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Spectroscopic Study of the Optical Counterpart to the Fast X-ray Transient IGR J17544-2619 Based on Observations at the 1.5-m RTT-150 Telescope

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Abstract—We present the results of our long-term photometric and spectroscopic observations at the Russian–Turkish RTT-150 telescope for the optical counterpart to one of the best-known sources, representatives of the class of fast X-ray transients, IGR J17544-2619. Based on our optical data, we have determined for the first time the orbital and physical parameters of the binary system by the methods of Doppler spectroscopy. We have calculated theoretical spectra of the optical counterpart by applying non-LTE corrections for selected lines and obtained the parameters of the stellar atmosphere ($T_{\rm eff} = 33\,000$ K, $\log g = 3.85$, $R = 9.5\ R_\odot$, and $M = 23\ M_\odot$). The latter suggest that the optical star is not a supergiant as has been thought previously.

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INTRODUCTION

The source IGR J17544-2619 belongs to supergiant fast X-ray transients (SFXTs), a new population of X-ray objects discovered by the INTEGRAL observatory (Sunyaev et al. 2003b; in't Zand 2005; Negueruela et al. 2006; Sguera et al. 2006; Grebenev 2009; Romano et al. 2014). X-ray binaries containing an early-type (OB) supergiant and a neutron star with a strong magnetic field (an X-ray pulsar) are representatives of this population.

Supergiants are characterized by a strong outflow of material (with a rate $\sim 10^{-6}$–10^{-5} $M_\odot\,{\rm yr}^{-1}$). Such a dense stellar wind must supply sufficient material to maintain spherically symmetric accretion onto the neutron star. Therefore, one would think that these binary systems must be powerful X-ray sources with a luminosity $\sim 10^{37}$ erg s^{-1} (Grebenev and Sunyaev 2007). Actually, this is not the case. Most of the time SFXTs have a very low luminosity $\sim 10^{32}$–10^{33} erg s^{-1} and are not accessible for detection by wide-field X-ray telescopes. However, they occasionally flare up for a short ($\lesssim 1$ day) time, becoming the brightest objects in the X-ray sky. Their luminosity rises by 4–6 orders of magnitude in a few minutes. Various models have been proposed to explain the so unusual properties of SFXTs (the absence of persistent emission, the brevity of outbursts, the huge range of luminosity variations). Historically, the first model of a clumpy stellar wind from a supergiant (in't Zand et al. 2004) did not explain the observed wide range of luminosity variations, the model of a highly asymmetric stellar wind (like the wind from Be stars, Sidoli et al. 2007) did not explain the outburst brevity, and the model of a magnetic barrier (Bozzo et al. 2008) suggested an extremely strong neutron star magnetic field. The model by Grebenev and Sunyaev (2007) (see also Bozzo et al. 2008), where the accretion of matter is halted by a centrifugal barrier at the magnetospheric boundary of a rapidly spinning neutron star (the propeller effect), while the outbursts are explained by the temporary overcoming of this barrier due to local fluctuations of the stellar wind density and velocity, and the model by Shakura et al. (2014),

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