Homogeneous investigation of lithium in globular clusters

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In collaboration with E. Pancino, E. Franciosini, A. Mucciarelli, M. Tsantaki & the GES Consortium

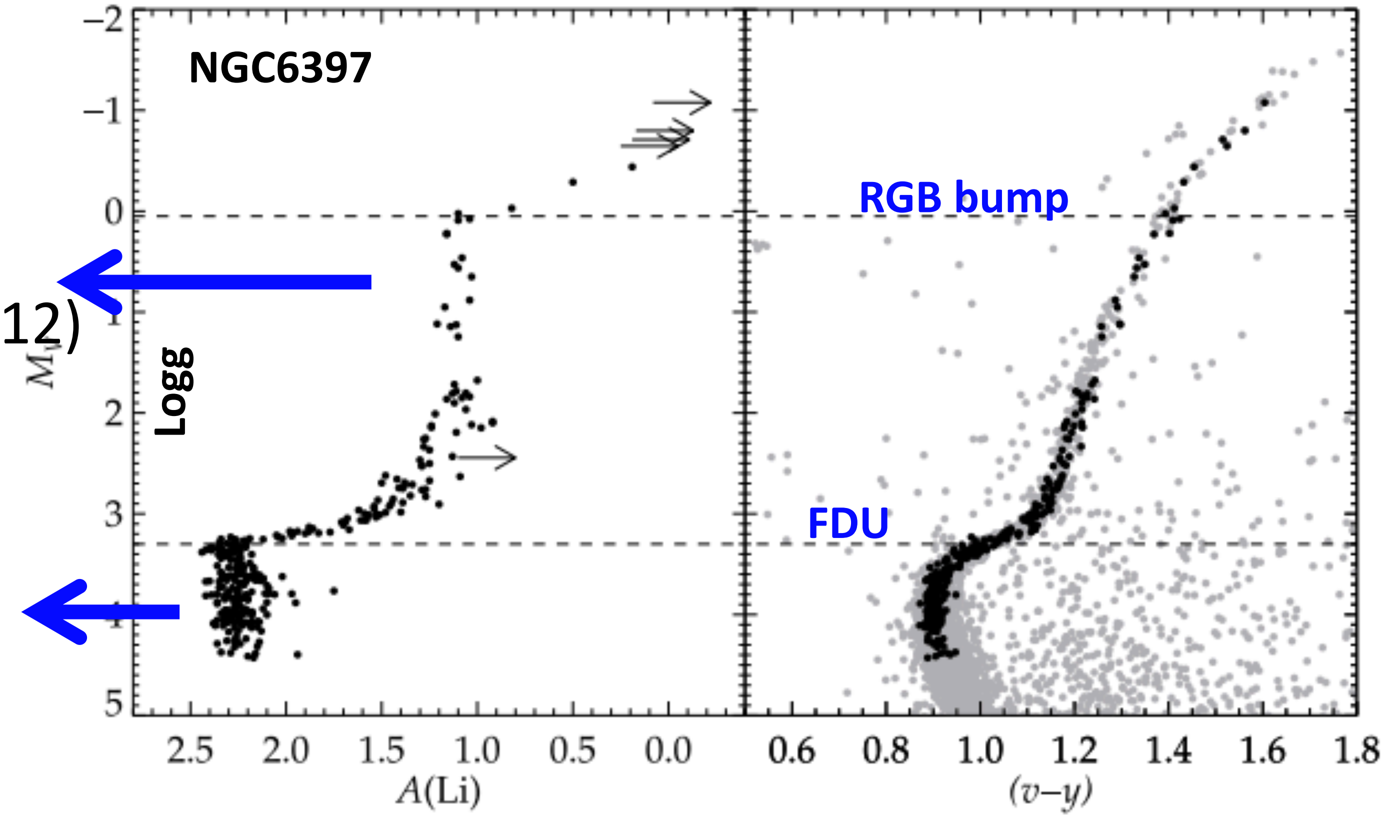
Why Li in GCs?

