

LETTERS

## 1RXS J232953.9+062814: a New SU UMa Dwarf Nova below the Period Minimum

Jian-Yan Wei, Xiao-Jun Jiang, Da-Wei Xu, Ai-Ying Zhou and Jing-Yao Hu

National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012

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**Abstract** 1RXS J232953.9+062814 was identified as a cataclysmic variable by Wei et al. (1999). Four low-resolution spectra of 1RXS J232953.9+062814 were obtained with the 2.16-m telescope of the National Astronomical Observatories, of which two were at outburst, and two were at quiescence. The system is about 16.8  $B$  and 16.5  $V$  at quiescence, and 12.6  $B$  and 12.6  $V$  at outburst. The quiescent spectra were dominated by double-peaked Balmer emissions, which indicates a hydrogen-rich system with a high-inclination accretion disc. MgH and TiO absorption bands appeared in the quiescent spectrum which implies a companion with a spectral type of early M dwarf. If we take it as a M0 dwarf, then the system is located at a distance of 350 pc with a proper motion velocity 150 km s<sup>-1</sup>. The superhump period of 0.046311 days was confirmed by our  $V$  photometry. The short period and the hydrogen-rich nature reveal that this system is another SU Ursae Majoris-type dwarf nova below the period minimum after V485 Centauri. 1RXS J232953.9+062814 is one of the most important systems for studying the evolutionary scenario of cataclysmic variables since it is much brighter than V485 Cen.

**Key words:** stars: dwarf novae — stars: cataclysmic variables: individual: 1RXS J232953.9+062814

### 1 INTRODUCTION

1RXS J232953.9+062814 was identified as a cataclysmic variable (CV) by Wei et al. (1999) when they selected a bright AGN sample from the optical identifications of the Bright Source Catalog of ROSAT All Sky Survey (RASS-BSC) (Voges et al. 1999). It was classified as a dwarf nova by Hu et al. (1998). The CCD photometric observations by Uemura et al. (2001) on 2001 Nov. 4.47–6.17 revealed superhumps with amplitudes of 0.2–0.3 mag and a period of 0.046311(12) days, indicating that this object is an SU UMa-type dwarf nova. This short superhump period means that its orbital period is below the ‘period minimum’ (about 1.3 h). Our low-resolution quiescent spectra show it to be a hydrogen-rich system. The only

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\* E-mail: [wjy@bao.ac.cn](mailto:wjy@bao.ac.cn)

other known object in this class is V485 Cen (Augusteijn et al. 1996; Olech 1997). However, 1RXS J232953.9+062814 is much brighter, hence much easier to observe than V485 Cen (about 18.0 *V* at outburst). Uemura et al. (2001) also pointed out that this object shows a large proper motion (up to 0.1'' yr<sup>-1</sup>), which indicates a small distance for the system. Thus this object is one of the most important systems for studying the evolutionary scenario of cataclysmic variables.

We carried out four spectroscopic observations of 1RXS J232953.9+062814 after its discovery, between 1996-11-05 and 2001-11-08. It happened to be in outburst when it was observed for the first time on 1996-11-05. In Wei et al. (1999) only the quiescent spectrum obtained on 1997-06-06 was published. In this paper, we publish all the spectra and some preliminary results of new photometric observations, paying special attention to the hydrogen-rich nature of this system and the spectral classification of the companion, which is very important for an understanding of the nature of the object.

## 2 OBSERVATIONS

A star on the Digitized Sky Survey (DSS) at RA=23<sup>h</sup>29<sup>m</sup>54<sup>s</sup>.38 and Dec=+06°28'10.2'' (2000.0) was identified as the optical counterpart to 1RXS J232953.9+062814 (Wei et al. 1999). The spectrum of the optical counterpart was observed four times with the 2.16-m telescope of the National Astronomical Observatories of CAS (NAOC). The observations were carried out on 1996-11-05, 1997-06-10 and 11, and 2001-11-08. All the observations were done with the OMR low-resolution Cassegrain spectrograph equipped with a TEK 1024×1024 back illuminated CCD camera with pixel size of 24 microns. The spectra ranged from 3800 Å to 8200 Å with a resolution ~9 Å. He/Ar lamp was used as the wavelength calibration, and two or three KPNO standard stars were observed every night for flux calibrations. All the data were reduced with IRAF using standard method.

