The Digitized First Byurakan Survey Database. Late-type stars candidates. New confirmations.

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Abstract

More than 3000 Late-Type Stars (LTS) candidates was confirmed among the sample, selected on the Digitized First Byurakan Survey (DFBS) spectral plates. The DFBS is the digitized version of the First Byurakan Survey (FBS, or Markarian survey). This objective-prism survey was carried out in 1965-1980 by B. E. Markarian and colleagues using the 1 m Schmidt telescope of the Byurakan Astrophysical Observatory (BAO). FBS spectral plates have been used long period to search and study faint LTS (C-type (carbon) and M-type) stars at high Galactic latitudes. Thousands of objects was confirmed as LTS. The confirmation is based on Gaia DR3 BP/RP low-resolution spectral database. In previous studies of the DFBS plates, these objects were presented as LTS candidates. Some objects are located more than 10 kpc. The predominant part of the new confirmed objects are M dwarfs.

Keywords:*late-type -stars: M dwarfs, M giants, carbon stars*

1. Introduction

Markarian survey (or the First Byurakan Survey (FBS)), is the first systematic survey of the extragalactic sky. This objective-prism (op) low-resolution (lr, 1.5^0 prism, a reciprocal dispersion of 1800 Å/mm near H_β, providing a 3400-6900 Åspectral range) survey was carried out in 1965-1980 by Markarian and collaborators using the 1 m Schmid telescope of the Byurakan Astrophysical Observatory (BAO, Armenia) and resulted in discovery of 1517 UV-excess galaxies (Markarian et al., 1989). FBS lr spectral plates have been used to search and study faint Late-Type Stars (M-type and C-type stars at high Galactic latitudes, Gigoyan et al. (2001)). All FBS lr spectral plates have been now digitized, resulting in the creation of the Digitized First Byurakan Survey (DFBS) database. Its images and spectra are available on the web portal in Trieste (on-line at https://www.ia2-byurakan.oats.inaf.it). All DFBS plates are analyzed with help of analysis softwares FITSView and SAOImage ds9. A second version of the "Revised and Updated Catalogue of the First Byurakan Survey of Late-Type Stars", containing data for 1471 M and C stars was generated (Gigoyan et al., 2019), CDS Vizier Catalogue http://cdsarc.u-strasbg.fr/viz-bin/Cat?J/MNRAS/489/2030. This visualization allows to detect very red and faint C and M star candidates close to the detection limit in each plate (Gigoyan, 2022). Candidates of N-type (Asymptotic Giant Branch-AGB) C stars and M-type giants, for which very short (∼6600-6900 Å) spectra is visible on the DFBS plate, no C_2 and TiO molecule absorption bands are detectable. Moderate-resolution slit spectroscopy was carried out for some of them, confirming the C-rich nature of them (Gigoyan et al., 2012). Several of such candidates could be M dwarfs also (Gigoyan, 2022). Meanwhile, a huge amount of such candidates detected on the DFBS plates, remained to be confirmation on spectral types (Gigoyan, 2022). To classify LTS candidates, we use Gaia DR3 BP/RP lr spectroscopic database, which allows us to confirm the spectral types for candidates very easily.

2. New confirmations. Gaia DR3 spectra

The European Space Agency (ESA) mission Gaia (Gaia Collaboration, Prusti et al., 2016), has already released three catalogues to the astronomical community, of increasing richness in terms of content, and

