A super-Li rich turnoff star in NGC 6397

The puzzle persists

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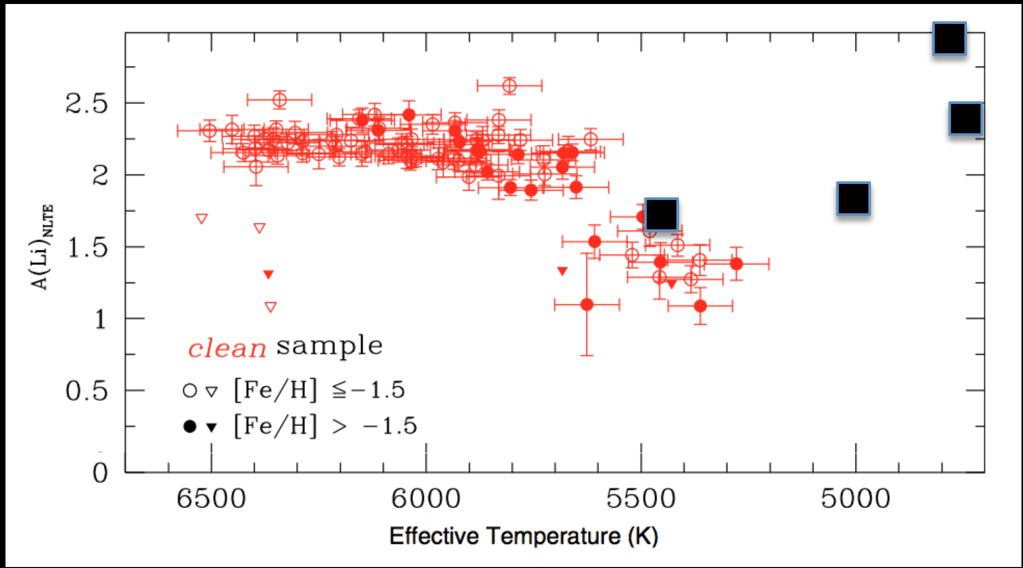
Lithium production / destruction

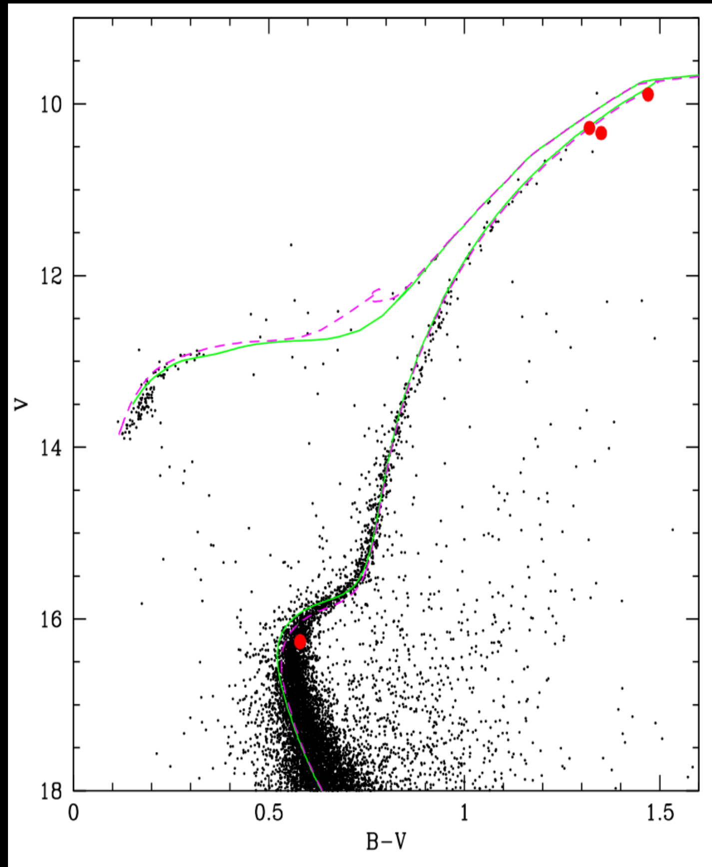
Plateau is well established (Spite & Spite 1982; Charbonnel et al. 2005); depletions from BBN A(^{7}Li) = 2.72 (WMAP; Cyburt et al.2008), albeit persistent puzzles.



