CHARACTERIZING THE STELLAR-SUBSTELLAR LIMIT: A STEP TOWARDS A BETTER UNDERSTANDING OF THE ULTRA-COOL DWARFS REVEALED BY GAIA

A. Ficot[1], C. Reylé[1], N. Lagarde[1], R. L. Smart[2] and A. J. Burgasser[3]

Abstract. Ultra-cool dwarfs (spectral type later than M7) serve as a link between stars and brown dwarfs which have not a sufficient mass to support the combustion of hydrogen. Although they are numerous in the Galaxy, they remain elusive due to their low luminosity and the modelling is still a chalenge. In this work we characterized 120 ultra-cool dwarfs revealed by *Gaia* for which spectroscopic monitoring have been obtained using various instruments of medium spectral resolution. Our results illustrate the impact of physics considered in atmospheric models on the characterization of these objects.

Keywords: stars: low-mass, ultra-cool dwarfs, brown dwarfs, spectroscopy

1 Analysis method

Thanks to its photometric and astrometric accuracy, the *Gaia* satellite (Gaia Collaboration et al. 2016) has revealed several tens of thousands of ultra-cool dwarfs (Reylé 2018; Smart et al. 2020; Scholz 2020). The spectroscopic follow-up has started for the closest ones. In order to confirm their spectral type and derive their effective temperature, we have compared our observed spectra with standard and synthetic spectra using the SpeX Prism Library Analysis Toolkit (*SPLAT,* Burgasser & Splat Development Team 2017).

The best fit is shown for four of our targets in Fig. 1 on the left panel. Spectral types are obtained from the best fit with a library of standard spectra (in blue). Effective temperature are obtained from the best fit with a grid of atmopshere models (in orange). For that, we have used five different grids computed from the recent atmosphere model *Bt-Settl* (Allard 2014) and *Drift* (Witte et al. 2011). They considere different physics: taking in count or not the results of radiation hydrodynamic simulations on the mixing length and considering different solar abundances (Asplund et al. 2009; Caffau et al. 2011; Grevesse et al. 1992).

2 Results

The spectral types we have obtained confirm the nature of our sample (excepted for a few low signal-to-noise spectra or bad pointing to a brighter, close star). The derived effective temperatures from the most recent *Bt-Settl* grid (Baraffe et al. 2015) are shown as a function of spectral type in Fig. 1 on the right panel (orange). Our work completes results of previous other studies (Schweitzer et al. 2003; Testi 2009; Rajpurohit et al. 2013; Pecaut & Mamajek 2013; López-Valdivia et al. 2019) (in gray on Fig. 1 on the right panel) to build the calibration relation $T_{\rm eff}$ vs spectral type.

As mentionned above, we also derive effective temperatures assuming different grids of synthetic spectra. Depending on the solar abundances assumed in the models, the variation of temperature can go up to 1000 K. If we now compare the models with different physics but same solar abondance, the variation is a little lower but can still go up to 600 K. These descrepancies are most important for the spectral type range M9 to L2, where the beginning of dust sedimentation in the atmosphere occurs and is a complex physic to model.

[1] Institut UTINAM CNRS UMR6213, Université Bourgogne Franche-Comté, OSU THETA Franche-Comté Bourgogne, Observatoire de Besançon, BP1615, 25010 Besançon Cedex, France
[2] INAF - Osservatorio Astrofisico di Torino, via Osservatorio 20, 10025 Pino Torinese (TO), Italy
[3] Center for Astrophysics and Space Science, University of California San Diego, La Jolla, CA 92093, USA

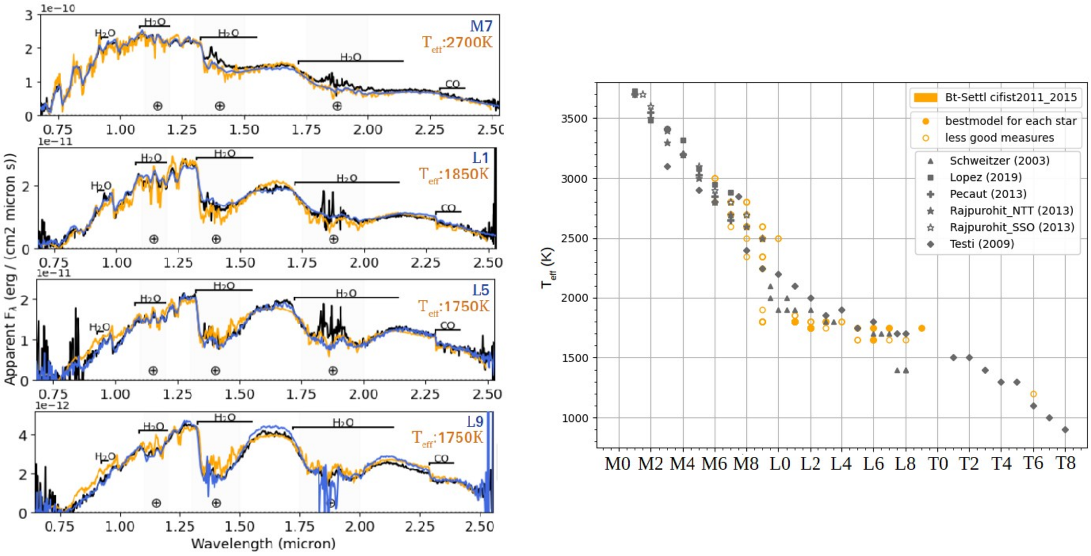

Fig. 1. Left: Comparison of four observed spectra (black) with the best fit by a standard spectral type (blue) and synthetic spectrum *BT-Settl*/cifist2011_2015 (Baraffe et al. 2015) (orange). **Right:** Effective temperature as a function of spectral type for our sample (orange) and previous other studies (gray). Markers are filled when this model shown here has the best χ^2.

3 Conclusions

This work is a first step towards a systematic analysis of a large numbers of brown dwarfs revealed by the Gaia satellite and will allow a better understanding of these stars that are difficult to characterize, the determination of stellar parameters being very sensitive to models atmosphere used. A better understanding of these objects is essential in the framework of future space missions, such as EUCLID which will detect more than hundreds of thousands of brown dwarfs, to the coldest and in the different populations of the Galaxy.

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