 8
Wagner R. M., Starrfield S. G., Austin S. J., Vanlandingham K. M., 1994, BAAS 26, 1324
Warner B., 1995, Cataclysmic Variable Stars, Cambridge University Press, Cambridge, p. 478
Webbink R. F., Livio M., Truran J. W., Orio M., 1987, ApJ 314, 653
Wesemael F., Green R. F., Liebert J., 1985, ApJS 58, 379

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