Low-mass M-type eclipsing variable star found in the third catalogue of DFBS late-type stars

G. R. Kostandyan*[1], K. K. Gigoyan†[1], and K. S. Gigoyan‡[1]

[1]INAS RA V. Ambartsumian Byurakan Astrophysical Observatory (BAO), Byurakan 0213, Aragatzotn Province, Armenia

Abstract

Based on the Transiting Exoplanet Survey Satellite (TESS) phased light curve, we confirm the eclipsing type variability nature for low-mass M-dwarf DFBS J095623.83+064801.9, as presented in the third version of the DFBS (Digitized First Byurakan Survey) catalog of late-type stars (LTSs). We present the most important physical parameters of this object from the Gaia Data Release 3 (DR3) catalog and TESS catalogs.

Keywords: *Variables: Algol-type eclipsing variables: Gaia and TESS data*

1. Introduction

Variable stars are classified into several broad classes: pulsating, eclipsing, rotating, eruptive, cataclysmic, and others. Each class of variable stars is divided into several subclasses. In more detail, the improved system of variability classification is presented by the authors of the "General Catalogue of Variable Stars" (GCVS) (Samus' et al., 2017). An overview of variable stars in general, the techniques for discovering and studying them, and a description of the main types are also presented in John Percy's book (Percy, 2007) and in papers by Drake et al. (2014, 2017)

There are three basic classes of eclipsing variables, based solely on the overall light curve shape: EA (Algol), EB (Beta Lyrae), and EW (W Ursae Majoris) types. Eclipsing binaries include contact, semi-detached, and detached systems.

In recent years, there have been many searches of eclipsing variable stars. Large-scale surveys significantly increased the number of eclipsing variable stars. A catalog of 1292 low-mass, short period eclipsing binaries is presented by Oddo et al. (2026). A large number of eclipsing binary candidates based on Gaia Data Release 3 (DR3) are presented by Mowlavi et al. (2023) and collaborators. An updated catalog of 4680 northern eclipsing binaries with Algol-type light curve morphology was presented by Papageorgiou et al. (2018). Data for more than 40,000 eclipsing binary candidates identified by the ASAS-SN, were also presented by Rowan et al. (2022). Xiong et al. (2023) published data for 56 eclipsing binaries selected from the LAMOST Medium-Resolution Survey (MRS). Data for 4584 TESS (Transiting Exoplanet Survey Satellite, Ricker et al., 2014, 2015) eclipsing binary stars were published by (Prša et al., 2022). The catalog of eclipsing binaries found in the Entire Kepler data was reported by David et al. (2016). Many papers are devoted to the study of individual eclipsing variables.

As part of the M dwarf research program, we analyzed phase-dependent light curves for all DFBS M dwarfs (Gigoyan et al., 2025), using the Pre-search of Data Conditioning Simple Aperture Photometry (PDCSAP) at the Mikulski Archive for Space Telescopes (MAST). While analyzing the TESS data, we discovered an Algol-type light curve of the M dwarf DFBS J095623.83+ 064801.9.

This paper is organized as follows. Section 2 presents the TESS light curve for the M dwarf DFBS J095623.83+064801.9. Section 3 presents Gaia DR3 low-resolution spectra for this object. Section 4 considers photometric data and important physical parameters. We discuss the results obtained for this object and provide concluding remarks in Section 5.

*kostandyan@bao.sci.am, Corresponding author

†kgigoyan@bao.sci.am

‡karengigoyan@bao.sci.am

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Table 1. TESS Observations of DFBS J095623.83+064801.9 from the MAST

DFBS Number	TESS target name	Data of observations	Exposure length (sec.)
J095623.83+064801.9	TIC 377129640	2021-11-07	120

2. TESS light curve.

The Transiting Exoplanet Survey Satellite is NASA's ongoing Astrophysics Explorer Mission, designed to detect exoplanets around the nearest M dwarfs, which are ideal for follow-up observations and further characterization. TESS was launched on April 18, 2018, and its prime mission (PM) ran from July 26, 2018, to July 4, 2020. TESS observed nearly 73% of the sky across 26 observing "Sectors" during its two-year PM. TESS monitored bright stars with a 2 minute short cadence and provided full-frame images every 30 minutes. The wide red bandpass of the TESS cameras (600-1000 nm) enables TESS to detect Earth and super-Earth-sized exoplanets transiting M dwarfs.

