Spectroscopic characterisation of CARMENES target candidates from FEROS, CAFE and HRS high-resolution spectra

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Abstract. CARMENES, a new high-resolution spectrograph at Calar Alto Observatory, started its observing mission to search for planets in the habitable zones of M dwarfs on January 1st 2016. High-resolution spectra from CAFE (2.2 m Calar Alto), FEROS (2.2 m La Silla) and HRS (10 m Hobby-Eberly) have been obtained to characterize the candidate sample. We developed an algorithm using PHOENIX-ACES model spectra and χ^2-minimization to determine effective temperature (T_{eff}), surface gravity (log *g*) and metallicity ([Fe/H]). We show the final results from the CAFE, FEROS and HRS and first results from four months of CARMENES data.

Introduction. We determine stellar parameters of the CARMENES M-dwarf sample using high-resolution spectra taken with CAFE, FEROS and HRS. This will help to characterize planets that might be found orbiting those stars. M-dwarf spectra are very complex due to molecular lines, which makes a full spectral synthesis necassary.

Method. We fit PHOENIX-ACES model spectra [1] to our observed spectra. This latest PHOENIX model grid especially account for the formation of molecules in M dwarfs. A downhill simplex uses linear interpolation between the model grid points and a χ^2-minimization determines the best fit to the data. Fig. 1 shows an example fit to CARMENES data.

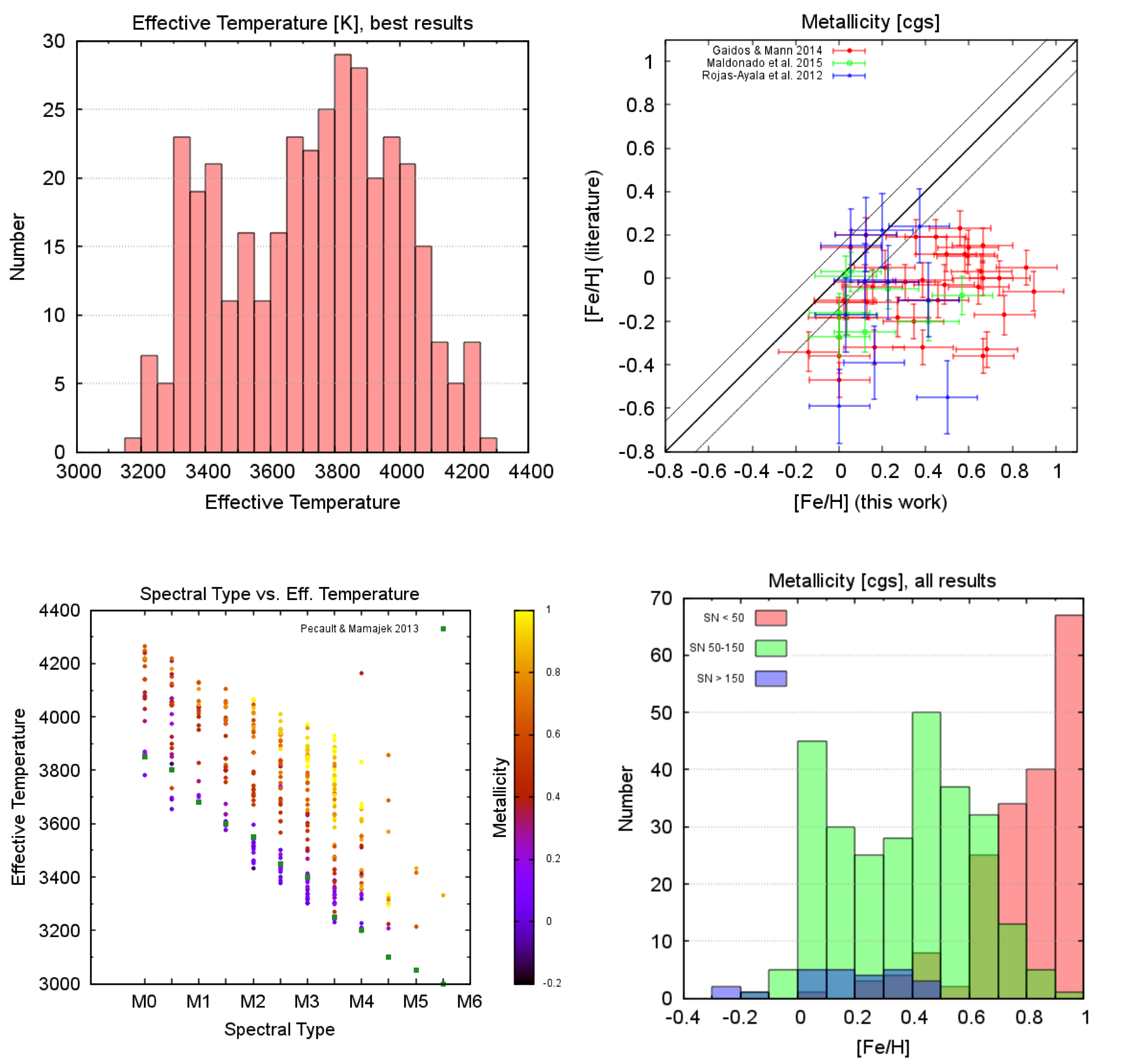

Fig. 2: Temperature distribution of candidate sample (upper left), literature comparison for metallicity (upper right), spectral type-temperature relation (lower left, green dots: literature values for solar metallicity found by Pecault & Mamajek [7]), metallicity distribution for stars observed with FEROS, CAFE and HRS for different SNRs (lower right).

