



The contact binary system TYC 7275-1968-1 as seen by optical, UV and X-ray observations

I.J. Lima ^{a,b,*}, A.C. Mattiuci ^c, G.J.M. Luna ^d, A.S. Oliveira ^e, C.V. Rodrigues ^c, N. Palivanas ^e, N.E. Nuñez ^b

^a CONICET-Universidad de Buenos Aires, Instituto de Astronomía y Física del Espacio (IAFE), Av. Inte. Güiraldes 2620, Buenos Aires, C1428ZAA, Argentina

^b Universidad Nacional de San Juan, Facultad de Ciencias Exactas, Físicas y Naturales, Av. Ignacio de la Roza 590 (O), Complejo Universitario "Islas Malvinas", Rivadavia, J5402DCS, San Juan, Argentina

^c Instituto Nacional de Pesquisas Espaciais (INPE/MCTI), Av. dos Astronautas, 1758, São José dos Campos, São Paulo, Brazil

^d CONICET-Universidad Nacional de Hurlingham, Av. Gdor. Vergara 2222, Villa Tesei, Buenos Aires, Argentina

^e IP&D, Universidade do Vale do Paraíba, Av. Shishima Hifumi, 2911, Urbanova, 12244-000, São José dos Campos, São Paulo, Brazil

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ABSTRACT

We present an analysis of publicly available X-ray and optical observations of TYC 7275-1968-1, a contact binary, red nova progenitor candidate. The long optical time series of ASAS-3, SuperWASP, CRTS, Gaia, ASAS-SN, and TESS enabled us to improve its orbital period to 0.3828071 ± 0.0000026 d. We show the presence of an X-ray and UV source associated with TYC 7275-1968-1 from Neil Gehrels Swift Observatory, that was previously assumed to be the counterpart of CD -36 8436 (V1044 Cen), a symbiotic star located 22 arcsec from the red nova candidate. The X-ray data indicate the presence of a region with a temperature of $kT = 0.8^{+0.9}_{-0.1}$ keV and a luminosity of $1.4^{+0.1}_{-0.2} \times 10^{31}$ erg s⁻¹ in the range 0.3 – 10 keV. The detection of X-rays and modulated UV emission suggests that both components of the binary are chromospherically active.

1. Introduction

Red novae and luminous red novae are considered the result of mergers of contact binary systems, which can eject the common envelope (e.g., Pastorello et al., 2019). The resulting optical transients show luminosities between those of classical novae and supernovae, and they have atypical red colors. Kochanek et al. (2014) predicted an occurrence rate for a merger of about ~ 0.1 to ~ 0.03 yr⁻¹ for bright red novae in our Galaxy, such as V838 Mon and V1309 Sco. Indeed, nova V838 Mon ($M_V < 7$ mag) is proposed to be the result of a stellar merger, but its progenitor still remains unidentified. So far, V1309 Sco ($M_V < 10$ mag) is the only red nova unambiguously originated from the merging of a low mass-ratio contact binary system that was known before the red nova event (Mason et al., 2010).

Wadhwa et al. (2022b) proposed to identify potential red-nova progenitors based on the temperature of the components, mass ratio (q), and amplitude of the light curve determined by some geometrical parameters such as the degree of contact and inclination. The low-mass-contact-binary systems ($0.6 M_\odot < M_1 < 1.4 M_\odot$) candidates to red-nova progenitors have a narrow period range from 0.27 d to 0.4 d with a peak near 0.35 d (see Figure 3 of Wadhwa et al., 2022b).

These systems tend to have a dynamically unstable orbit. However, it is possible that periods above 0.5 d can also present orbital instabilities if the mass ratio is extremely low ($q < 0.3$, see Figure 63 of Kobulnicky et al., 2022).

TYC 7275-1968-1 (from now on TYC 7275), also cataloged as CRTS J131559.4-370018, was first identified as an eclipsing binary by the Catalina Real-Time Transient Survey (CRTS) with an orbital period of 0.382807 d and a mean magnitude of 11.37 mag with a dispersion of few tenths of mag in V band (Drake et al., 2017). It is a low-mass binary and a candidate to red-nova progenitor with an inclination of $69.8 \pm 1.5^\circ$, $q = 0.075$, and deep contact (up to 95%), indicating that the temperatures of the components are similar (Wadhwa et al., 2022a). X-ray emission was detected by ROSAT at less than 20 arcsec from TYC 7275, with an exposure time of 351 s and a count rate of 3.18×10^{-2} counts s⁻¹ (Voges et al., 2000). The measured flux was 3.36×10^{-13} erg cm⁻² s⁻¹ and the luminosity was estimated to be 4.27×10^{30} ergs s⁻¹ at a quoted distance of 326.7 ± 60 pc (Wadhwa et al., 2022a).

In this work we report the analysis of ASAS-3, SuperWASP, CRTS, Gaia, ASAS-SN, TESS and Swift data of TYC 7275. In Section 2.1, we

* Corresponding author at: CONICET-Universidad de Buenos Aires, Instituto de Astronomía y Física del Espacio (IAFE), Av. Inte. Güiraldes 2620, Buenos Aires, C1428ZAA, Argentina.

E-mail address: isabellima01@gmail.com (I.J. Lima).

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