Puzzling mid-infrared spectra of lithium-rich K giant stars

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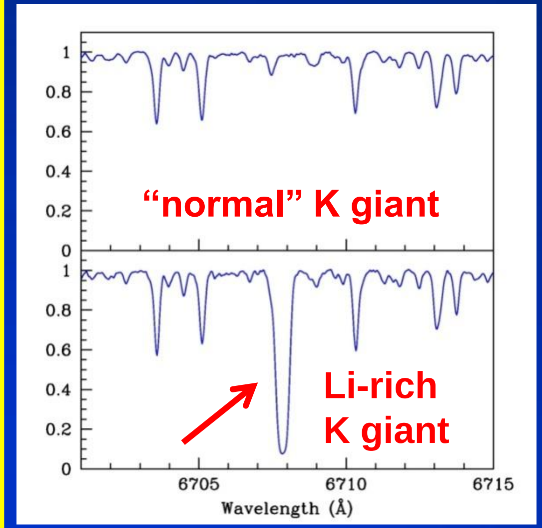
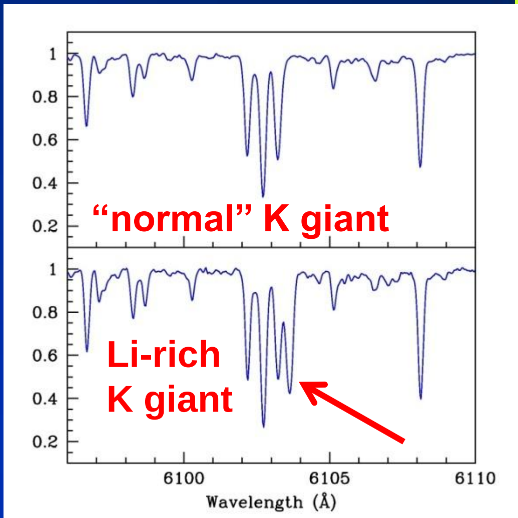




Spectra in the regions of the Li I lines at 6104 and 6708 Å

First discovery: Wallerstein & Sneden (1982)

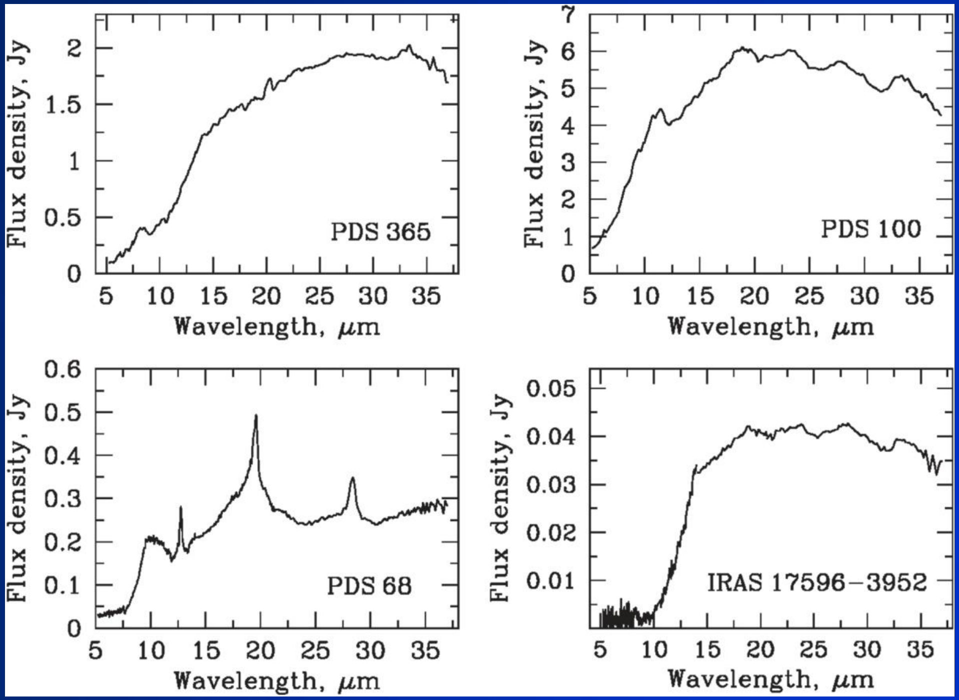
Gregório-Hetem et al. (1993): large majority of Li K giant stars are IR sources measured by *IRAS*.

