

# New calibration of the Vilnius photometric system

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**Abstract.** The medium-band Vilnius photometric system with the mean wavelengths at 345 (*U*), 374 (*P*), 405 (*X*), 466 (*Y*), 516 (*Z*), 544 (*V*), and 656 (*S*) nm for many years was an important tool to determine interstellar reddenings and distances of single stars due to its ability to classify stars of all temperatures in spectral classes and luminosity classes in the presence of different interstellar reddenings. At present, Gaia DR2 presents distances to stars with an unprecedented accuracy at least up to 3 kpc. However, multicolor photometry, which allows the classification of stars as well as the preliminary determination of stellar temperatures, gravities, metallicities and interstellar reddenings, remains an important method for distant stars. Here we present an empirical calibration of the intrinsic color indices of the Vilnius system in terms of physical parameters of stars for dwarf and giant stars of spectral classes F-G-K-M. In any attempted photometric determination of physical parameters of stars it is important to have an extensive and homogeneous sample of spectroscopically determined parameters for stars for which there are also accurate photometric data. As a source catalogue for the Vilnius photometry the latest updated version of the Catalogue of Photoelectric Observations in the Vilnius System was used, which contains compilations from the published photometry for about 11 000 stars. The stars which had both the Gaia DR2 parallaxes and the determinations of stellar parameters from high-dispersion spectra were extracted from this catalogue. The final sample contains more than 1500 stars of spectral classes F-M. The majority of these stars (ca 70%) are not reddened, for others the values of interstellar reddening  $A_V$  were determined using the regular techniques of photometric classification in the Vilnius system. The absolute magnitudes  $M_V$  and consequently the luminosity classes were determined using Gaia DR2 parallaxes. We present the analytical expressions for the effective temperature  $T_{eff}$  and surface gravity  $\log g$  and evaluate the errors of solutions for dwarf and giant stars. To test the accuracy of the proposed method, we have compared our results with the stars observed by Gaia and with the stellar parameters available from the large spectroscopic surveys: APOGEE, Gaia-ESO, GALAH, LAMOST, RAVE and SEGUE. The results of comparison contain 5-6 % outliers.

The proposed method allows the fast and straightforward evaluation of stellar physical parameters for the stars observed in the Vilnius photometric system. Despite the fact, that the accuracy of determination is significantly lower than in the case of spectroscopic methods, the method described may be useful for distant faint stars, which are still inaccessible for spectroscopic observations.

**Keywords.** Techniques: photometric - Vilnius photometric system, stars: fundamental parameters, classification.