In addition, immediately after the detection of the outburst of the dwarf nova on 2001 November 3.926 UT (Uemura et al. 2001), Johnson *V* photometry covering four periods was performed with the three-channel high-speed photoelectric photometer (Jiang & Hu 1998) on the 85-cm Cassegrain telescope of NAOC on 2001 November 8.

## 3 RESULTS

All of the four spectra are presented in Fig. 1. The CV was in outburst on 1996-11-05, while on 2001-11-08, the CV was halfway between outburst and quiescence, and the spectrum shows emission features on the enhanced blue continuum. The quiescent spectrum obtained on 1997-06-10 has a low signal to noise ratio due to cloudy sky during the observations. The spectrum in outburst (see Fig. 1a) clearly shows broad Balmer absorption lines, like the spectrum of a typical DA white dwarf. The two quiescent spectra present Balmer and HeI emission lines, which indicates that 1RXS J232953.9+062814 is not an AM CVn star but a hydrogen-rich system. This hydrogen-rich nature and the 0.046311(12) day superhump period indicate that this object is certainly below the 'period minimum'. The emission lines of the second quiescent spectrum also show double-peak emission features (send spectrum requests to: Jian-Yan Wei), which indicate a high-inclination accretion disc.

For this system, USNO A1.0 (Monet et al. 1996) give 16.6 *B* and 15.6 *R*. The *B* and *V* magnitudes estimated from the spectra shown in Fig. 1 are as follows: 12.6 *B* and 12.6 *V*



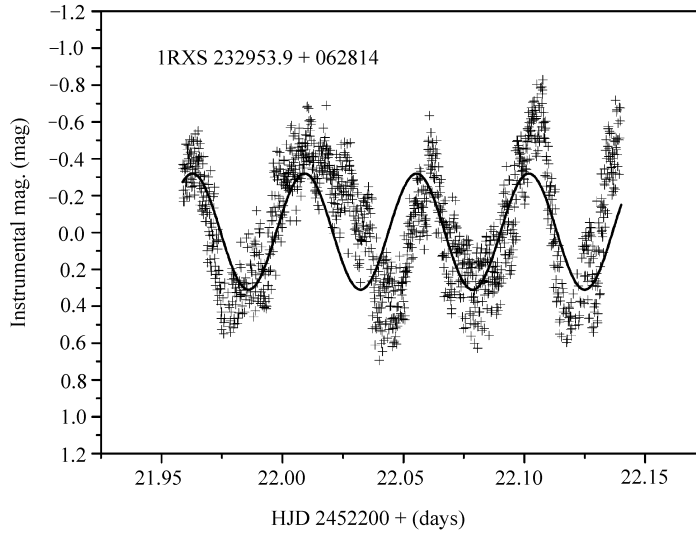


Fig. 2  $V$  light curves (crosses) of 1RXS J232953.9+062814 during its super-outburst on 2001-11-08 together with a sinusoid of period 0.04633 d. The integration time for each point is 10 s.

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## References

- Augusteijn T., van der Hooft F., de Jong J. A. et al., 1996, *A&A*, 311, 889  
 Hu J. Y., Wei J. Y., Xu D. W. et al., 1998, *Ann. Shanghai Obs.*, 19, 235  
 Jiang X.-J., Hu J.-Y., 1998, *Acta Astron. Sin.*, 39, 438  
 Monet D.G. et al., 1996, *USNO-A1.0* (Washington DC, USNO)  
 Olech A., 1997, *IAUC*, 6666  
 Uemura M., Ishioka R., Kato T. et al., 2001, *IAUC*, No. 7747  
 Voges W., Aschenbach B., Boller Th. et al., 1999, *A&A*, 349, 389  
 Wei J. Y., Xu D. W., Dong X. Y. et al., 1999, *A&AS*, 139, 575