Ground-based contribution of average-sized telescopes to characterisation of PLATO targets

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Abstract

A spectroscopic characterization is available for less than 30% of the bright stars in the Solar neighborhood. This missing information about the Galactic environment in this region of space is very important for asteroseismic and planetary studies and space missions (e.g., ESA PLATO or NASA TESS) that are designed to perform an in-depth analysis of large fields of the sky-sphere and searching for exoplanets around bright stars. Accurate atmospheric parameters and chemical composition of stars play a vital role in characterizing physical parameters of exoplanetary systems and understanding their formation. A full asteroseismic characterization of a star is also possible if its main atmospheric parameters are known.

We present the ongoing spectroscopic survey SPFOT that employs Vilnius University Echelle Spectrograph (VUES) mounted on the 1.65 m telescope of the Molėtai Astronomical Observatory in Lithuania. Using the high resolution (up to R=68000) and long wavelength coverage (400 - 900 nm) VU ES spectra we are able to provide the detailed spectroscopic characterization for bright stars. We have already observed about 2000 brightest stars in fields covering the PLATO LOPN and TESS continuous viewing zone. Most of LOPN P2 targets are already observed. Results for a part of the sample were already published in a number of contributions where we presented detailed atmospheric parameters and abundances of up to 34 chemical elements.

SPFOT project

During the period of the Spectroscopic and Photometric Survey of the Northern Sky (SPFOT) at the Molėtai Astronomical Observatory (MAO, Lithuania) we colected a catalogue of about 2000 brightest stars in the Northern hemisphere. This led us to the several scientific publication: Mikolaitis et al. (2018, 2019), Tautvaišienė et al. (2020, 2021, 2022), and Stonkutė et al. (2020). In Mikolaitis et al. (2018, 2019), all F, G, and K spectral type dwarf and subgiant stars with V < 8 mag were observed within two fields of approximately 20º radii centred at α(2000) = 161º.03552, δ(2000) = 86º.60225 and at α(2000) = 265º.08003, δ(2000) = 39º.58370, respectively. These fields are preliminary targets of the upcoming ESA PLATO space mission. In Tautvaišienė et al. (2020), all F5 and cooler stars with V < 8 mag were observed within a field of approximately 12º radii centred at α(2000) = 270º, δ(2000) = 66º. This field corresponds to the continuous viewing zone of the NASA TESS space mission.

