KELT-17: a chemically peculiar Am star and a hot-Jupiter planet

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Abstract. There is very little information to be found in the literature regarding the detection of planets orbiting chemically peculiar stars. We carried out a detailed abundance determination in the planet host star KELT-17 via spectral synthesis. Also, we estimated the stellar radius using two methods: a) comparing the synthetic spectral energy distribution with the available photometric data and the Gaia parallax, and b) using a Bayesian estimation of stellar parameters using stellar isochrones. We found over-abundances of Ti, Cr, Mn, Fe, Ni, Zn, Sr, Y, Zr, and Ba, together with subsolar values of Ca and Sc. Notably, the chemical pattern agrees with those recently published for Am stars, making KELT-17 the first exoplanet host whose complete chemical pattern is unambiguously identified with this class. The stellar radius derived by two different methods agrees to each other and with those previously obtained in the literature.

1. Context

Am stars present over-abundances of most heavy elements in their spectra, particularly Fe and Ni, together with under-abundances of Ca and Sc (e.g. Catanzaro et al. 2019). Chemically peculiar Am stars rotate more slowly than average A-type stars

The detection of planets orbiting early-type stars in general is more difficult than in late-type stars, due, for example, to the rotational broadening and lower number of spectral lines. Just in the last few years, the detection of planets orbiting A-type stars is slowly growing (e.g. Zhou et al. 2016, Nielsen et al. 2019). Recently, Zhou et al. (2016) announced the detection of a transiting hot-Jupiter planet orbiting the early-type star KELT-17. We currently have an ongoing program aiming to study [Fe/H] in early-type stars with and without planets. The star KELT-17 is included in our sample, and a preliminary inspection of the spectra led us to suspect peculiar abundances.

Then, the exciting possibility of finding a planetary host with an abnormal composition motivated us to perform a detailed chemical analysis on this remarkable star. This object would be the second Am star with planets detected to date, and the first one whose individual abundances are derived and compared to an Am pattern in detail.

2. Methods

The spectroscopic observations of KELT-17 were acquired at Complejo Astrónomico El Leoncito (CASLEO) between April 3 and 4, 2019. We used the Jorge Sahade 2.15 m telescope equipped with a REOSC echelle spectrograph, selecting, as a cross disperser, a grating with 400 lines/mm.

The stellar parameters Teff and log g were estimated iteratively. We fit the observed Hα and Hβ line profiles with synthetic spectra calculated with SYNTHE. Figure 1 shows a comparison of observed (black) and synthetic (blue) spectra near the Hβ line.

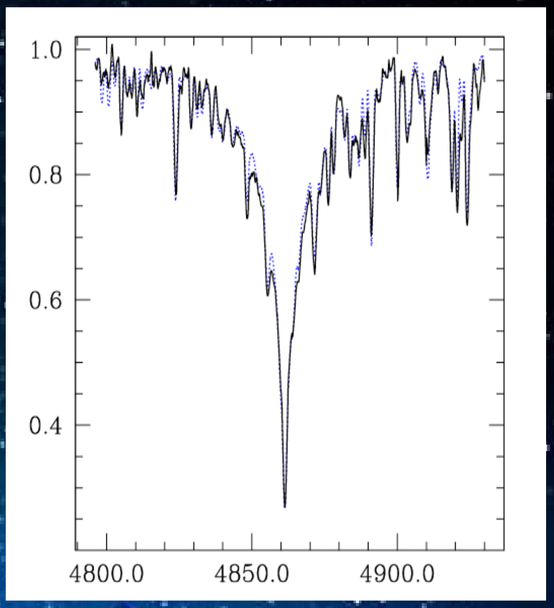

Figure 1. Observed (black) and synthetic (blue) spectra near the Hβ line, for the star KELT-17.

The ionization equilibrium was used to refine the log g value. Projected rotational velocity v sin i was first estimated by fitting the observed line Mg II 4481.23, and then refined using the most metallic lines in the spectra. Abundances were determined iteratively by fitting different metallic lines using the program SYNTHE.

3. Results

Table 1 shows the resulting stellar parameters. They agree well within the errors with those derived by Zhou et al. (2016).

Figures 2, 3 and 4 present synthetic (red), observed (black) and Solar composition spectra (blue) for the star KELT-17.

Metallic species such as Fe, Cr and Y are clearly overabundant compared to the solar values (Fig. 2).

Also, subsolar values of Ca and Sc are detected (Fig. 3 and 4, respectively).

These characteristics agree with those of Am stars.

Table 1. Stellar parameters derived in this work for the star KELT-17.