- Li is mostly created during the Big Bang nucleosynthesis
- Li is rapidly destroyed in the stellar interior owing to proton capture reactions at $\sim 2.5 \times 10^6$ K
- Li traces mixing processes: it should be “primordial” in dwarf stars and diluted in evolved stars

Why Li in GCs?

RGB plateau
(Mucciarelli+2012)

Spite plateau



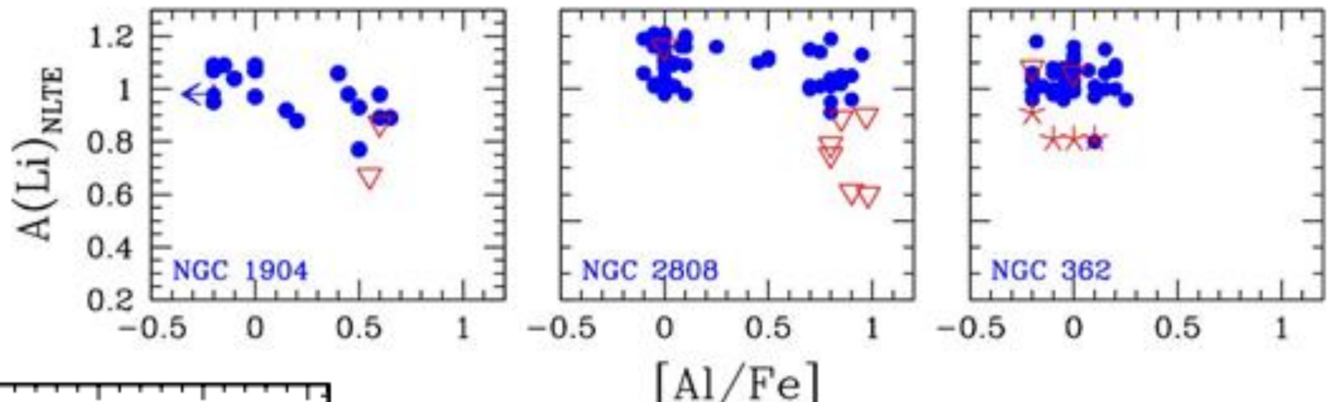
Lind+2009

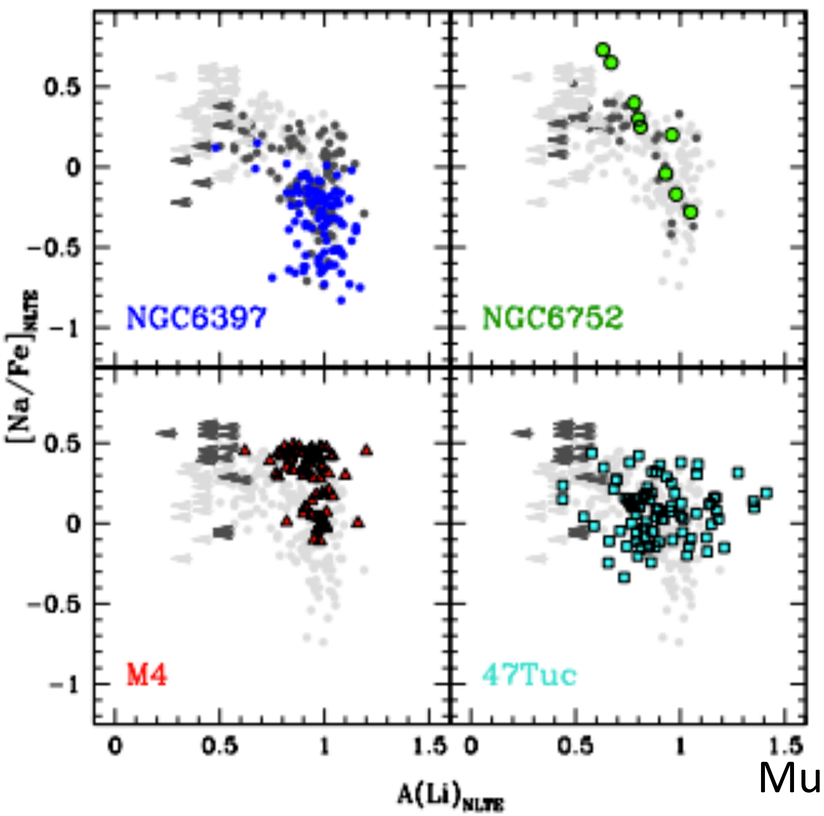
Why Li in GCs?

