Origins: From the Protosun to the First Steps of Life
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Spectroscopic and photometric survey of the northern sky: Towards understanding of the Galactic chemical environment in the Solar vicinity

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Abstract. High-resolution spectra for all bright ($V < 8$ mag) and cooler than F5 spectral class dwarf stars were observed in two fields with radii of 20 degrees (centered at $\alpha(2000) = 161.03^{\circ}$ and $\delta(2000) = 86.60^{\circ}$ and at $\alpha(2000) = 265.08^{\circ}$ and $\delta(2000) = 39.58^{\circ}$) towards the northern ecliptic pole. They coincide with two of the preliminary ESA PLATO fields which also will be targeted by the NASA TESS mission. We use high-resolution spectra obtained with the VUES spectrograph mounted on the 1.65 m telescope at the Moletai Astronomical Observatory of the Institute of Theoretical Physics and Astronomy, Vilnius University. In total we observed 405 stars. Spectroscopic atmospheric parameters and abundances of 23 neutral and ionised atomic species were determined for 261 slowly rotating stars (up to 15 $\mathrm{km\,s^{-1}}$). 73 % of stars were analysed spectroscopically for the first time. We also derived stellar ages and orbital parameters to draw a chemical picture of the Solar vicinity.

Keywords. stars: abundances

1. Introduction

A spectroscopic characterisation is available for less than 30 % of bright stars in the Solar neighbourhood leaving us with missing information about the Galactic environment in this region of space. This is very unfortunate for astero-seismic and planetary studies. For example, new space missions (e.g. NASA TESS or ESA PLATO) will perform an in-depth analysis of large fields of the sky-sphere searching for extraterrestrial planets around bright stars that are similar to the Sun. In order to achieve their goals, the space missions need a full characterisation of observational objects. However, large spectroscopic surveys that have the greatest input in studying properties of Solar environment and far beyond, usually exclude brightest nearby stars. Thus here we present results of our observations and data analysis. Majority (83 %) of investigated stars are in the TESS object lists and all of them are in the preliminary PLATO fields.

2. Observations and method of analysis

Spectra of programme stars were observed with the Vilnius University Echelle Spectrograph (VUES) designed and constructed at the Exoplanet Laboratory of the Yale University (Jurgenson *et al.* 2016) and mounted on the f/12 1.65 meter Ritchey-Chretien

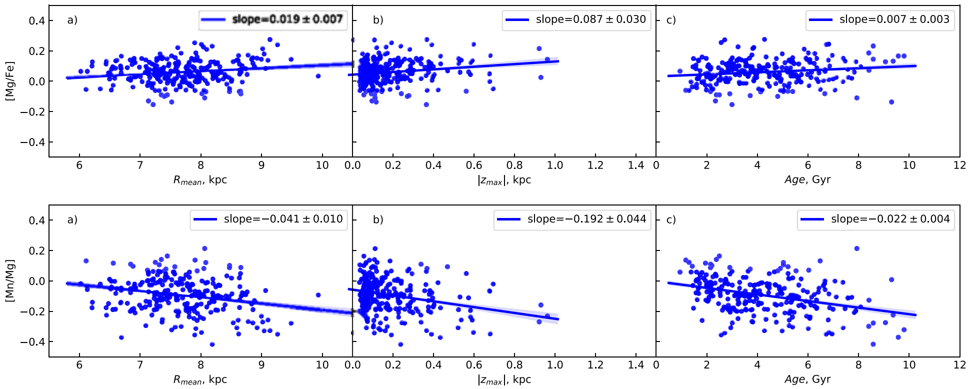

Figure 1. [Mg/Fe] and [Mn/Mg] ratios as a function of [Fe/H], R_{mean}, and $|Z_{max}|$.

telescope at the Molėtai Astronomical Observatory of the Institute of Theoretical Physics and Astronomy, Vilnius University. For observations we used a resolving power $R \approx 60\,000$ and the wavelength range from 4000 to 8800 Å. During our observations in 2016–2017, we obtained spectra of 405 FGK dwarf stars. After the primary spectral revision and identification of spectroscopic double-line binaries and fast-rotating stars, the further analysis was performed for 261 stars. We analysed the spectra using a differential model atmosphere technique. For more information about observations and determination of stellar atmospheric, kinematic, and orbital parameters see Mikolaitis *et al.* (2018). Abundances of NaI, MgI, AlI, SiI, SiII, SI, KI, CaI, CaII, ScI, ScII, TiI, TiII, VI, CrI, CrII, MnI, FeI, FeII, CoI, NiI, CuI, ZnI were determined as described by Mikolaitis *et al.* (2017).

3. Results

The elemental abundance trends (e.g. Figure 1) in our sample of stars resemble the typical α- or iron-peak-element behaviour (e.g. Adibekyan *et al.* 2012 or Bensby, Feltzing, & Oey 2014). From the kinematical point of view, almost all our stars belong to the thin disk substructure of the Milky Way. The derived galactocentric metallicity gradient is -0.062 ± 0.017 dex kpc^{-1} (2.5 σ significance), the vertical metallicity gradient is -0.179 ± 0.064 dex kpc^{-1} (3 σ significance), the age-metallicity gradient is -0.025 ± 0.007 dex kpc^{-1}. Gradients comply with the latest inside-out thin disk formation models, including those with stellar migration taken into account (e.g. Toyouchi & Chiba 2014; Minchev, Chiappini, & Martig 2013, 2014).

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