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Lithium abundances in dwarfs of intermediate age open clusters

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Abstract. Lithium abundance measurements in dwarf stars in open clusters are of crucial importance for our understanding of the mixing mechanism and have allowed us to achieve important conclusions on the matter. However, in order to further our understanding of what drives lithium depletion, lithium abundance measurements have to be coupled with accurate temperature determinations, which are best achieved when the analysis of iron lines is employed. Effective temperature estimations from photometry, on the contrary, can be affected by errors as large as several hundred kelvins due to uncertain open cluster reddening, especially when studying old open clusters, which tend to be more distant. We present lithium abundance in 12 dwarfs belonging to 4 open clusters at about 1 or 2 Gyr. The stellar effective temperatures, along with the other parameters, were estimated from the analysis of about 60 Fe I lines and 10 Fe II. Even though the few datapoints call for caution, we notice that stars in the open cluster IC 4651 seem to present a steep decline with temperature below 6000 K.

Keywords. Galaxy: open clusters – stars: low-mass, abundances

1. Data sample and analysis

The sample consists of 12 dwarf stars in the following 4 open clusters whose ages, as found by Salaris *et al.* (2004), are indicated in the legend of Figure 1. The spectra were taken with UVES @ VLT, they have a resolution of about R≈ 100 000 and S/N of about 100 in the range between 4800 and 6800 Å.

Stellar parameters, namely temperature, gravity, metallicity, and microturbulence, were obtained (Pace *et al.* 2008, 2010) with the classical equivalent width analysis of the iron lines (about 60 for Fe I and about 10 for Fe II). Apart of the precision achievable, especially when, as in our case, spectra with high resolution and good S/N are available, this method has the great advantage of being independent of the cluster reddening.

We find differences of several hundred Kelvin between the temperatures as evaluated from the spectroscopic analysis and the temperatures evaluated by means of photometry and published calibration. Most of this difference is probably due to the error in the reddening of the cluster and in the zero point errors in the calibration of the photometry.

Lithium abundances were measured by comparing the observed spectrum of the lithium doublet at 6707.8 Å with the synthetic one, and changing the assumed abundance until a match between the two was obtained. The typical errors are between 0.05 and 0.15 dex. Using the same procedure, we also compared the synthetic spectrum of the Sun with the UVES-archive solar spectrum, and we obtained the best match by assuming $A(Li) = 1$ rather than the canonical $A(Li) = 1.1$.

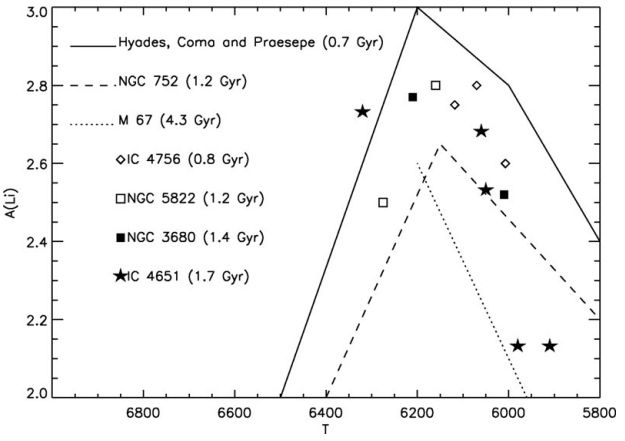

Figure 1. Our data on dwarfs in intermediate age open clusters compared with literature data about young open clusters and NGC 752 (also about 1 Gyr old) and the much older M 67.

2. Results and conclusions

In the Figure we show a temperature versus lithium abundance diagram, in which we compare the 12 data points from the present analysis with published open cluster data at 3 different ages. Hyades, Coma, and Praesepe data are depicted in one single curve, another represents NGC 752 and the third M 67. M 67 data are taken from Pasquini *et al.* (2008), the remainder from the compilation in Xiong & Deng (2009). The curves that represent the published cluster data at the 3 different ages, are fits by eye to the datapoints. The temperatures for the Hyades age clusters and NGC 752 are derived from photometry. For the former the uncertainty in the colour excess should not play a major role, since they are nearby clusters. The curve representing the clusters at the Hyades age form an upper envelope to the distribution of the other datapoints. The curve representing M 67 and, for temperatures higher than 6000 K, that of NGC 752, form, instead, a possible lower envelope. Only one datapoint falls slightly outside the region defined by the two envelopes. Even though the few datapoints call for caution, we notice that IC 4651 seems to present a steep decline below 6000K.

When studying the dependence of lithium abundances as a function of temperatures in stars in open clusters , the use of temperature measurements by spectroscopic analysis is essential to avoid errors due to uncertain reddening.

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