$T_{\rm eff}$ (K)	$\log g$ (dex)	$v_{\rm micro}$ (km s^{-1})	$v \sin i$ (km s^{-1})
7471 ± 210	4.20 ± 0.14	2.50 ± 0.50	43.0 ± 2.4

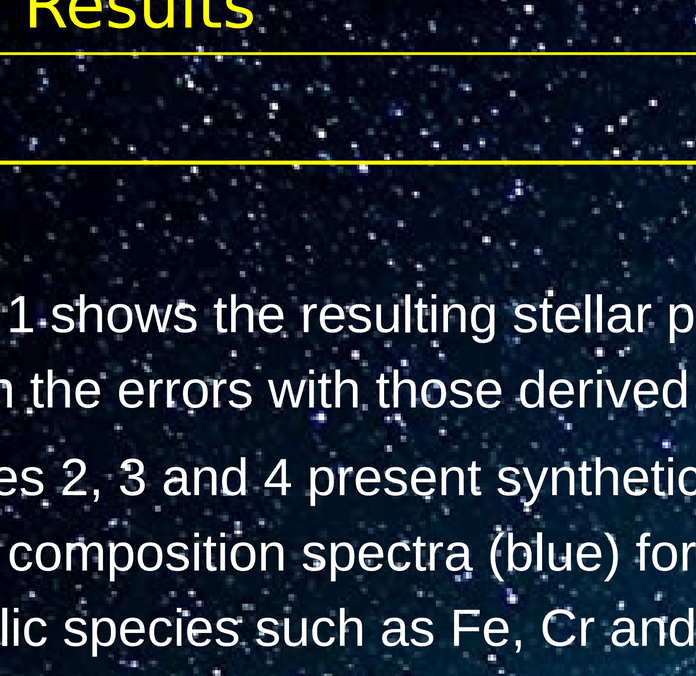

Figure2

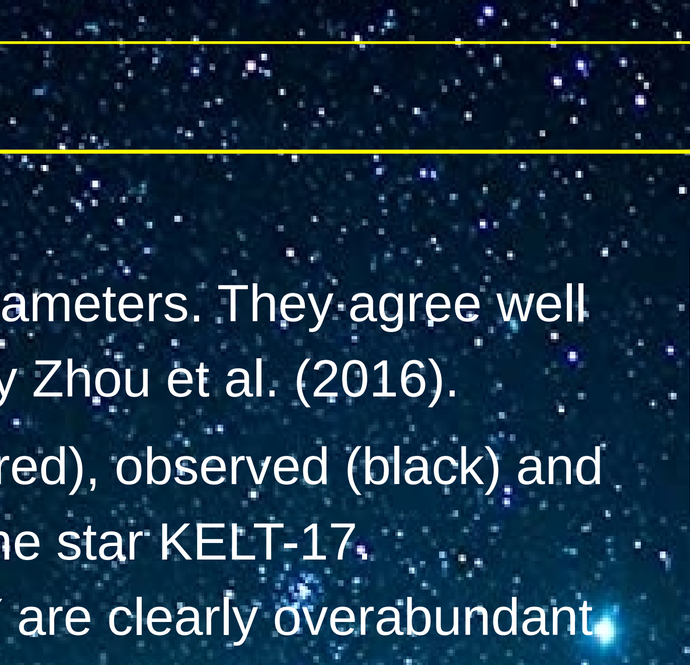

Figure 3

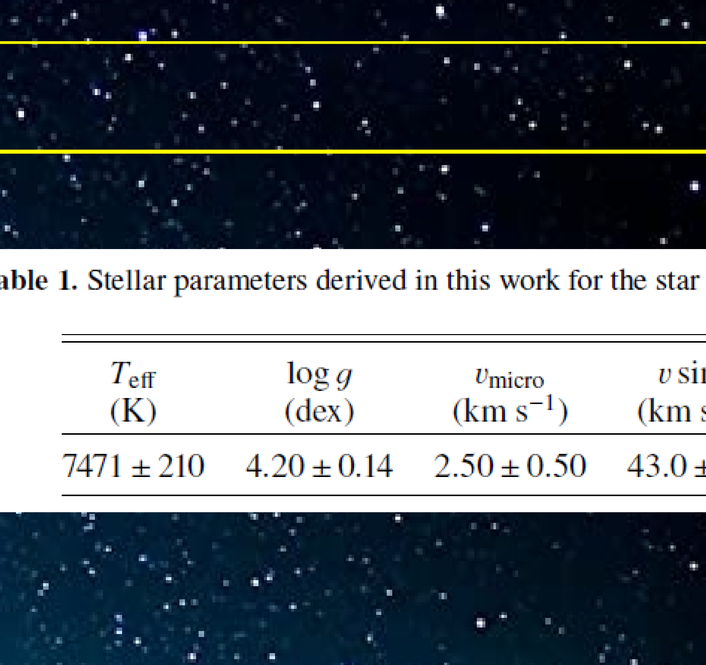

Figure 4

3. Results

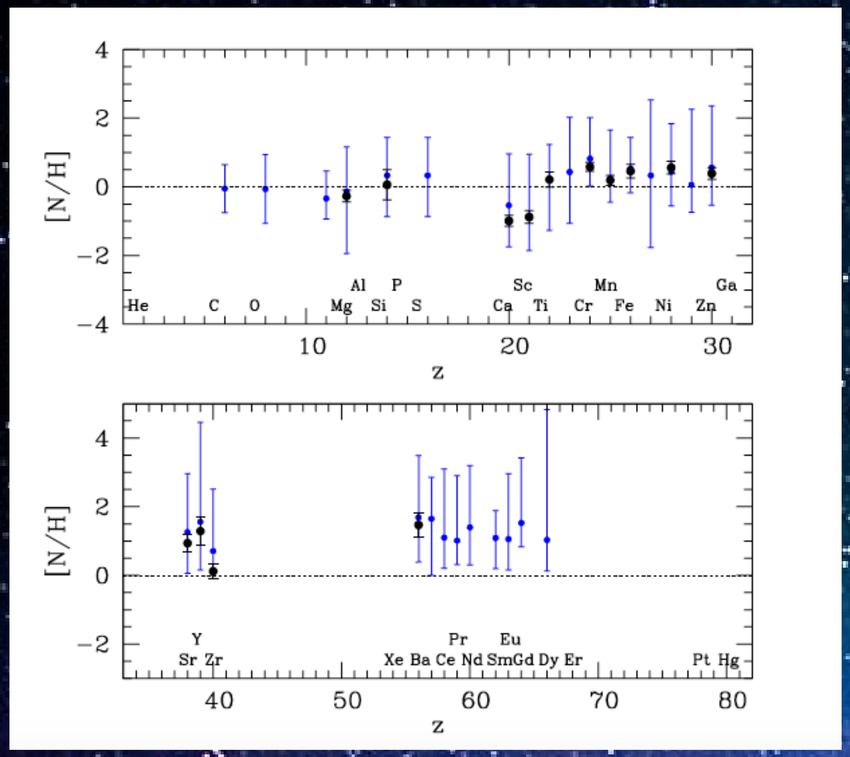

Figure 5

Figure 5 shows the chemical pattern as the abundance versus atomic number for the different chemical species. For the abundance pattern of Am stars (blue in Fig. 5), we used the average values recently derived by Catanzaro et al. (2019) from a sample of 62 Am stars, where vertical bars correspond to their maximum and minimum values. The abundance values derived for the star KELT-17 are shown in black, agrees in general with those of Am stars.

Figure 6 presents the Spectral Energy Distribution modeled with ATLAS12 together with the available photometry in different bands. Reddening was derived by using