Searching for IR Excesses around Li-Rich and Rapidly Rotating K Giants Using WISE

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Abstract: Using WISE data, we have searched for infrared (IR) excesses around a large sample of red giant stars. Such excesses have previously been discovered using lower-resolution IRAS data. de la Reza et al. (1997) and others have suggested a link between red giants with overabundant Li, rapid rotation, and the ejection of circumstellar shells or disks. Various hypotheses have been proposed to explain this trio of effects, including the accretion of nearby giant planets equivalent to a few Jupiter masses, or a newly triggered nuclear fusion stage that could eject a dusty shell. In this work, our goal was to look for IR excesses to elucidate the link between these 3 unusual red giant properties: fast rotation, enriched Li, and IR excess. Our findings suggest that 30% of the original IRAS sources may not be RGB stars, casting doubt on the correlations found previously. Among our expanded sample of red giants, very few were found to have IR excesses, making it difficult to assess if there is a correlation in this sample.
This research was conducted as part of the NASA/IPAC Teacher Archive Research Project (NITARP).

Subsample from Carlberg et al. (2012; C12):

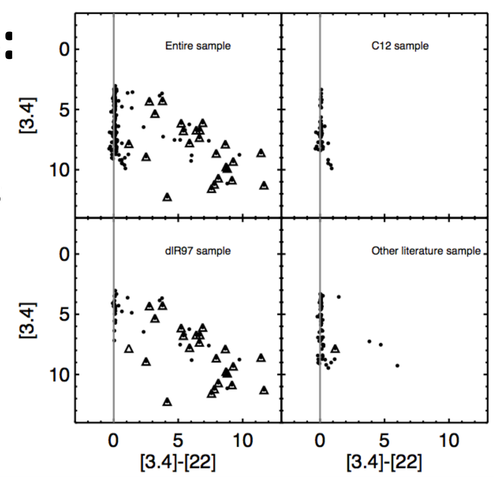
- Sample selected with intention of exploring relationship between rotation and abundances, so is unbiased in Li (and selected without regard to IR brightness), and covers a range of v sin i and Li abundances.
- 86 K giants, one of which is also in dlR97.
- 2 stars have small IR excesses χ_{22}>3, where $\chi_{22} = \frac{([3.4]-[22])_{observed} - ([3.4]-[22])_{predicted}}{\sigma([3.4]-[22])}$
- Very hard to draw conclusions about correlations with other parameters with only 2 sources.

Subsample from the literature:

- Wide-ranging literature looking for Li-rich K giants.
- 151 additional targets, all claimed to be Li-rich, not in dlR97 or C12, but in any of ~20 other papers in the literature.
- Some IR-selected, most not. Some too faint for WISE.
- 8 have plausible IR excesses; 1 has confusion issues as in dlR97.

WISE excesses in the samples:

- [3.4] vs. [3.4]-[22] for the samples →
- •= targets, Δ= the targets to worry about (for SED or source confusion or references suggesting not K giants).
- Very few K giants in our larger sample have IR excesses.
- Similar plot obtained for K_s vs K_s-[22].

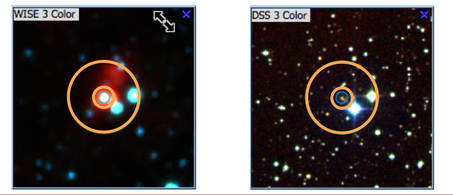


Approach:

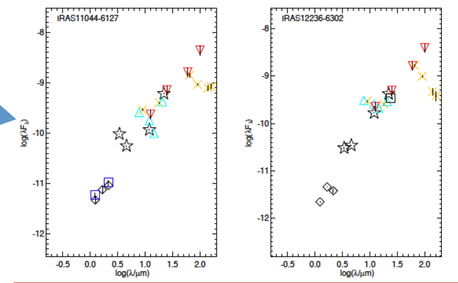
- Assemble target list (318 sources) from literature.
- Use IRSA tools to look for counterparts in IRAS, WISE, 2MASS, AKARI, MSX, Spitzer (SEIP), DENIS, and SDSS.
- Use IRSA tools to inspect images of source at POSS DSS, 2MASS, WISE, and IRAS bands to assess quality of (point) source match.
- Construct spectral energy distributions (SEDs) to assess (a) quality of point source match, & (b) whether or not there is an IR excess.
- Look for small excesses by comparing [3.4]-[22] to expected value.

Subsample from de la Reza et al. (1997; dlR97):

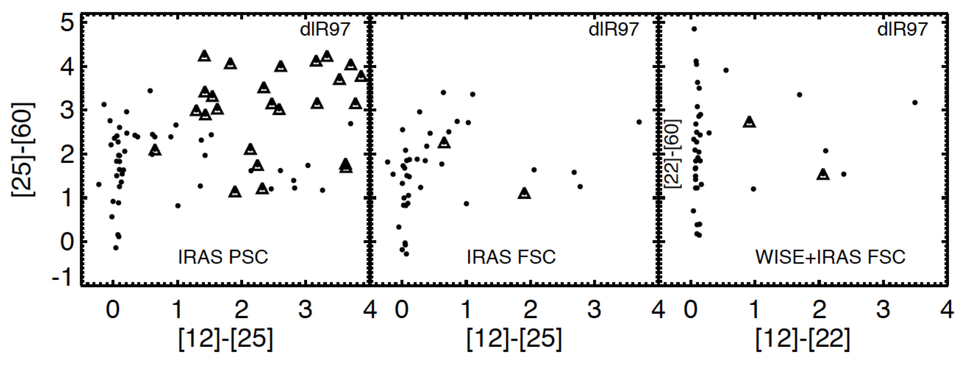
- Sample selected from IRAS colors, so all very bright in IR.
- 82 targets, 40 of which are claimed to be Li-rich K giants.
- They obtained spectra, but in 22 cases, it is not at all clear what they took a spectrum of. *These may not be K giants, or the IR does not come from the K giant.*
- In some cases, the assembled SED does not look like a K giant but rather a deeply embedded source. *It is unclear what is going on with these sources.*
- dlR97 and others (e.g., Siess & Livio 1999) made a plot from IRAS data, postulating an evolutionary sequence of K giants. However, between IRAS PSC → FSC, excesses decrease; when WISE points are used for [12] and [25], the excesses further decrease.



300" swatches of sky for IRAS06365+0223. Left: WISE 3-color; Right: DSS 3-color. Orange circles: min/max IRAS beam (25 um: 30"-100 um: 120"); blue circle: target position. *What source did dlR97 observe in the optical?*



SEDs for 2 sources that do not look like K giants. ◆=2MASS, □=DENIS, ★=WISE, Δ=MSX, x=Akari, □= Spitzer ▽= IRAS



Disk fractions (w/ good sources, [12]-[25]), L to R, ~40%, ~30%, ~15%.

- In the figure, •=dlR97 targets, Δ= the 24 (30%) targets to worry about (for SED or source confusion or literature suggesting not K giants). In panels L to R, points move to smaller excesses. *The correlation with IR excess is no longer so obvious for the bulk of the targets (and 30% of the sources used initially to establish the correlation have issues).*
- 14 of the K giants have plausible IR excesses.