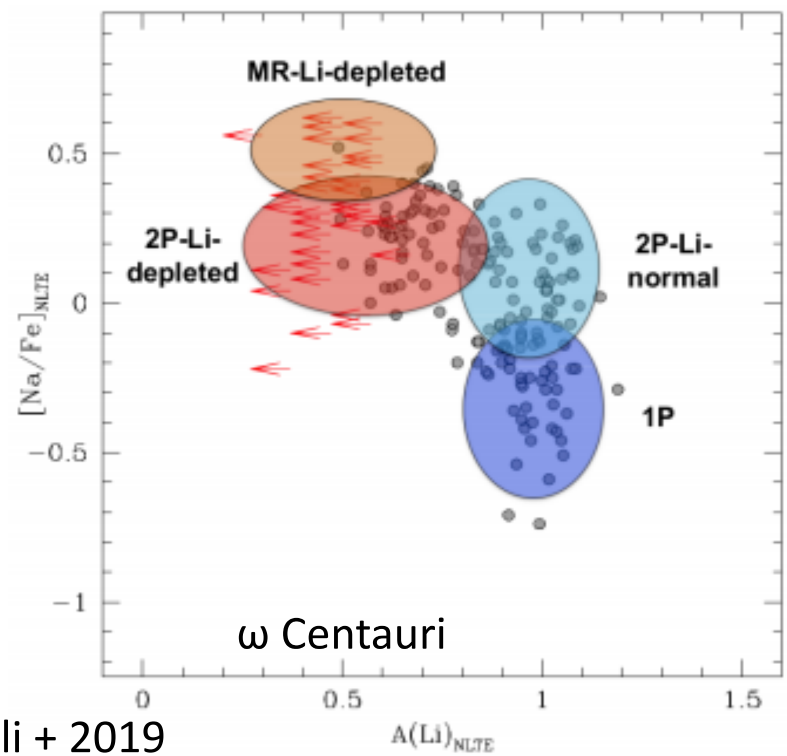
2P stars in GCs should be Li-free or Li depletion