*Over*abundances: Li-rich giants (Ruchti et al. 2011) in the MW disk and in GCs (Kraft et al. 1999): ~1% of RGB are Li-rich (e.g., Kumar et al. 2011). Very few super-Li rich dwarfs (e.g., Deliyannis et al. 2002).

NGC 6397

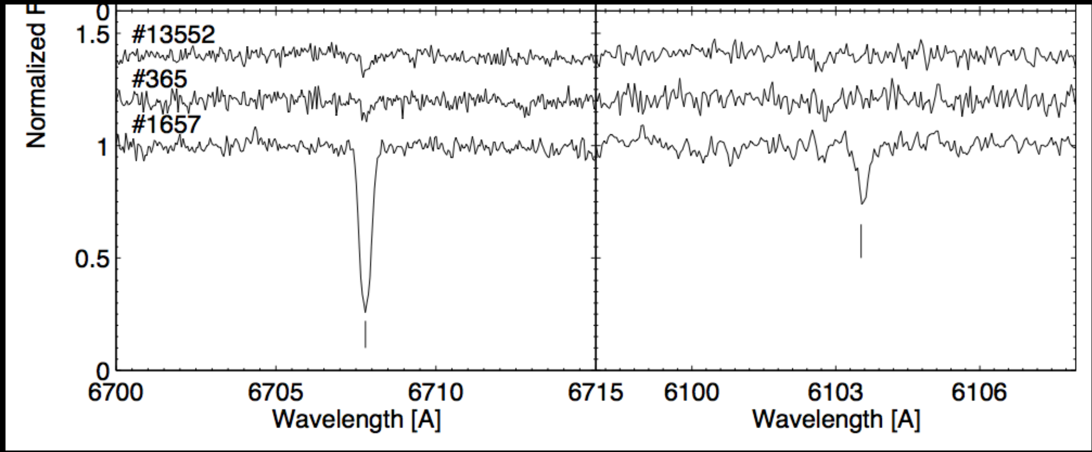
- 2nd closest Galactic globular cluster (d_o = 2.3 kpc, R_{GC} = 6.0 kpc).
- Archetypical, metal-poor ([Fe I / H] = -2.10) halo GC.
- Typical GC abundance patterns:
  - enhanced [α/Fe];
  - Na-O anticorrelation
  - Na-Li anticorrelation
- Trends of [X/H] with T_{eff} due to diffusion (Korn et al. 2007; Nordlander et al. 2012)
- MIKE: 3 RGB, 3 TO stars