Table 1 presents TESS observational data for M dwarf DFBS J095623.83+064801.9 from the MAST. We downloaded the PDCSAP light curves for these stars from the MAST (on-line access available at https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html/) using the lightcurve package (Barentsen et al., 2019).

Figure 1 shows the TESS SAP (Simple Aperture Photometry) light curve for object DFBS J095623.83+064801.9. We estimate the orbital period P = 0.762631 d for this object, using Box Least Squares (BLS) (Kovács et al., 2002).

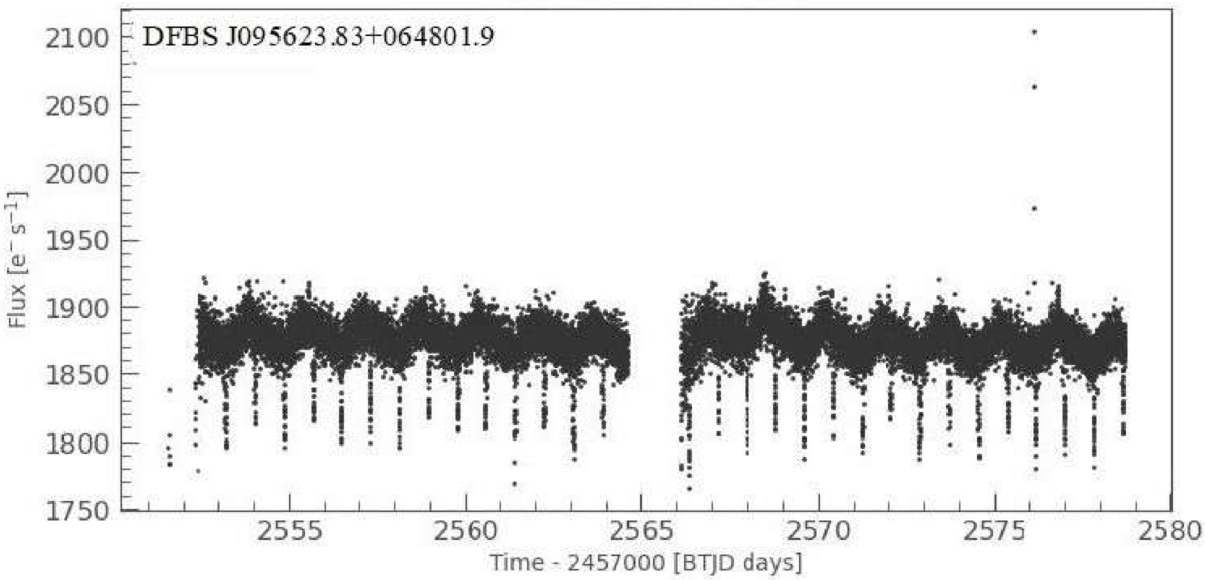

Figure 1. DFBS lr spectral shape (A) and Gaia DR3 BP/RP spectra (B) for new confirmed M giant DFBS J035851.35+700544.9. G mag =12.679, T_eff = 3269 K, TIC Catalogue number is 85987534.

3. Gaia DR3 spectra.

In Figure 2 we present Gaia Data Release 3 (Gaia Collaboration, Vallenari et al., 2023) low-resolution spectra (De Angeli et al., 2023a) (CDS VizieR Catalog I/355/spectra) for M dwarf DFBS J095623.93+064801.9.