but this is not what we observe

D’Orazi + 2015







Mucciarelli + 2019

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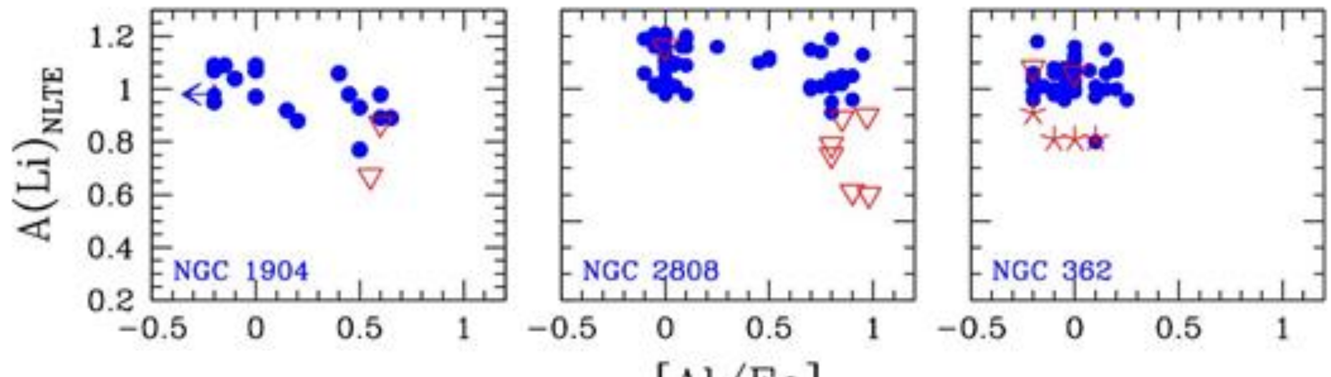
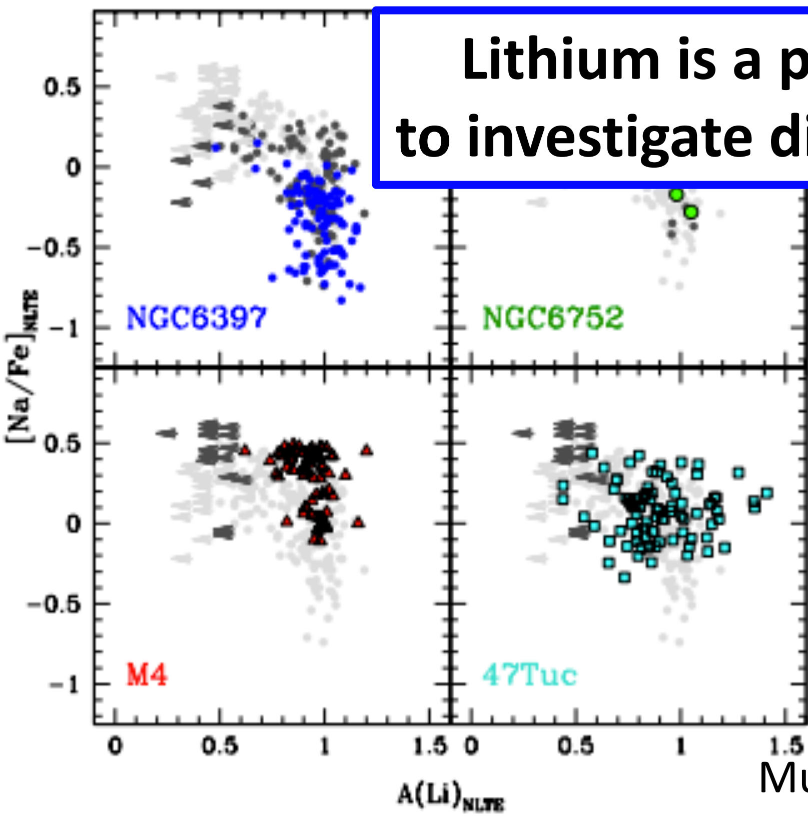
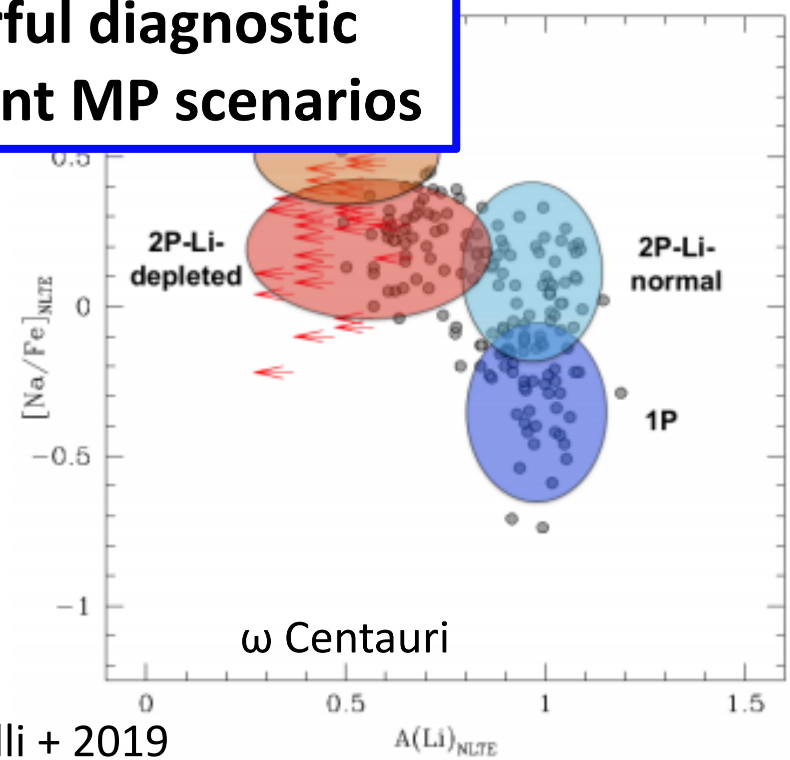