the extinction maps of Schlegel et al. (1998). The stellar radii estimated was 1.697+/-0.063 Ro, in agreement with those previously determined by Zhou et al. (2016).

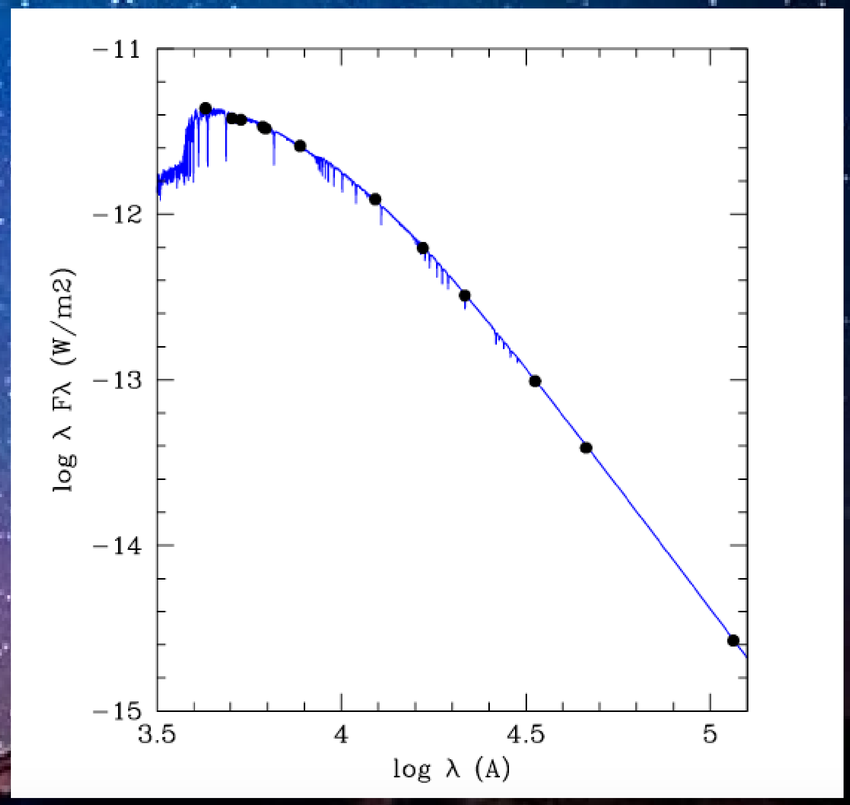

Figure 6

4. Conclusions

We performed a chemical analysis of the exoplanet host star KELT-17 and found over-abundances of Ti, Cr, Mn, Fe, Ni, Zn, Sr, Y, Zr, and Ba, together with subsolar values of Ca and Sc. The chemical pattern agrees with those recently published concerning Am stars, with KELT-17 being the first exoplanet host whose complete chemical pattern is unambiguously identified with this class. We also derived the stellar radius using two different methods: obtaining good agreement between them and with those previously derived in the literature. Therefore, the classification of KELT-17 as an Am star has no significant impact on the corresponding planet parameters.

References

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