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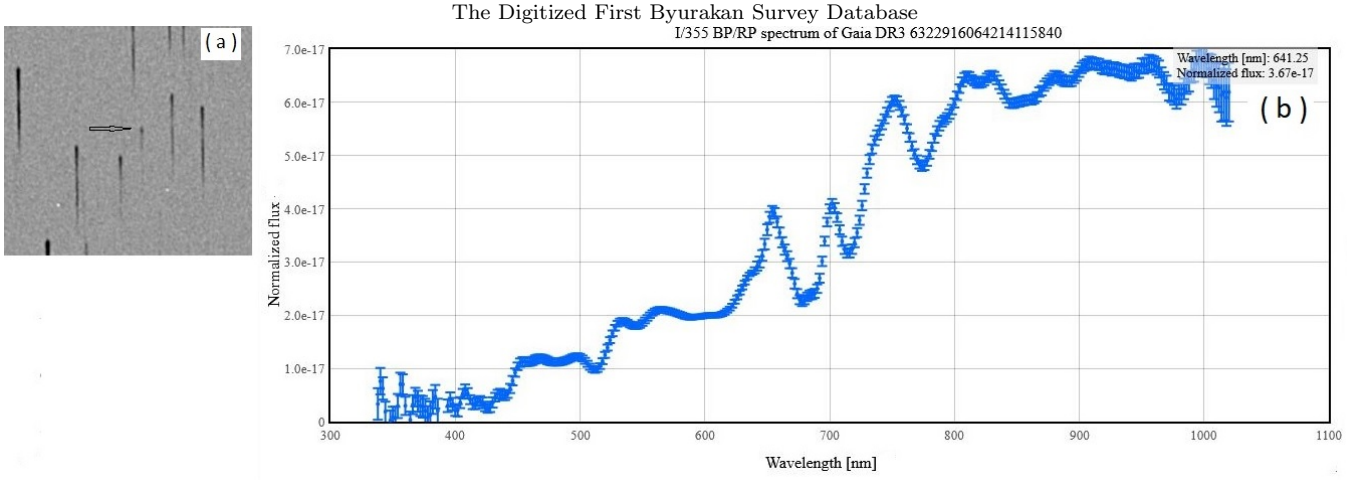

Figure 1. DFBS lr spectral shape (1a) for LTS candidate object with RA = $15^h23^m09.021^s$ and DEC = -$05^d50^m08.15^s$ (DFBS J152309.20-055005.8). Figure 1b present Gaia DR3 spectra confirmed. This object is M dwarf, r = 56.5644 pc and V = 15.75 mag..

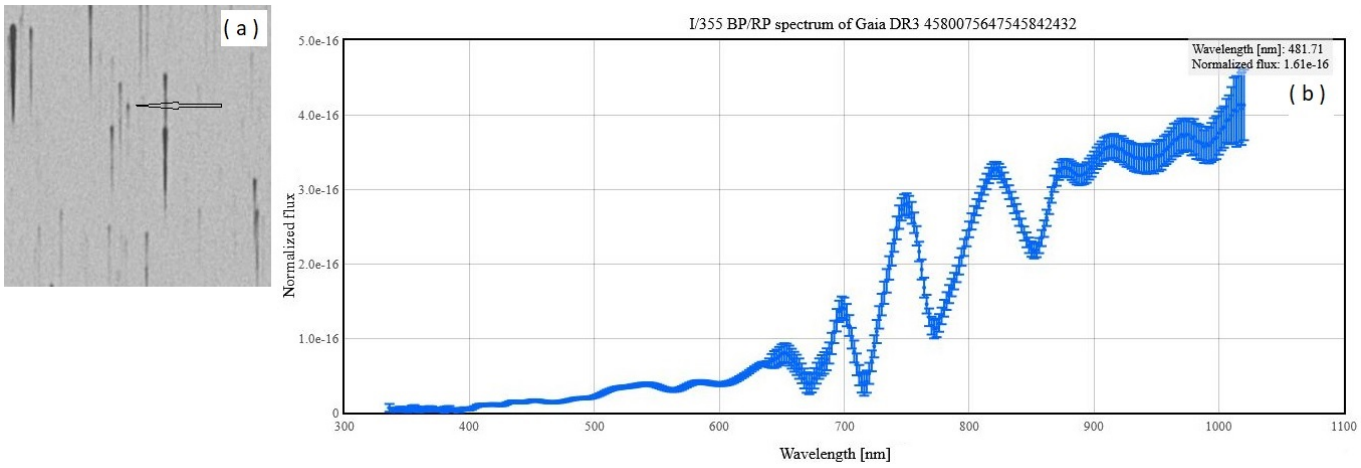

Figure 2. DFBS lr spectral shape (1a) for LTS candidate object with RA = $18^h12^m31.207^s$ and DEC = +$26^d35^m47.95^s$ (DFBS J181231.22+263548.0). Figure 2b present Gaia DR3 confirmed spectra. This object is M giant at a distance r = 8150 pc and high (Z) from the Galactic plane Z = 2780 pc.