4. Photometric data. Important stellar parameters: Gaia DR3 and TESS Input Catalog Data.

Gaia DR3 (Gaia Collaboration, Vallenari et al., 2023) provides high-precision astrometry, three-band photometry, radial velocities, effective temperatures, and information on numerous astrophysical parameters

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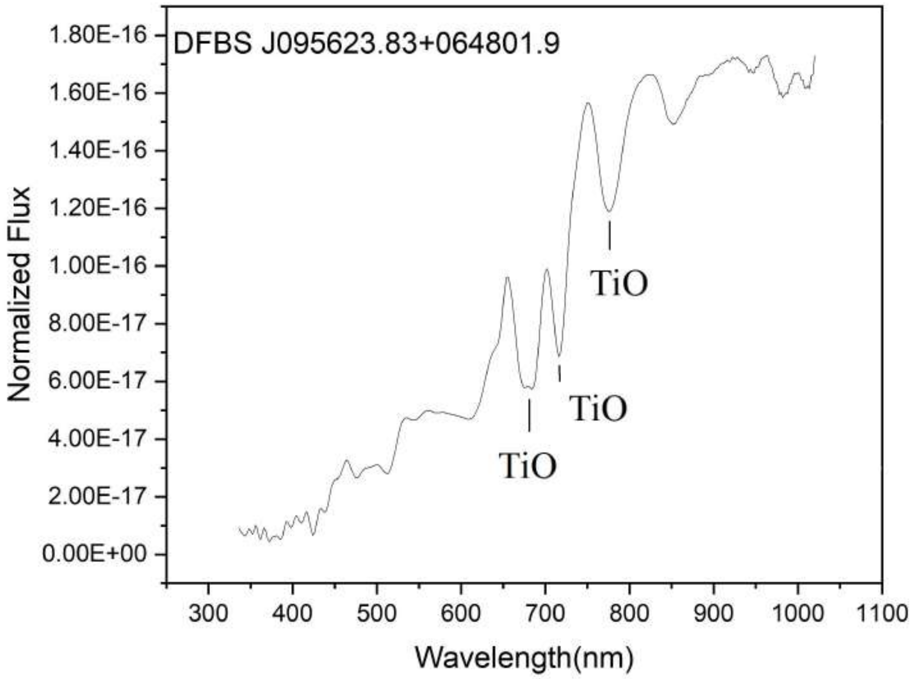

Figure 2. Gaia DR3 BP/RP lr spectra of M dwarf DFBS J095623.83+064801.9. The absorption broadbands of the TiO molecule in the range 600-800 nm are indicated. Spectral subclass can be estimated as M2-M3.

Table 2. Some Important Gaia DR3 Data for DFBS M Dwarfs

DFBS Number	Gaia DR3 Name	G-mag	BP mag	BP-RP mag	R (pc)
J095623.83+064801.9	3850549957388322816	13.643	15.023	2.536	87.11

for approximately 1.8 billion sources brighter than G = 21.0 magnitude (CDS Vizier Catalog I/355/gaiadr3). Table 2 provides important Gaia DR3 data for DFBS J095623.83+064801.9. We provide distance information from Gaia EDR3 by Bailer-Jones et al. (2021).

The Gaia G-band absolute magnitudes can be estimated as M(G) = + 8.942 for DFBS J095623.83+064801.9. This is typical for M2 – M3 dwarfs (Carmo et al., 2020, Gaia Collaboration et al., 2018) (see the website at https://www.pas.rochester.edu/∼emamajek/spt/ for more details).

Table 3 also includes other important parameters, such as effective temperature, stellar mass, and radii in solar units, for three DFBS M dwarfs from the TESS Input Catalog (Version 8.2, TIC V8.2 (Stassun et al., 2019), CDS Vizier Catalog IV/39/tic82).

5. Summary And Future Works

Eclipsing binary stars are very important in stellar astrophysics for a variety of reasons. The discovery and characterization of Algol-type eclipsing binaries provide an opportunity to improve our understanding of the structure of low-mass stars (defined as M ¡ 0.8 M (Carmo et al., 2020, Kroupa et al., 2013, Stassun et al., 2019). In this work, we present important physical parameters for Algol-type eclipsing binary DFBS J095623.83+064801.9, confirmed as low-mass M dwarfs in the third DFBS catalog of late-type stars. The

Table 3. TIC Catalog Important physical parameters for M dwarf DFBS J095623.83+064801.9

DFBS Number	Teff (K)	Radius (M_{Sun})	Mass (M_{Sun})	Luminosity (M_{Sun})
J095623.83+064801.9	3413	0.543	0.539	0.03609

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subtype is M2-M3.

In the future, high-spatial-resolution CCD imaging and speckle interferometry will allow us to study the nature of the companions around these objects in more detail.

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