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Carbon and oxygen abundances in dwarf stars of the Solar neighbourhood

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Abstract. Stars and planets form from the same material, thus some of their properties are expected to be inter-connected. In order to characterise exoplanets, we need to investigate the planet-hosting stars. Carbon and oxygen are quite abundant and play an important role in stellar interiors by generating energy in thermonuclear reactions. Abundances of C and O may influence water availability on exoplanets. The C/O ratio also controls an amount of carbides and silicates that can be formed. Thus, we are performing a uniform study of C/O ratios in bright stars ($V < 8$ mag) located towards the northern ecliptic pole which will be targeted by the TESS and JWST space missions. The first results for a sample of 140 stars analysed are presented.

Keywords. stars: abundances

1. Introduction

Numerous studies have been performed during last years in order to determine a chemical composition of extrasolar planets (see review by Madhusudhan 2018). Since planets and their host stars are formed within the same environment their composition is expected to be interconnected (Suárez-Andrés *et al.* 2017 and references therein). Elemental ratios in stellar atmospheres are important because they govern a distribution and formation of chemical species in the protoplanetary disc. Mg/Si governs a distribution of silicates while an amount of carbides and silicates formed in planets is controlled by the C/O ratio (Thiabaud *et al.* 2015). Information of carbon and oxygen abundances serve for testing and improving planetary formation models, as C/O ratio is one of the key parameters to define structures of planets.

2. Observations and method of analysis

Spectra of programme stars were taken 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 telescope at the Molėtai Astronomical Observatory of the Institute of Theoretical Physics and Astronomy, Vilnius University. A resolving power of this spectrograph is $R \approx 60\,000$ and the wavelength range is from 4000 to 8800 Å. For more information about observations see Mikolaitis *et al.* (2018).

During our observations in 2016–2017, we obtained 365 spectra of 213 FGK spectral type dwarf stars. After the primary spectral revision and identification of spectroscopic double-line binaries and fast-rotating stars, the further analysis was performed for 140 stars, for 47 of which we determined C/O ratios. Unfortunately, a large fraction of spectra were suspended from further investigation due to weakness or telluric contamination of oxygen lines.

We analysed the spectra using a differential model atmosphere technique described in Mikolaitis *et al.* (2018). Stellar atmospheric parameters were determined using traditional equivalent width (EW) based methods. EWs were measured using the DAOSPEC (Stetson & Pancino 2008) software. Stellar atmospheric parameters were computed using the 10th version of the MOOG code (Sneden 1973) using a grid of MARCS stellar atmosphere models (Gustafsson *et al.* 2008).

A spectral synthesis method was used to derive carbon and oxygen abundances. We used the forbidden line at 6300.3 Å for the O abundance determination. Two C_2 molecular bands at 5135 Å and 5635 Å were used to determine C abundances. All calculations were differential with respect to the Sun. Solar elemental abundances were taken from Grevesse *et al.* (2007). The Vienna Atomic Line Data Base (VALD, Piskunov *et al.* 1995) was used for preparation of input data. Abundances of C and O, we investigated in unison, since they are bound together by the molecular equilibrium.

3. Results

The median C/O ratio of our sample is 0.44 ± 0.04(r.m.s.). The Solar value, which we derived from spectra obtained with the same VUES spectrograph, in our study is 0.54. Thus, the distribution of C/O ratios are slightly shifted to lower values compared to Solar. Only four stars (HD 133002, HD 96511, HD 110010, and HD 135143) have C/O ratios higher than 0.65 which are necessary to form carbon rich rocky planets (Moriarty *et al.* 2014).

We investigated C/O ratios as a function of age, effective temperature and metallicity. There are no indications of C/O trends as a function of age and $T_{\rm eff}$, however C/O values slightly increase with metallicity, which is in agreement with other studies (e.g. Suárez-Andrés *et al.* 2018; Brewer & Fischer 2016).

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