Light Elements in the Universe
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Lithium abundances in the α Persei Cluster

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Abstract. As a sequel to the Li observations by Balachandran, Lambert & Stauffer (1988, 1996) in 35 stars of the 50 Myr old cluster α Persei, we have obtained and analyzed high resolution spectra of another 51 stars. Following a reconsideration of the cluster membership of the stars (Prosser 1992, Makarov 2006, Mermilliod *et al.* 2008, and Patience *et al.* 2002), we discuss the Li abundances for 70 stars. With our larger sample, we reexamine the question of whether the scatter in Li abundance at a given $T_{\rm eff}$ seen in young clusters at cool temperatures is real or not.

Keywords. Galaxy: open clusters – stars: abundances

1. Observations, abundances and their interpretation

High S/N echelle spectra were obtained for 30 stars at the 2.7m telescope at the McDonald Observatory at R = 60,000 and for 21 stars at the 4m telescope at KPNO at R = 40,000. The Li abundance as determined from the 6707.8 Å feature is singularly sensitive to the adopted $T_{\rm eff}$. For an error of ±200 K in $T_{\rm eff}$, the uncertainty in log N(Li) varies from 0.28 to 0.14 over the temperature range from 4500 K to 6500 K. We choose (V−K) colour index as our principal indicator of $T_{\rm eff}$. Our fresh estimates of reddening for stars with available Strongren photometry yield E(b−y) in the range of 0.02 to 0.12 with an average of 0.075 (± 0.05). We adopt this average that translates to E(V−K) = 0.284 and use the (V−K) - $T_{\rm eff}$ calibration of Alonso *et al.* (1986) to derive $T_{\rm eff}(V-K)$ for all the stars. A mean Fe abundance of 7.40 ± 0.08 dex was obtained for the 26 slowly rotating stars from a fine spectroscopic analysis; the standard error comparable to the estimate of the precision of a single determination. As is apparent from Fig.1, Li abundance in the hottest stars approaches a constant value (taken as the initial value for young open clusters), close to the meteoritic value of 3.25 ± 0.06, as also to the abundance derived of T Tauri stars suggesting it has changed little in the last 4.5 Gyrs.

1589, 1604, 56 and 93 (> 5300 K) and # 1612, 1735 (< 5300 K) are outliers that do not define the mean relation. This could possibly be either because their assigned $T_{\rm eff}$ is too low or they are non-members that have experienced normal Li depletion for their age or an unusual amount of Li depletion has occurred. At $T_{\rm eff}$ < 5300 K, Li vs. $T_{\rm eff}$ relation plunges steeply and develops a scatter in Li abundance; it widens into a band with a lower envelope defined by low *vsini* stars from Li of 2.1 at 5000 K to −0.4 at 4500 K and an upper envelope defined by high *vsini* stars from Li of 2.5 at 4700 K to 0.6 at 4300 K; width of the band at $T_{\rm eff}$ < 4700 K is ∼ 1.5 dex, as is observed in the Pleiades.

Pre-Main Sequence (PMS) depletion of Li is ineffective for the hotter stars of α Per. In cooler stars it is best mappable by looking at the youngest of clusters, for, stars in α Per have experienced PMS depletion that is essentially complete. A Li abundance

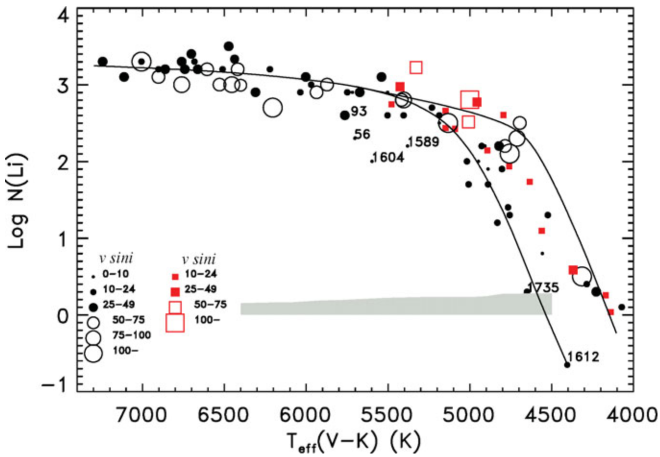

Figure 1. $T_{\rm eff}$ vs Li abundance for α Per with data (red squares) added from Randich *et al.* (1998). *vsini* is represented according to the legend of the figure. The shaded strip shows the Li spread resulting from an uncertainty of $\pm$100K in $T_{\rm eff}$. The labelled stars are possible outliers. Suggested upper and lower envelopes to the relation are indicated.

study of 5 associations with age ranging from 10 to 100 Myr (Mentuch *et al.* 2008) suggests increasing Li depletion with age as predicted for the PMS phase. The peak-to-peak scatter increases from $\pm$0.3 (for β Pic) to $\pm 0.5 - \pm 0.8$ (for Tucanae-Horolagum and the AB Doradus), less than that seen for α Per. Clusters younger than α Per - IC 2602, IC 2391, NGC 4665, NGC 2547 also have smaller star-to-star scatter in Li. The older cluster, the Pleiades (70 Myr) has a similar scatter as α Per and in fact M 34 (250 Myr) has as much. These observations imply that that spread in Li among cooler stars is not well developed in the youngest clusters/associations and it may take 20 Myr or so to develop fully. Li depletion seems to be dominated by that occurring in the PMS phase for clusters up to the ages of 50-100 Myr. For older clusters, it is the Main Sequence depletion that begins to reduce Li in the coolest stars. Very apparent, *e.g.*, in M 34 where the star-to-star scatter remains similar to the Pleiades and α Per but the mean abundances are noticeably reduced.

The large scatter observed at cooler temperatures is far larger than could be explained by the standard sources of uncertainty. Several studies in the past report a strong correlation between the Li scatter and stellar activity. We have to have contemporaneous indicators of stellar activity for pairs of stars with maximum and minimum Li abundance but similar observed properties such as colour and rotation period. In the absence of these, the debate continues on whether the star-to-star spread is due to real differences in Li abundances or arises due to atmospheric effects.

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