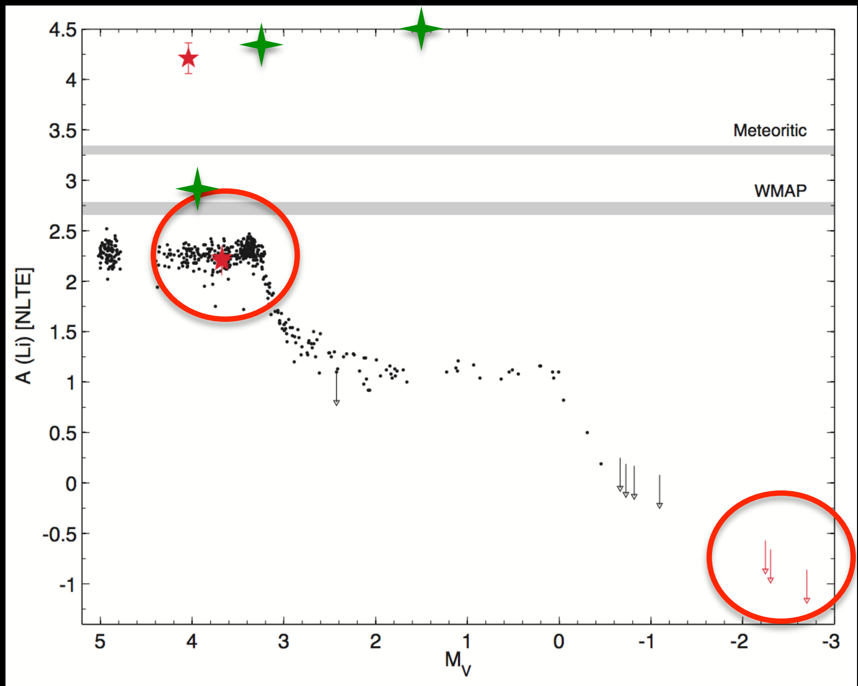
AK& McWilliam 2011, AJ,142, 63

Li in NGC 6397

EW (6707 Å) = 325 mÅ



EW (6103 Å) = 65 mÅ



$A_{NLTE}(Li)$ = 4.21 ± 0.06 ± 0.14

(AK, Lind, & Rich, ApJL, 738, 29)

Lind et al. (2009); Deliyannis et al. (2002); Monaco et al. (2011); Adamów et al. (2012)

Possible origins of the Li-enhancement

1) Ingestion of planetary bodies (Takeda et al. 2001; Ashwell et al. 2005):
   + Happens in giants and WDs
   - No systematic difference of refractory vs. volatile elements
   - Too metal poor.

2) Type II Supernovae (e.g., Woosley & Weaver 1995):
   + can produce Li in ν-process
   - No abnormal hydrostatic element abundances

3) Diffusion / rad. acceleration (e.g., Deliyannis et al. 2002; Richer et al. 1993)
   + Can yield such high enhancements
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   - only works in very narrow T-range (6900 – 7100 K)

4) Binary mass transfer:
   + Is #1657 in a binary?

