The *Kepler* Field of View Covered with the LAMOST Spectroscopic Observations – Application of the ROTFIT pipeline to the LAMOST Spectra

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For 51,385 stars in the field of view of the *Kepler* space telescope, we provide a homogeneous determination of the atmospheric parameters ($T_{\rm eff}$, $\log g$, and [Fe/H]) and the radial velocities (RV). The projected rotational velocities ($v \sin i$) have been measured for the rapid rotators ($v \sin i > 120\,{\rm km\,s^{-1}}$). For the cool stars ($T_{\rm eff} < 6000\,{\rm K}$), the H$\alpha$ and Ca II infrared triplet (IRT) fluxes have been computed. Those parameters have been obtained from the spectroscopic observations acquired with the LAMOST instrument in the observing seasons 2011-2014. Our analysis was carried out with a purposely developed version of the code ROTFIT. The typical accuracy of our determinations is 10–15 ${\rm km\,s^{-1}}$ in RV, 3.5% in $T_{\rm eff}$, 0.3 dex in $\log g$, and 0.2 dex in [Fe/H]. All the spectra have been searched for peculiarities.

1 Observations

The spectroscopic observations which we used to derive $T_{\rm eff}$, $\log g$, [Fe/H], RV, $v \sin i$ and the Hα and Ca II infrared triplet (IRT) fluxes at 854.2 nm were obtained with the LAMOST instrument that combines an aperture of 3.6-4.9 m with a 5° field of view and houses 4000 optical fibers connected to 16 multi-object optical spectrometers (Wang et al., 1996; Xing et al., 1998). The LAMOST spectra are of low resolution, $R \leq 1800$ with the slit width at 2/3 of the fiber size. The data were acquired in the framework of the LAMOST–*Kepler* project described in detail by De Cat et al. (2015). We collected a total of 101,086 spectra during 38 nights between 30 May 2011 and 29 September 2014. The reduction and calibration of those data were done with the LAMOST pipeline (Luo et al., 2012, 2015).

2 Atmospheric parameters, $v \sin i$, and RV

We derived the atmospheric parameters and the radial velocities for 61,753 spectra which correspond to 51,385 unique targets. That comprehensive and homogeneous determination of stellar parameters of stars in the *Kepler* field of view can be used for statistical studies of the properties of those stars or for individual studies of the selected targets. 30,213 of those stars were observed by the *Kepler* space telescope. The other stars which we observed with LAMOST were used to fill the spectrograph fibres.

For 8832 stars, more than one LAMOST spectrum was acquired and an independent set of the atmospheric parameters and *RV* has been provided for each. The projected rotational velocities have been derived for 3540 stars with $v \sin i > 120\,\mathrm{km\,s^{-1}}$. In our analysis, described in detail by Molenda-Żakowicz et al. (2013), we used the ROTFIT code (Frasca et al., 2003, 2006) that has been modified for the use of the LAMOST spectra (see Frasca et al. submitted to A&A), and a set of 1150 low-resolution reference spectra from the Indo-US Library of Coudé Feed Stellar Spectra (Valdes et al., 2004; Wu et al., 2011).

Since we were looking for stars that are chromospherically active, for stars that are cooler than 6000 K, we calculated the H α and Ca II-IRT fluxes, which are can be used as proxies of chromospheric activity.

A comparison of our determinations of *RV* and the literature values obtained from the high-resolution spectra shows an offset of $+5\,\mathrm{kms^{-1}}$, which is likely not significant, and the rms scatter of $14\,\mathrm{km\,s^{-1}}$ between ours and literature determinations of *RV*. The offset and the rms scatter in $T_{\rm eff}$, in the temperature range of 3000-7000 K, are equal to +30 K and 150 K, respectively. The compared values of $\log g$ display a relatively larger scatter which amounts to about 0.30 dex. Moreover, our values of $\log g$ cluster around 2.5 and 4–4.5 dex which are typical for the K-type stars in the red giant branch and the main-sequence stars, respectively. The [Fe/H] values derived by us are only in good agreement with the literature values between -0.3 and +0.2 dex, i.e., around the solar metallicity. For stars with [Fe/H] lower than -0.3 or higher than +0.2 dex, our determinations are systematically over- or underestimated, respectively.

3 Chromospherically active stars

By examining the Balmer Hα line of our targets, we selected 577 spectra of 547 stars which display an emission in that line or filling in. In the catalog by Frasca et al. (submitted to A&A) we provide information whether the line is observed as a pure emission feature and we flag those determinations which are uncertain because of, e.g., a low signal-to-noise ratio of the spectra. For those 547 stars, we investigated also the behavior of the Ca II-IRT lines by subtracting the spectrum of a non-active template, keeping in mind that for late-type stars, the emission which can be seen in the cores of the Ca II lines, originates from the chromosphere. As a result, we selected 442 stars in which we detect the emission features and which we classify as chromospherically active stars (see table A4 in Frasca et al., submitted to A&A). One of those stars is a likely accreting object. In some cases we detected the forbidden lines of [N II] at 6548 and 6584 Å which can be a result of nebular emission that has not been fully removed during the sky subtraction procedure.

4 Summary

We show that the LAMOST spectra can be successfully used to derive the atmospheric parameters and the radial velocities of stars of all spectral types and classes, and that the projected rotational velocities can be determined for stars with $v \sin i > 120\,\mathrm{km\,s^{-1}}$. We find also that the LAMOST spectra can be used to detect stars variable in *RV*, if the variations of the amplitude of *RV* are large

($\Delta RV > 50\,\mathrm{km\,s^{-1}}$ when $\sigma_{RV} \leq 20\,\mathrm{km\,s^{-1}}$), stars with emission lines and stars which show indications of the chromospheric activity in spectra.

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