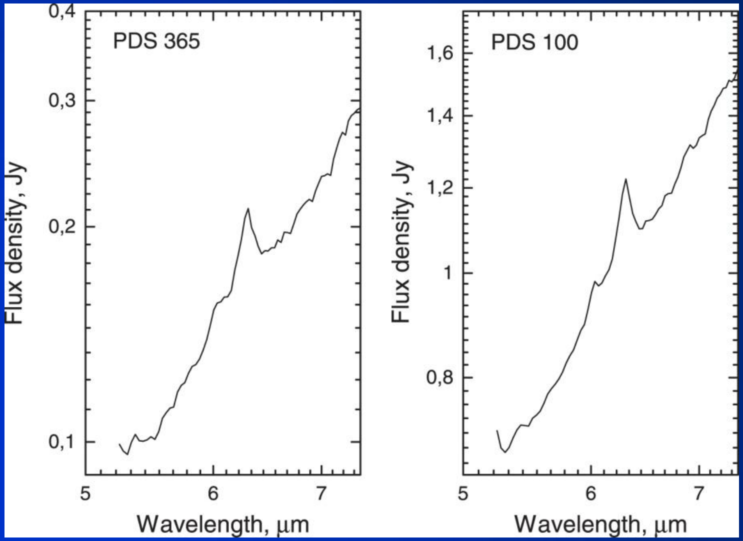
de la Reza et al. (1996, 1997): scenario linking Li enrichment to the evolution of circumstellar shells

Drake et al. (2002): among rapid rotating (vsin i $\geq$ 8 km/s) K giants about 50% are Li-rich

"Li excess in K giants is one of the most puzzling stellar astrophysical problems to which, in the last two decades, great deal of research has been devoted" (Kumar & Reddy, 2009)