Lithium is a powerful diagnostic to investigate different MP scenarios





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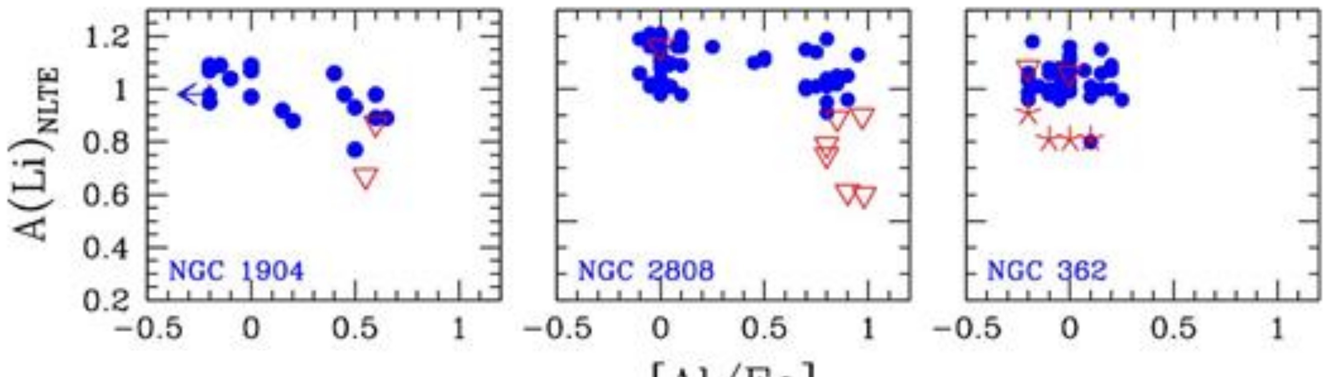

