Asteroseismology of Red Giants: Discovering the Origins of Li-rich Giants

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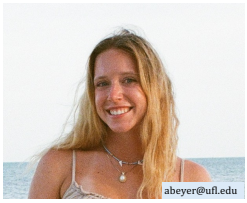
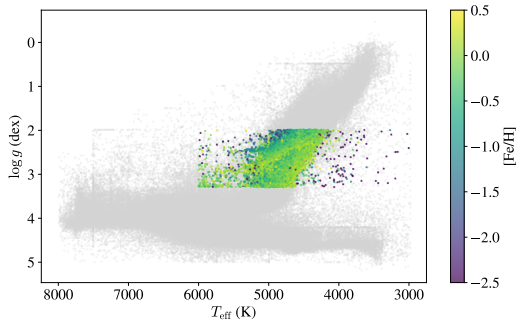


Why are Li-rich Giants Weird ?

Lithium, as an easily destroyed element, provides a sensitive tracer for the interiors of low-mass stars. From stellar evolution models, we expect from the PMS and MS destruction of lithium and dilution from post-MS first dredge-up, we expect lithium abundances for giants to be A(Li) < 1.5 dex. Observations have found < 1% of giants are "li-rich".

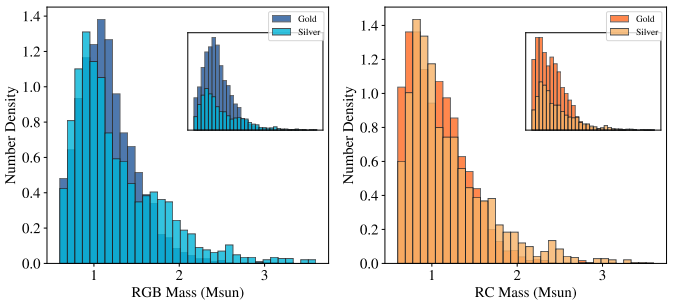


Data:

We collect a sample of 15,016 red giants observed by TESS from the Wang et al. 2023 3D NLTE sample of lithium abundances. Our pySYD returned asteroseismology for 10,597 stars with Tmag < 12.8 and 5 or more sectors of data.

Seismology:

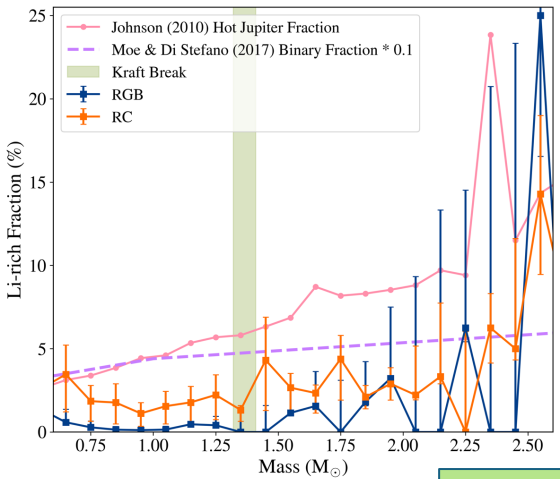
We do seismic analysis of TESS light curves using the pySYD software to identify the region of excess power to determine the frequency of maximum power ($\upsilon_{\rm max}$) and the large frequency spacing ($\Delta\upsilon$).



Masses and Ages:

Of 15,016 stars:
- 3583 gold stars with νmax and Δν.
- 1763 additional silver stars with νmax only.
- 10,825 stars with spectroscopy and *Gaia* but no reliable seismic detections.
- Standard seismic corrections ($f_{\nu{\rm max}}$ and $f_{\Delta\nu}$).
- Uncertainties 16.1% on mass.

How do giants become lithium rich ?

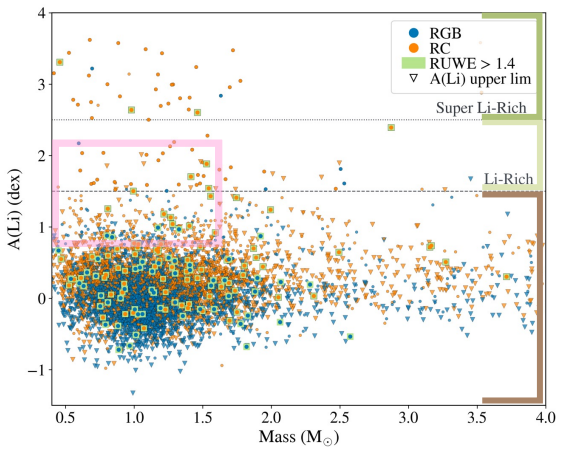


Planetary Engulfment

We compare the rate of lithium enrichment as a function of mass and metallicity to the hot Jupiter rates. Expecting all first ascent RGB stars have a max A(Li) ~ 2.2.

Binary Merger

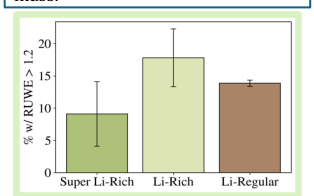
The rate of close (<1AU) stellar companions is much higher than the rate of Li-Rich giants, although the trends with mass may not be inconsistent with the rate of Li-Rich giants.

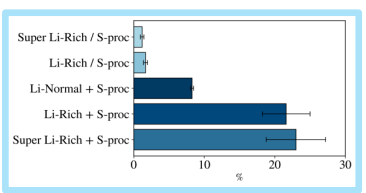


CONCLUSIONS:
- **Some stars are lithium-rich from AGB pollution** (they are often RC, Li-Rich, and s-process enhanced).
- Li-Rich RGB stars have mass trends that **may be consistent with planet engulfment**.
- **Most lithium rich stars are in the clump**, with many indications that they are likely related to stellar binarity, but the rate is not high enough and trends are not steep enough for this relationship to be simple.

Binary Interaction

Binary fraction accounts for a small fraction of our li-rich sample, comparable to the trend of binary fraction as a function of mass.





AGB Companion

If theorizing an AGB star companion, we expect to find in above average abundance of S-process elements (ex: Ba) or a remaining WD companion.