Spitzer mid-IR spectra of Li-rich K giants

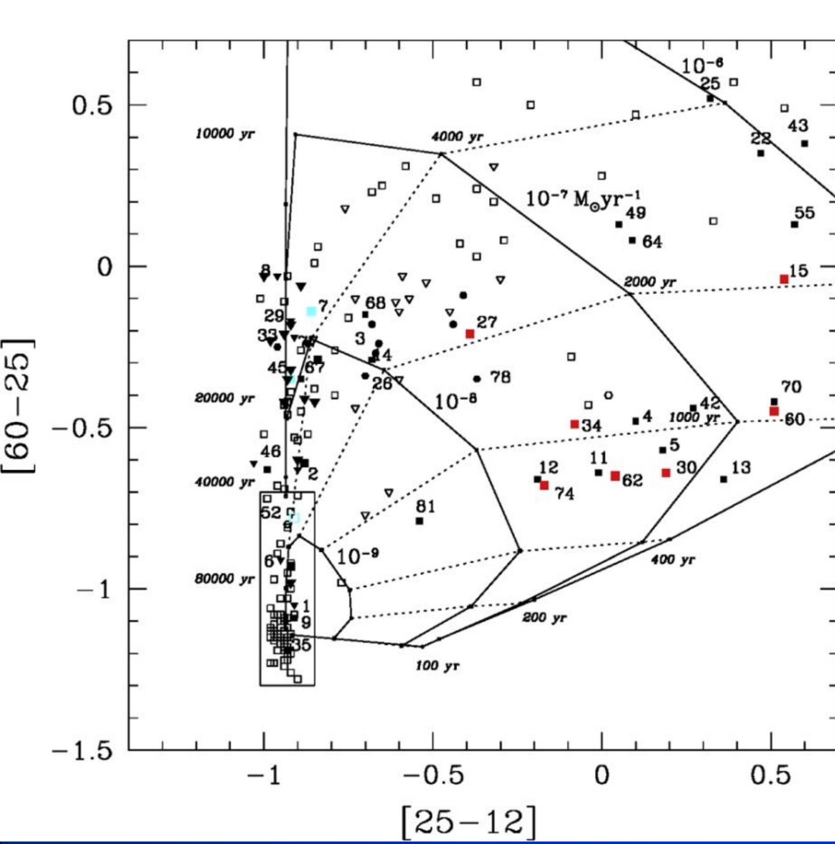




Mid-IR spectra between 5 and 38 *μ*m of RGB Li-rich K giants PDS 365, PDS 100, PDS 68, and IRAS 17596-3952 presenting the UIE features superposed to a strong adjacent continuum emission.

A log–log form is presented here for stars PDS 365 and PDS 100 to highlight the emission feature at 6.26 *μ*m

Cornell Atlas of Spitzer/IRS *sources* (CASSIS, *Lebouteiller et al. 2011*)



Distribution of IR excesses of K giant stars

Filled symbols – Li-rich K giants
Open symbols – Li-poor K giants
Red – Li-rich giants presenting UIE features
Blue – no UIE

Results

We detected several emission lines related to hydrocarbon organic and inorganic materials in the Spitzer mid-IR spectra of seven K giant stars (five RGB stars and two early-AGB stars) superposed to a strong underlying continuum emission

The hydrocarbon organic compounds (aromatic and aliphatic components) are supposed to be formed in the winds of the expanding shells (without the presence of a strong UV radiation fields?)

The wind-disk interaction model – a non-spherical geometry – optical polarization signals

We expect that the wind-disk interaction could be detected by directly imaging with ALMA

If episodic Li-enrichment process is indeed a universal phenomenon, we are facing a new source of organics in the ISM

Ramiro de la Reza, Natalia Drake, Isa Oliveira, Sridharan Rengaswamy "Complex Organic and Inorganic Compounds in Shells of Lithium-rich K Giant Stars", ApJ, 806, 86 (2015)

Ευχαριστούμε!

Thank you!

Stellar Properties and Spectral Emission Features

Table 1
Stellar Properties and Spectral Emission Features

Star	Number in Figure 1	Evolution Phase	T_{eff}, K	log ϵ (Li)	log $L/L_{\odot}$	Emission Features (μm)
HD 233517	15	RGB	4390	4.3	2.03[a]	6.26[b] A, 8.2 ALP?, 11.3[b] A, 12.7 ALP?
PDS 365	30	RGB	4540	3.3	1.86[c]	6.26 A, 8-9 ALP, 20.0 F/E?, 34.0 F/E?
IRAS 17596-3952	62	RGB	4600	2.30	1.70[a,d]	8.3[e] Si?, 20.0 F/E ?, 34.0 F/E ?
PDS 100	74	RGB	4500	2.40	1.65[a,f]	6.26 A, 11.4 A, 19.0 F/E?, 23.5 F/E?, 28.0 F/E?, 33.0 UIE
PDS 68	34	RGB	4300	3.9–4.2	1.60[a,d]	10.0[g] CE, 12.7 ALP, 19.5[g] CE, 28.3[g] CE
IRAS 17582-2619	60	EAGB?	···	~1.40	···	8.7 ALP
IRAS 12327-6523	27	EAGB	4200	1.4–1.6	2.91[d]	10.0 AM, 18.5 AM

Notes. Abbreviations: A—aromatic; ALP—aliphatic plateau; F—forsterite; E—enstatite; Si—silica; CE—crystal enstatite; AM—amorphous inorganic compound; UIE—unidentified infrared emission.

[a] Strassmeier et al. (2015).
[b] Jura et al. (2006).
[c] Drake et al. (2002).
[d] Reddy & Lambert (2005).
[e] Juhász et al. (2010).
[f] Reddy et al. (2002).
[g] Olofsson et al. (2009).