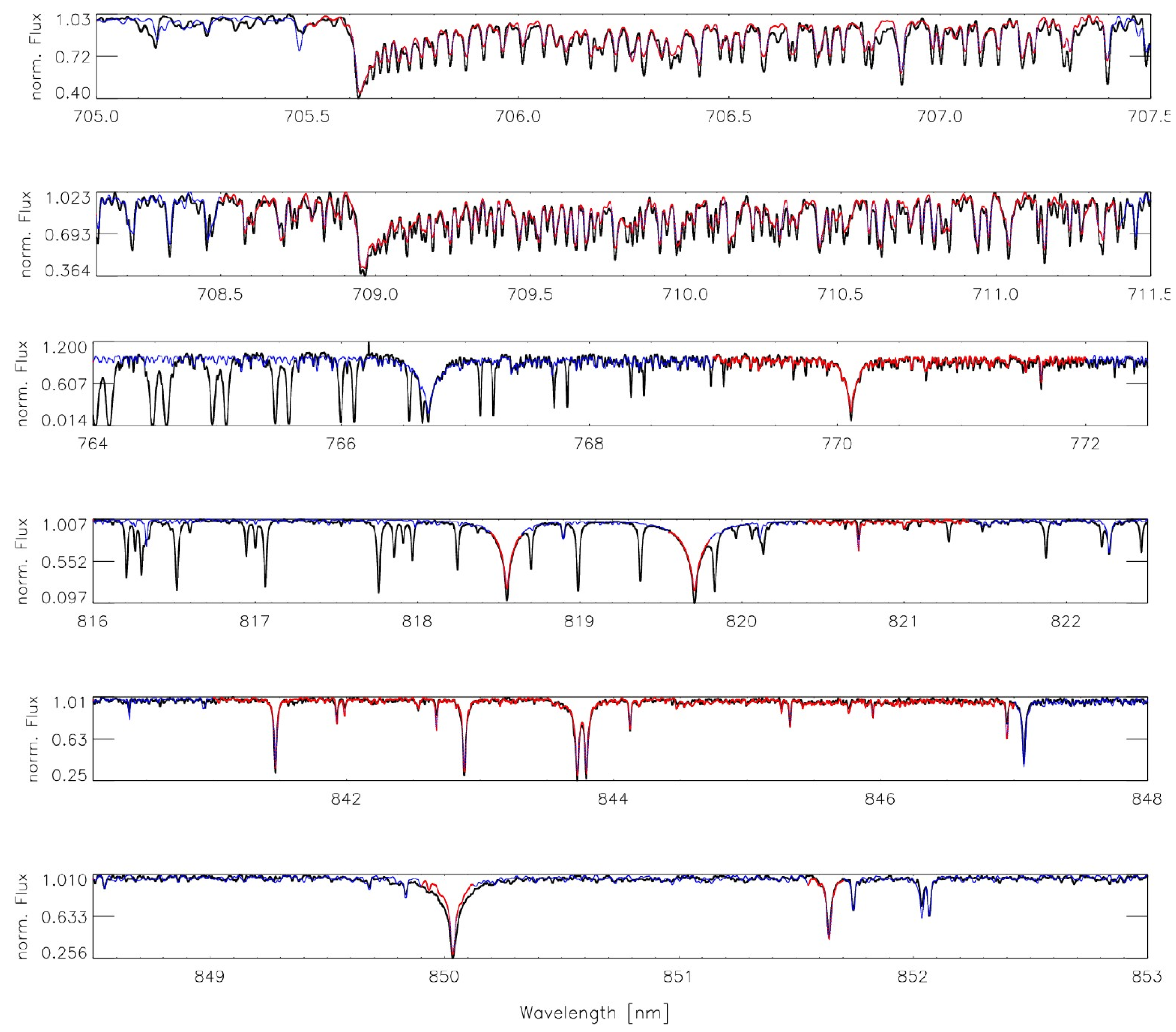

Fig. 1: Spectrum of BD+44 2051 (M1.5V, black) and the best fit model (blue: model outside fit region, red: model inside fit regions for χ^2-minimization).

Results. We obtained stellar parameters for 351 stars (977 spectra). The main conclusions (as shown in Fig. 2) are:

- Most stars lie within **3200-3900 K** (≙ M1V-M5V). (*upper left*)
- **The higher the metallicity the higher the temperature** for each spectral type. This is consistent with results by Mann et al. [3]. The spectral types have been calculated using spectral indices [2]. (*lower left*)
- A literature comparison ([4],[5],[6]) shows that our values for **metallicity turn out to be higher** than published ones. (*upper right*)
- PHOENIX-ACES models still **cannot reproduce the full depths** of some lines (see Fig. 1, 4th range), which might cause the algorithm to choose higher metallicity models to fit the lines.
- The **signal-to-noise ratio** also seems to be **very important** for parameter determination. We find good agreement with expected [Fe/H] values for SNR > 50-100. (*lower right*)
- For the first four months of **CARMENES data** we find that the parameters show better agreement with literature, having better SNRs.

References. [1] Husser et al. 2013, A&A, 553, A6. [2] Patrick Schöfer, "High-resolution spectroscopy of CARMENES objects", Msc thesis 2015, Georg-August Universität Göttingen. [3] Mann et al. 2015, ApJ, 804, 64. [4] Gaidos & Mann 2014, ApJ, 791, 54. [5] Maldonado et al. 2015, A&A, 577, A132. [6] Rojas-Ayala et al. 2012, ApJ, 748, 93. [7] Pecault & Mamajek 2013, ApJS, 208, 9.

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