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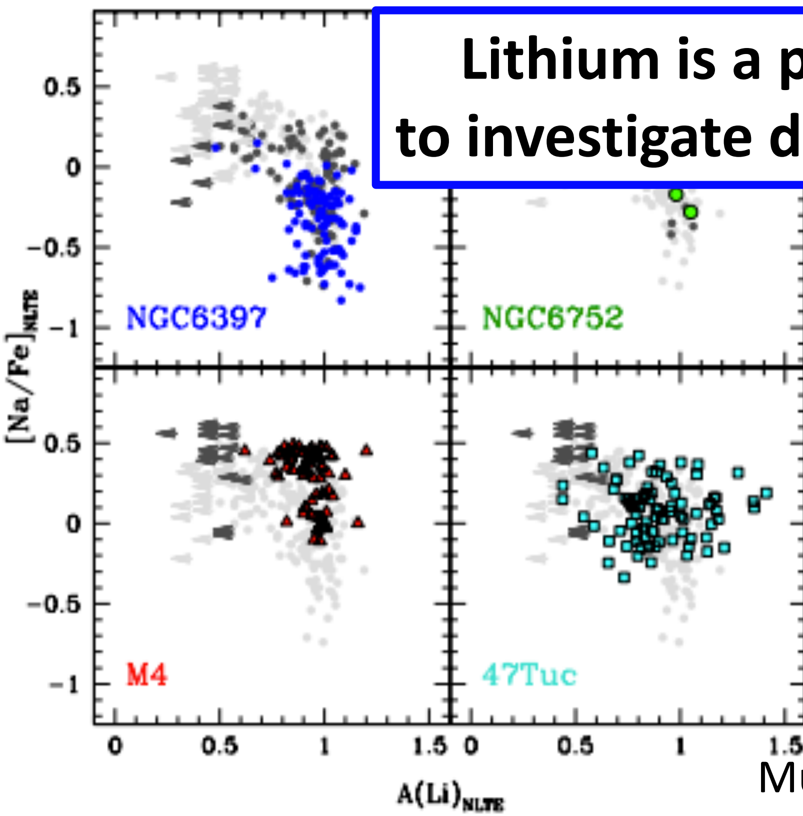
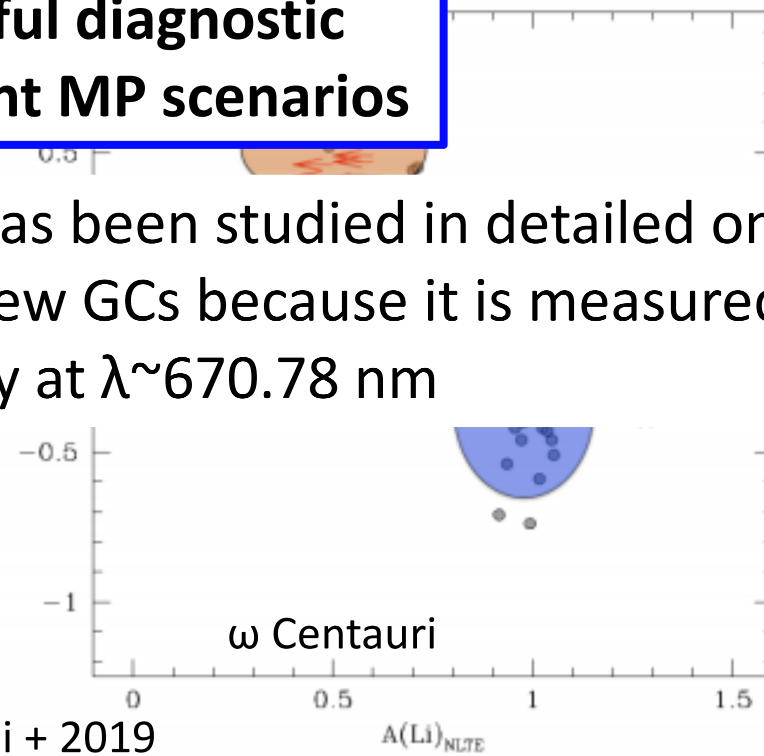


Li has been studied in detailed only in few GCs because it is measured only at λ~670.78 nm



Mucciarelli + 2019

GCs in iDR6 GES

GES consists of ~10^5 stars spectroscopically investigated using UVES + GIRAFFE (new observations + archive data)

Releases consist of reduced spectra, RVs, parameters, abundances homogenously analysed
Gilmore+2012; Randich+2013

https://www.gaia-eso.eu

Instrument	Setup	λ_{min} (Å)	λ_{max} (Å)	R ($\lambda/\Delta\lambda$)
UVES	520[a,d]	4140	6210	47000
UVES	580[b,d]	4760	6840	47000
UVES	860[c]	6600	10600	47000
GIRAFFE	HR3[a,d]	4033	4201	24800
GIRAFFE	HR4[a,e]	4188	4297	24000
GIRAFFE	HR5A[a,d]	4340	4587	18470
GIRAFFE	HR6[a,d]	4538	4759	20350
GIRAFFE	HR9B[d]	5143	5356	25900
GIRAFFE	HR10[f]	5339	5619	19800
GIRAFFE	HR14A[a,d]	6308	6701	17740
GIRAFFE	HR15N[d]	6470	6790	17000
GIRAFFE	HR21[f]	8484	9001	16200

