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*A. Recio-Blanco, P. de Laverny, A.G.A. Brown*
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# Understanding Li enhancement in K giants and role of accurate parallaxes

**Raghubar singh and B. E. Reddy**

Indian Institute of Astrophysics,
Bangalore 560034, India
email: raghubar.singh@iiap.res.in

Indian Institute of Astrophysics,
Bangalore 56003, India
email: ereddy@iiap.res.in

**Abstract.** Our recent studies based on a large sample of K giants with Hipparcos parallaxes and spectroscopic analysis resulted more than a dozen new Li-rich K giants including few super Li-rich ones. Most of the Li-rich K giants including the new ones appear to occur at the luminosity bump in the HR diagram. However, one can't rule out the possibility of overlap with the clump region where core He-burning K giants reside post He-flash at the tip of RGB. It is important to distinguish field K giants of clump from the bump region in the HR diagram to understand clues for Li production in K giants. In this poster, we explore whether GAIA parallaxes improve to disentangle clump from bump region, more precisely.

**Keywords.** Lithium, GAIA, RGB, planet engulfment, parallax.

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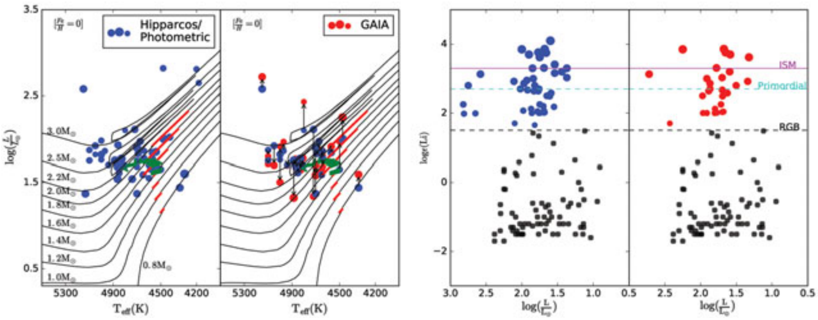
## 1. Introduction

Lithium is one of the primordial elements produced along with H and He during Big Bang nucleosynthesis (BBN). The observed Li abundance of $\log \mathrm{A(Li)} = 2.2$ dex in metal-poor stars is considered as primordial abundance. The observed value is significantly less than the value, $\log \mathrm{A(Li)} = 2.72$ dex (Cyburt *et al.* 2008), predicted by BBN models based on measured baryon density using WMAP. However, observations show that Li abundance ($\log \mathrm{A(Li)} = 3.3$ dex) in ISM and young stellar objects is about a magnitude more than the primordial value. It is not clear which are the sources of excess Li, and level of their contribution to the current Li values in the Galaxy. Recent observations suggest Red giant branch (RGB) stars may be significant source of Li to the Galaxy. This is contrary to prediction of standard stellar models which predict a maximum of $\log \mathrm{A(Li)} = 1.5$ dex in low mass (1-2.5$M_{\odot}$) RGB or K giants (Iben *et al.* 1967a). As per standard models, Li gets depleted as star evolves from main sequence to RGB due to deep convection and 1st dredge-up. However, a small group of K giants are found to have large amounts of Li in their photosphere (see Kumar *et al.* 2011), some times exceeding their natal clouds, $\log \mathrm{A(Li)} = 3.3$ dex Exact location, of Li-rich K giants in the H-R diagram is not well established. Location has important implications for our understanding of Li origin in K giants. In this context, improved accuracies in astrometry from GAIA will help.

## 2. Results & discussion

Origin for Li excess in giants has been a subject of study for over three decades, since its discovery by Wallerstein *et al.* 1982. There are three main hypotheses for excess Li in

K giants: a) Retaining of main sequence Li abundance due to inefficient mixing process., b) Internal nucleosynthesis and dredge-up process, and c) External source such as planet or brown dwarf engulfment. First of the three, an inefficient mixing, is obviously not the likely scenario as few K giants have been shown to have Li abundance which exceeds ISM values (Kumar *et al.* 2011). As per other two scenarios (b and c), current observational results do not rule out either of the two possibilities. Recent studies suggest occurrence of Li-rich K giants all along the RGB indicating some kind of external origin such as planet engulfment which can happen anywhere on the RGB. It is suggested that Li in photospheres of stars with respect to hydrogen can be enhanced by engulfment of planets (for example Earth) which have Li values similar to ISM but devoid of hydrogen




However, as shown in figures, most of the Li-rich K giants seems to be confined to a narrow range of luminosity in H-R diagram overlapping with luminosity bump and red clump regions. It is not clear whether Li enhancement is linked to internal mixing process during luminosity bump evolution or He-flash at the tip of RGB. Surveys for Li-rich K giants such as Kumar *et al.* 2011 suggest Li enhancement occur either at bump or clump. Their results do not show Li-rich K giants before or after the bump region. In this poster, we show Li abundances of known Li-rich K giants and Li abundance measurements of K giants along the RGB. It appears that scatter in luminosity reduced in the case of GAIA parallaxes compared to earlier estimates. But as our preliminary results indicate it is difficult to make conclusion though, in many cases GAIA results shows significantly different luminosities.

## 3. Conclusion

Preliminary analysis shows that GAIA results may help to reduce scatter in luminosities of Li rich K giants which in turn provide clues for Li enhancement excess in K giants.

This work has made use of data from the European Space Agency (ESA) mission *Gaia* (`https://www.cosmos.esa.int/gaia`), processed by the *Gaia* Data Processing and Analysis Consortium (DPAC, `https://www.cosmos.esa.int/web/gaia/dpac/consortium`). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the *Gaia* Multilateral Agreement.

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