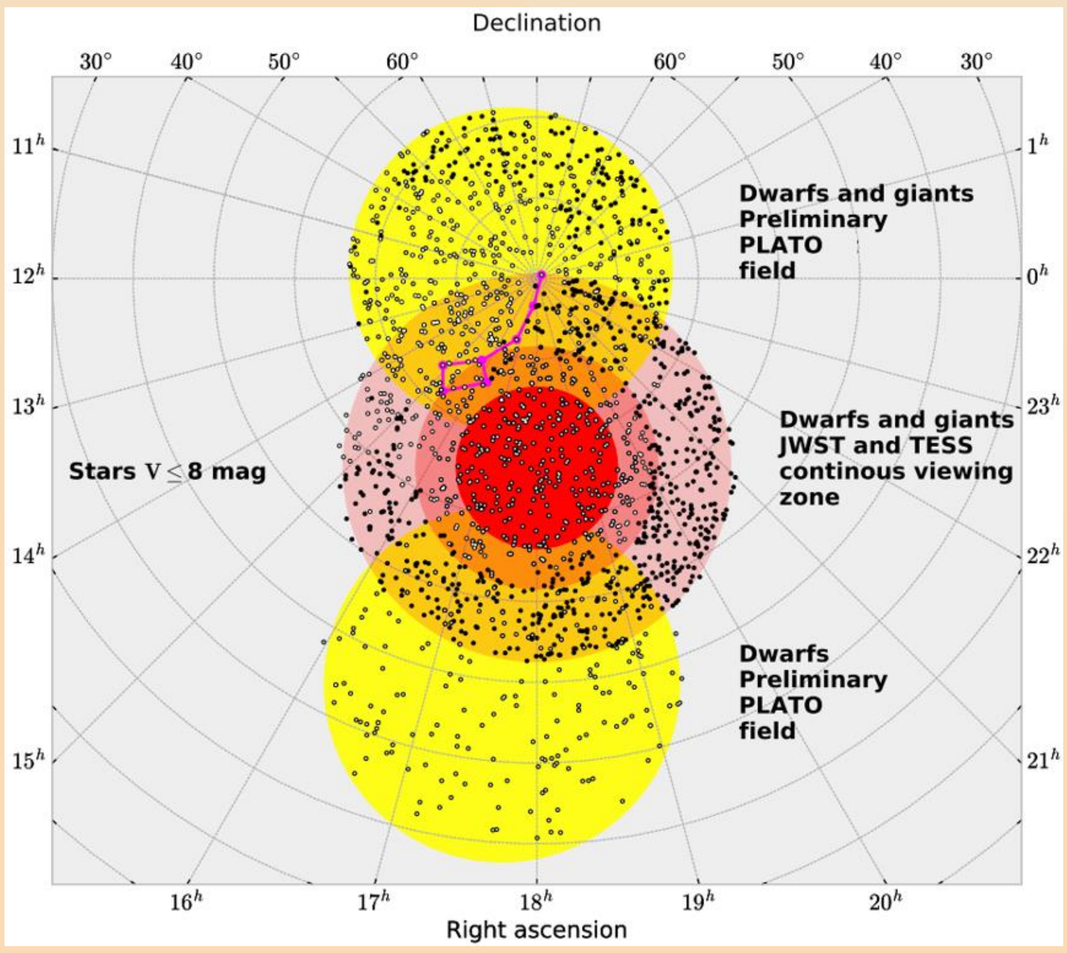

Fig. 1. Positions of all selected programme stars observed from the Molėtai Astronomical Observatory in Lithuania.