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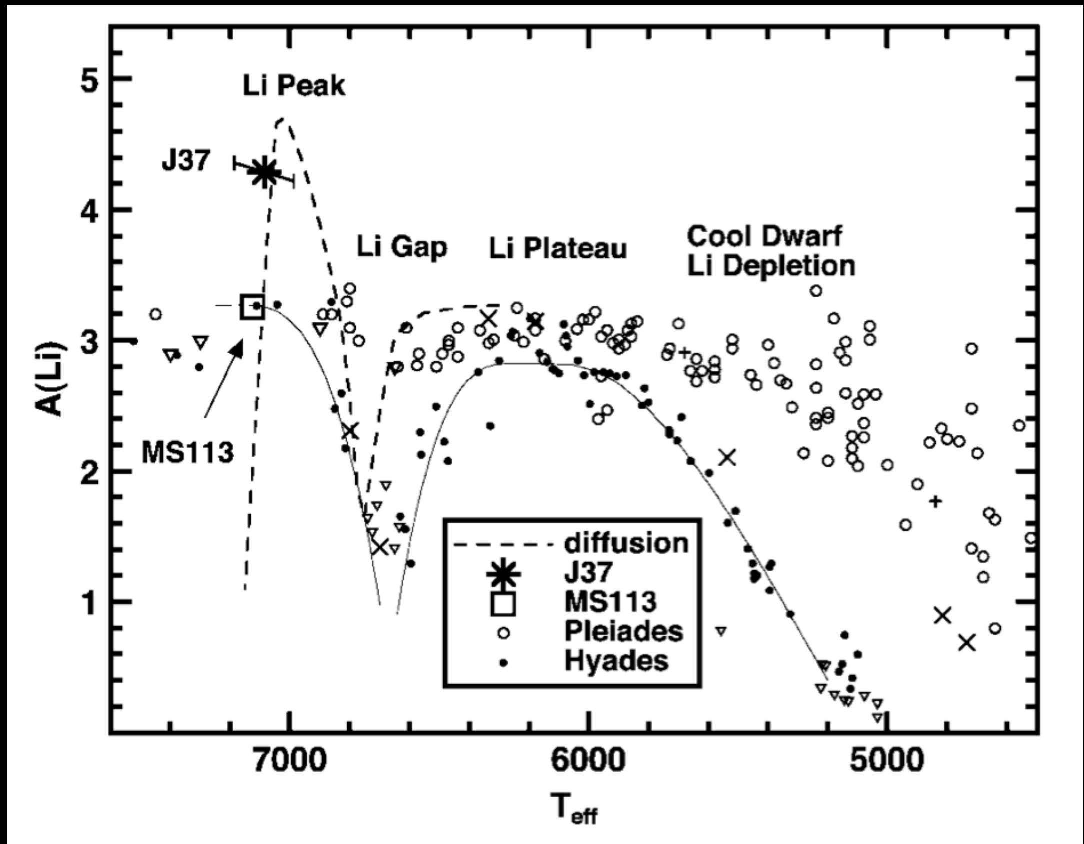
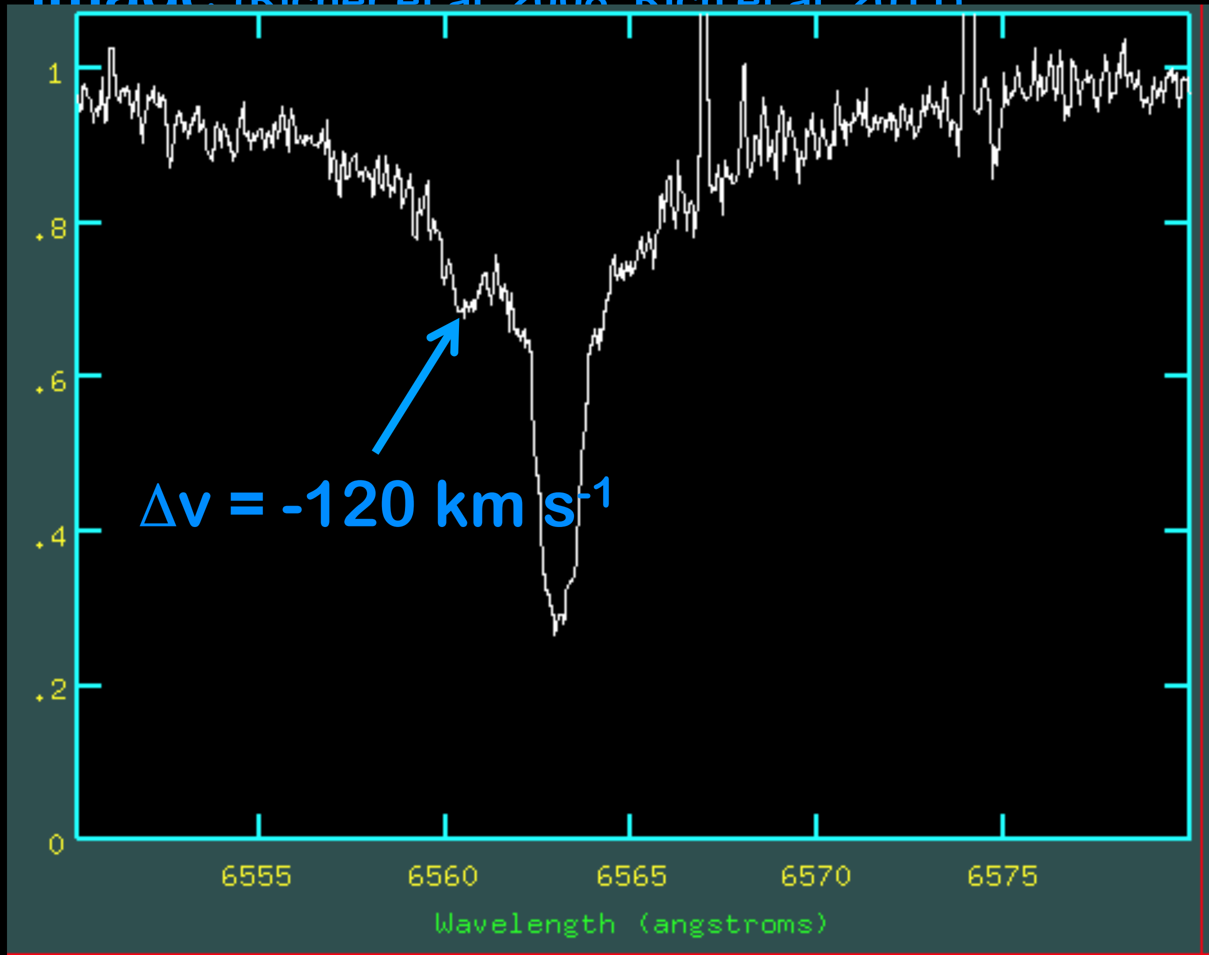


Deliyannis et al. (2002); model by Richer et al. (1993)

#1657 as a binary

HST image (Richer et al. 2008; Rich et al. 2011)



No more than 16% total (continuum) flux contribution.

