The stellar/substellar frontier as seen by LAMOST

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ABSTRACT

Brown dwarfs are low mass objects that are unable to sustain stable hydrogen burning. As a consequence, they do not reach the main sequence, continuing cooling down with time and evolving through the MLTY spectral sequence (Kirkpatrick 2005, ARA&A, 43, 195). Since the variation in the radius of field brown dwarfs ($\gtrsim$1 Gyr) is negligible, their surface gravity ($g=GM/R^2$) is determined by the mass. When these sources are at young evolutionary stages, they have both larger radii (since they are still contracting to its final radius) and lower masses than their same spectral type counterparts in the field (Burrows et al. 2001, Rev. Mod. Phys., 73, 719). As a result, young objects exhibit lower surface gravities. One strategy to distinguish between young and old field brown dwarfs is by inspecting spectral gravity-sensitive features. The optical spectra of the former would exhibit weaker lines of K I, Na I, Rb I, and Cs I, weaker bands of CaH, and stronger bands of TiO and VO than field dwarfs of the same spectral class (McGovern et al. 2004, ApJ, 600, 1020).

An additional gravity sensitive feature is the Li I (6708 Å) absorption line. However, given its volatile nature and the fully convective structure of late type objects, Li I measurements provide an astronomical clock for low mass clustered young stars via lithium depletion boundary (LDB). This is a highly robust method that can critically test other age estimates as the main sequence turn–off approach. Typically it is applied to stellar members of mid- to late-M spectral types in young clusters (Cargile et al. 2010, 725, 2). Recently, Juarez et al. (2014, ApJ, 795, 143) have shown the need to reinvestigate previous LBD age determinations due to the relevance of magnetic activity in low mass young stars.

Here we propose to use LAMOST spectroscopy to dig deeper in our current knowledge of the low mass stellar and substellar population in young environments. Our project has twofold aims: (1) to search and characterize massively the different spectral gravity–sensitive features that can be detected at optical wavelengths in young brown dwarfs. (2) to apply the LDB method in different young environments using spectra of faint, low–mass young stars that have not depleted their content of lithium yet in nearby regions. Taking into account the sensitivity limits and resolution of LAMOST, we estimate that we will be able to explore the gravity sensitive features of the late M- and early L-type population of young ($\lesssim$100 Myr) nearby regions. For doing so, we plan to generate a set of tested gravity sensitive features from known young brown dwarfs and reimplement the search presented by Zhong et al. (2015, AJ, submitted) for M-type field stars. We will translate it to a search for younger (i.e. brighter) sources in nearby environments. With this project, it will not only be possible the discovery of new young brown dwarfs, but also to establish if there is a unique set of parameters that can be tested in young candidates in order to confirm their low gravity atmospheres. Our approach will mine the LAMOST database with state-of-the-art machine learning techniques (in collaboration with M.Araya-López at UFSM) to ample our knowledge of the physical characteristics of the stellar/substellar boundary.

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