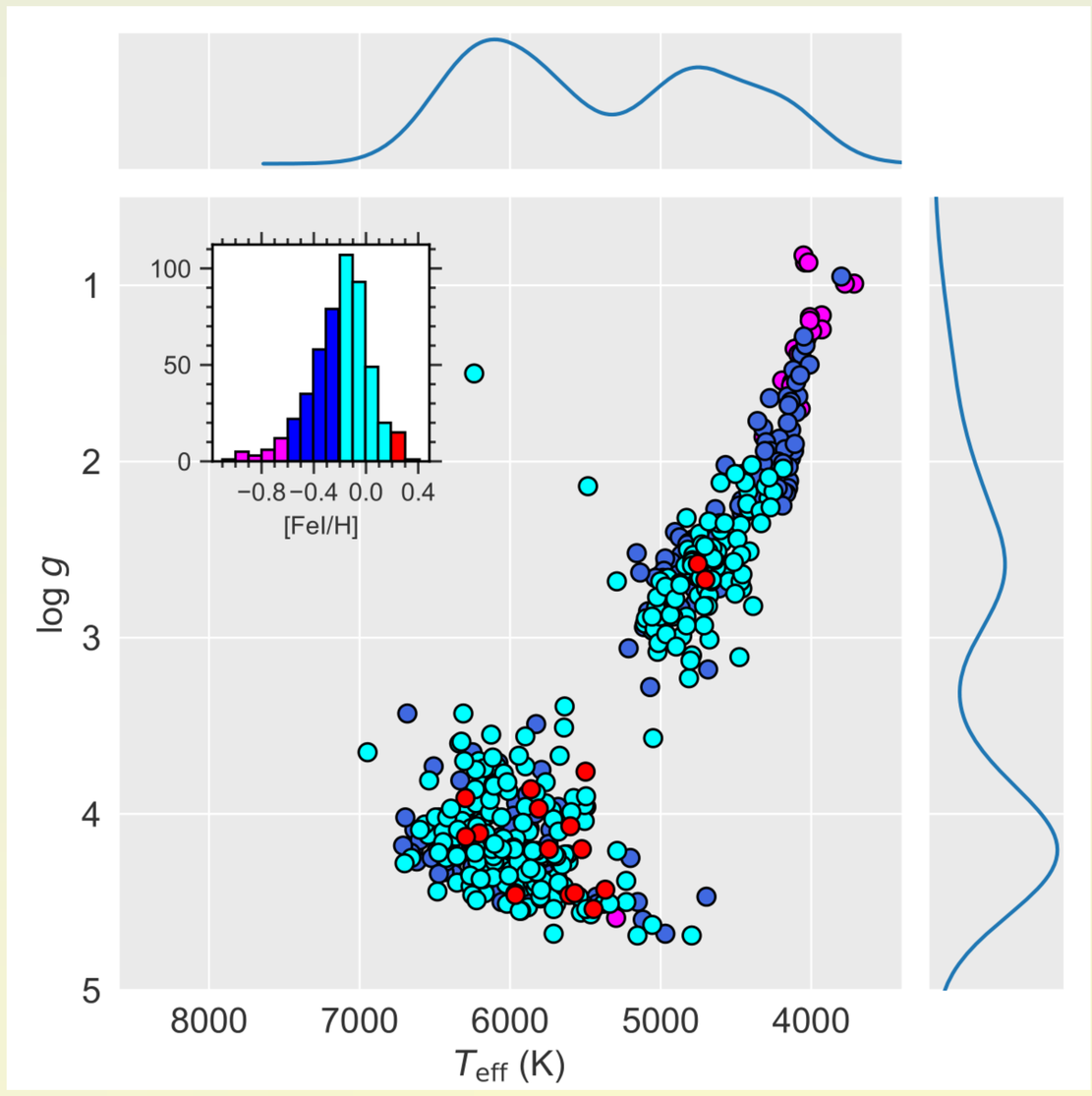

Fig. 2. Investigated stars in a surface gravity and effective temperature diagram showing a density estimation and bivariate distribution.

Our comprehensive stellar catalogue consists of main spectroscopic information: the main atmospheric parameters (effective temperature T_{eff}, surface gravity log g, metallicity [Fe/H], and microturbulence velocity v_t) and chemical abundances of Li, C, N, O, Na, Mg, Al, Si, S, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Sr, Y, Zr, Ba, La, Ce, Pr, Nd, Sm, and Eu. The stellar atmospheric parameters were determined from equivalent widths of FeI and FeII lines using standard spectroscopic techniques while the individual chemical element abundances were determined from spectral synthesis. For both tasks the one-dimensional plane-parallel LTE MARCS stellar model atmospheres were applied. With this study we also examined whether bright solar vicinity stars can provide important information about the Galactic chemical evolution, so we determined basic kinematic and orbital parameters for this sample of stars. Having in mind that only 30% of bright FGK main sequence stars have spectroscopic determinations of atmospheric parameters, we emphasize the importance of high-resolution spectral analysis of bright stars, especially for the “hot”-regions of the sky such as the PLATO fields.

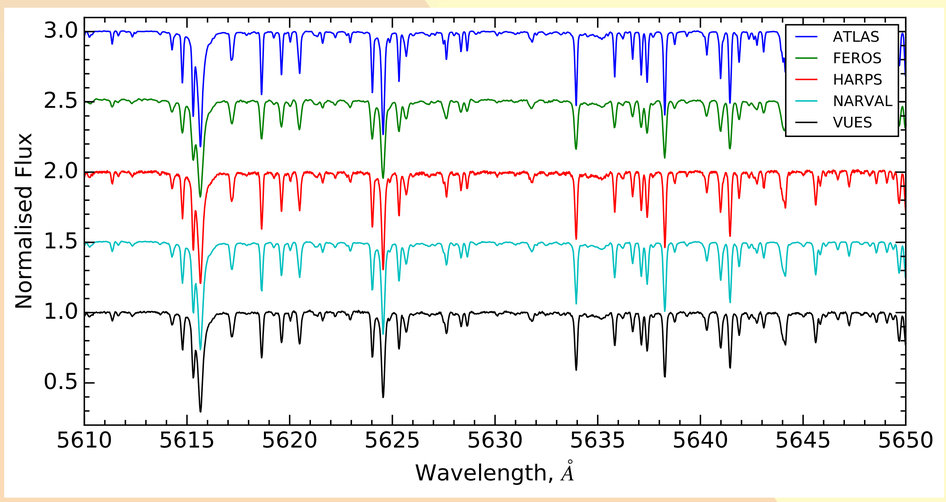

Fig. 3. Examples of the solar spectra from the ATLAS, FEROS, HARPS, NARVAL, and VUES spectrographs (original resolutions).

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