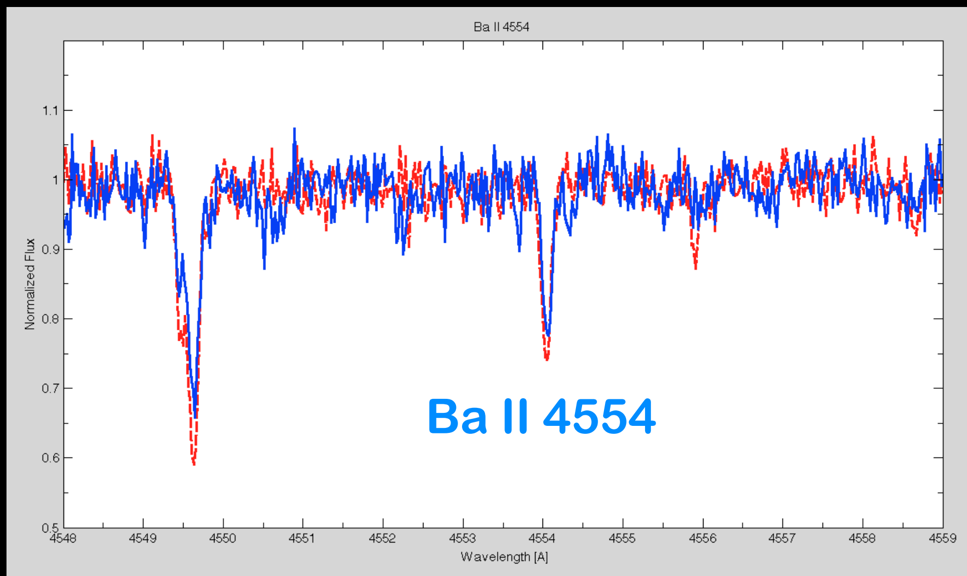
No evidence of velocity variations.

Possible origins of the Li-enhancement

1) Binary transfer from (S-)AGB companion

   + CF71 (Hot Bottom Burning) was originally conceived for AGBs (Ventura & D'Antona 2011)

   - *No* enhancements in s-process elements;
   - Na is *low*, not high. First generation star.



Possible origins of the Li-enhancement

2) Transfer from RGB companion (Sackmann & Boothroyd 1999)

+ CF71 also works here: *cool* bottom processing
+ "standard" abundances (modulo mixing patterns)
+ efficient in metal poor GCs

- very short lived phase (< 4 x 10^4 yr); needs fortunate timing.

Summary

- Serendipitous discovery of most Li-rich star in a GC:

  $$A_{NLTE}(^{7}Li) = 4.21 \pm 0.06 \pm 0.14.$$

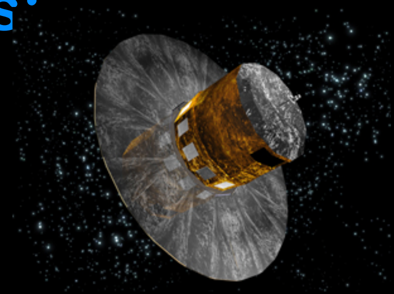
- None of the standard scenarios works satisfyingly: [X/Fe] is compatible with other stars in NGC 6397.

- We cannot rule out Li-production in CBP in a former RGB companion.

- Why aren't there more ?

Outlook

Future missions will unravel Galactic structures, substructures, and find many (Li-) oddballs:



Gaia (2013): radial velocities, PMs

Dedicated spectroscopic programs, as (Gaia-) follow-up, and also for themselves (complements):

GES (FLAMES/UVES), Jan. 2012
GYES (CFHT; R~20000)
MOONS (VLT; R~5000, 20000)
4MOST (NTT, VISTA; R~5000, 20000)
WEAVE (WHT; R~20000)
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