accuracy. With respect to previous Gaia Early Data Release 3 (EDR3, Gaia Collaboration, Brown et al., 2021), Gaia Data Release 3 (Gaia Collaboration, Vallenari et al., 2023) introduces a number of new data products based on the same source catalogue, including a total 1.8 billion objects based on the period of 34 months satellite operation. Blue (BP) and Red (RP) photometer lr spectral data are one of the exciting new product in Gaia DR3 (CDS VizieR Catalog I/355/gaiadr3). Time-averaged mean spectra covering the optical to near-infrared (NIR) wavelength range λ 3300-10500 Å are published for approximately 220 million objects (CDS VizieR Catalog I/355/spectra). Most of them are brighter than G=17.65 mag (De Angeli et al., 2023). M-type stars can be detected very easily in the Gaia DR3 lr spectral database by the presence of the broad absorption bands of the TiO molecule in the range 6500-7000 Å, 7000-7500 Å, and 8000-8500 Å, and C stars display strong Swan bands at 4383, 4737, 5165, and 5636 Å of C_2 molecule (Gigoyan et al., 2024). The list of DFBS LTS candidates (∼3200 objects) were cross-correlated with the Gaia DR3 lr spectroscopic database. We confirm the LTS nature practically for all of them. The great part of the confirmed objects are M dwarfs and M giants. We confirm C-rich nature for 13 objects also.

As examples, Figure 1(a,b) and Figure 2(a,b) shows spectral shapes for DFBS LTS candidates and Gaia DR3 confirmed spectra.

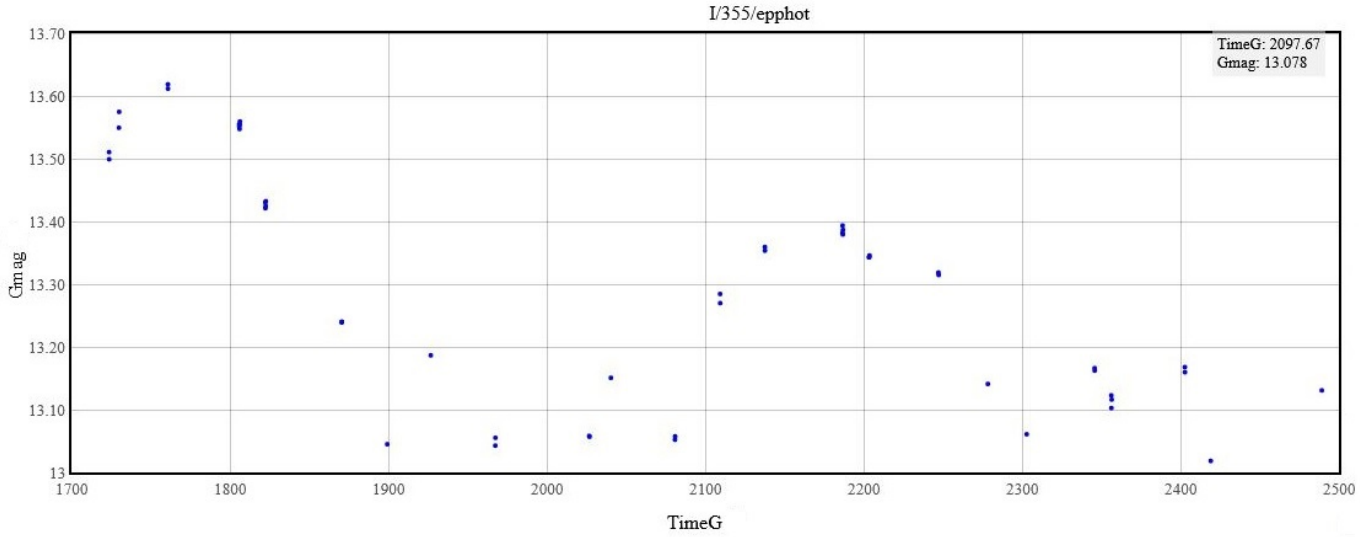

Figure 3. Gaia G-band phase dependent light curve for new confirmed M giant DFBS 181231.22+263548.0 (available on-line at https://vizier.cds.unistra.fr/viz-bin/VizieR?-source=I/355/.

