From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution
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Lithium survey in the solar age cluster M67

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Abstract. We present atmospheric parameters and Li abundances, obtained from a detailed spectroscopic analysis, for a sample of stars with different evolutionary stages (turn–off, subgiant and giant stars) in the solar age cluster M67. Observations were carried out with high resolution ($R \sim 47000$) at high S/N using the UVES + FLAMES at VLT/UT2. From available photometry and computed synthetic spectra for the region around the Lithium line at 6707.78Å, we derived atmospheric parameters (T_{eff}, $\log g$, [Fe/H], $v \sin i$) and A_{Li} for each star, in order to better understand the level of mixing and convective dilution of evolved stars in M67.

Keywords. Stars: atmospheres, stars: abundances, stars: evolution

1. Observations and analysis

Spectroscopic observations of 22 evolved stars of M67 were carried out in January 2004 with FLAMES+UVES at VLT (ESO, Paranal, Chile). We used a standard set–up centred at 580 nm and covering the spectral region 420–680 nm at a resolving power of ∼47,000. Exposure times of 1500 s (bright stars) and 3000 s (faint stars) could offer a signal–to–noise (S/N) ratio around 80, in the Lithium region (6700–6720Å).

We have measured atmospheric parameters and A_{Li} from spectroscopic analysis. New generation MARCS models (Gustafsson *et al.* 2005) and spectral synthesis tools (Alvarez & Plez 1998) were used. Solar abundances have been taken from Grevesse & Sauval (1998). First, T_{eff} were estimated from photometry (Montgomery *et al.* 1993; Houdashelt *et al.* 2000). Then, with synthetic spectra, T_{eff} were more precisely determined from H_β and H_α lines and from Fe I lines in the Li region. The surface gravity was estimated using the Michaud *et al.* (2004) evolutionary models. The solar metallicity was first adopted and then adjusted by fitting with synthetic spectrum the Fe I lines for the Li region. The v_{mic} was set at 1.0 km s^{-1} for turn–off and subgiant stars and at 2.0 km s^{-1} for giant stars. The $v \sin i$ were estimated by adjusting the FWHM of absorption lines in the Li region. Finally, the A_{Li} were derived by fitting synthetic spectrum to the Li I 6707.78Å line. We present in Fig. 1 the Li distribution for our sample of stars. The estimated errors on T_{eff} and A_{Li} are 200 K and 0.2 dex, respectively.

2. Results

Up to date, as mentioned in different studies (Balachandran 1995, Pilachowski *et al.* 1988), subgiant and giant stars in M67 show no significative A_{Li}, pointing to a severe Li depletion just past the main sequence turn–off. Jones *et al.* (1999) and Randich *et al.*

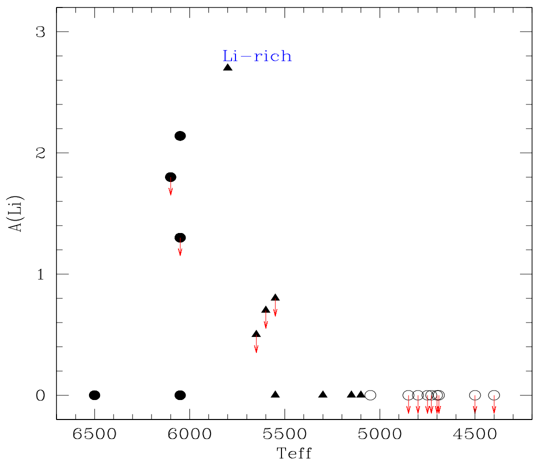

Figure 1. A_{Li} distribution versus T_{eff}. Turn–off (filled circles), subgiants (filled triangles) and giant (open circles) are represented. Down–pointing arrows represent upper limits in A_{Li}.

(2002) show a large dispersion on the A_{Li} for M67 solar–type stars. In this context, the analysis we performed on our sample complements the previous observational studies mainly devoted to stars of M67 near turn–off. The behavior of A_{Li} along evolutionary stages presents a dispersion for post–turn–off stars and subgiants, and a decrease in Li for cooler stars (showed in Fig. 1). This study confirms the suggestion made by Randich *et al.* (2002) that M67 is a peculiar cluster in comparison to other clusters with different ages.

The present result also reveals a Lithium excess in a binary system (Li–rich showed in Fig. 1) which appears unusual in comparison to other M67 subgiants (Canto Martins *et al.* 2005, submitted). Such a high Li content in this subgiant star may be explained by the preservation of its Li at turn–off stage, due to tidal effects.

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