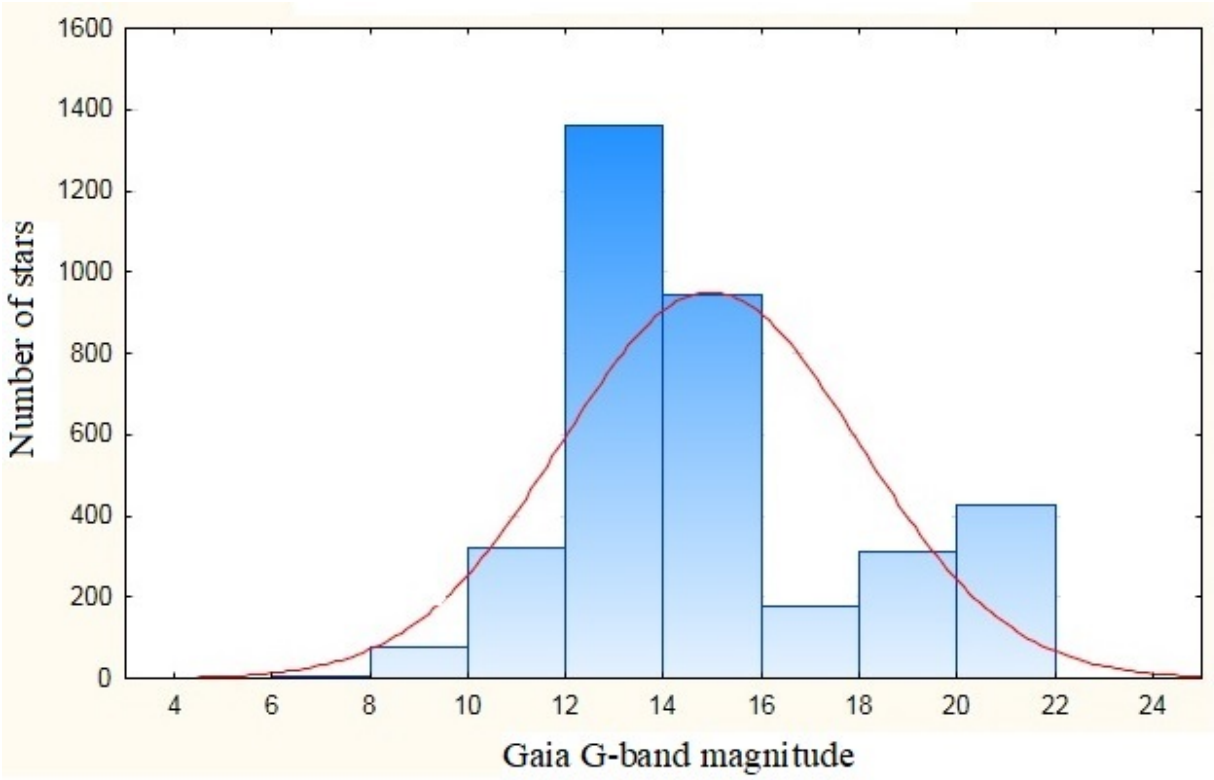

Figure 4. Gaia G-band magnitude distribution for 3200 DFBS LTS.

3. Variability

Figure 3 present light curve in Gaia G-band for object DFBS J181231.22+263548.0. This object is a long period variable.

Figure 4 presents the histogram of the Gaia DR3 G-wide band magnitude distribution for near 3200 new confirmed DFBS LTS.

4. Summary and future works

In this paper we report on a large number of new LTS confirmed in the Gaia DR3 spectral database. All these faint objects (V mag. in the range $14.0^m \div 17.0^m$) were presented as LTS candidates in DFBS database before the present study. We significantly extended the previous FBS survey for LTS. A study of the new LTS is now in progress, and the results will be appear very soon.

The list of all spectroscopically conformed DFBS LTS candidates, reported as a supplementary (value-added) catalogue to the second edition of the "Revised and Updated Catalogue of The First Byurakan Survey" will be presented in SIMBAD astronomical database very soon.

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