Pancino+2017

GCs in iDR6 GES

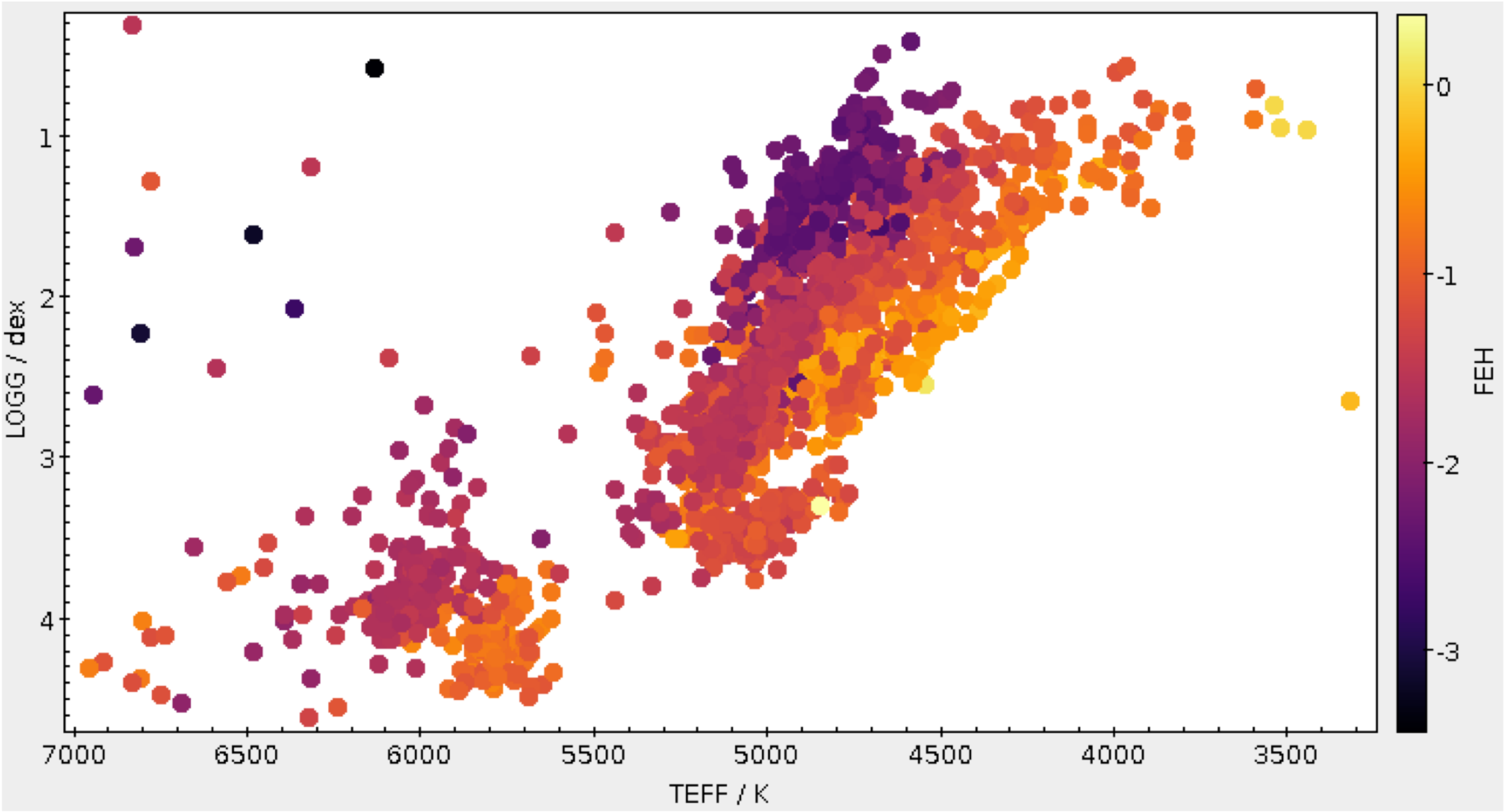
As calibrators GCs have been observed/analysed (Pancino+2017): giant stars 15 GCs + dwarf stars for 2

M12	**NGC 104***	**NGC 1851**	**NGC 4372**	**NGC 5927**
M15	**NGC 362**	**NGC 1904**	**NGC 4590**	**NGC 6553**
M2	**NGC 1261**	**NGC 2808**	**NGC 4833**	**NGC 6752***

Abundances homogenously analysed, including Li

Li in GCs with GES

Membership selections done with Gaia: we used the probabilities by Vasilev and Baumgardt 2021 (probability > 0.9)



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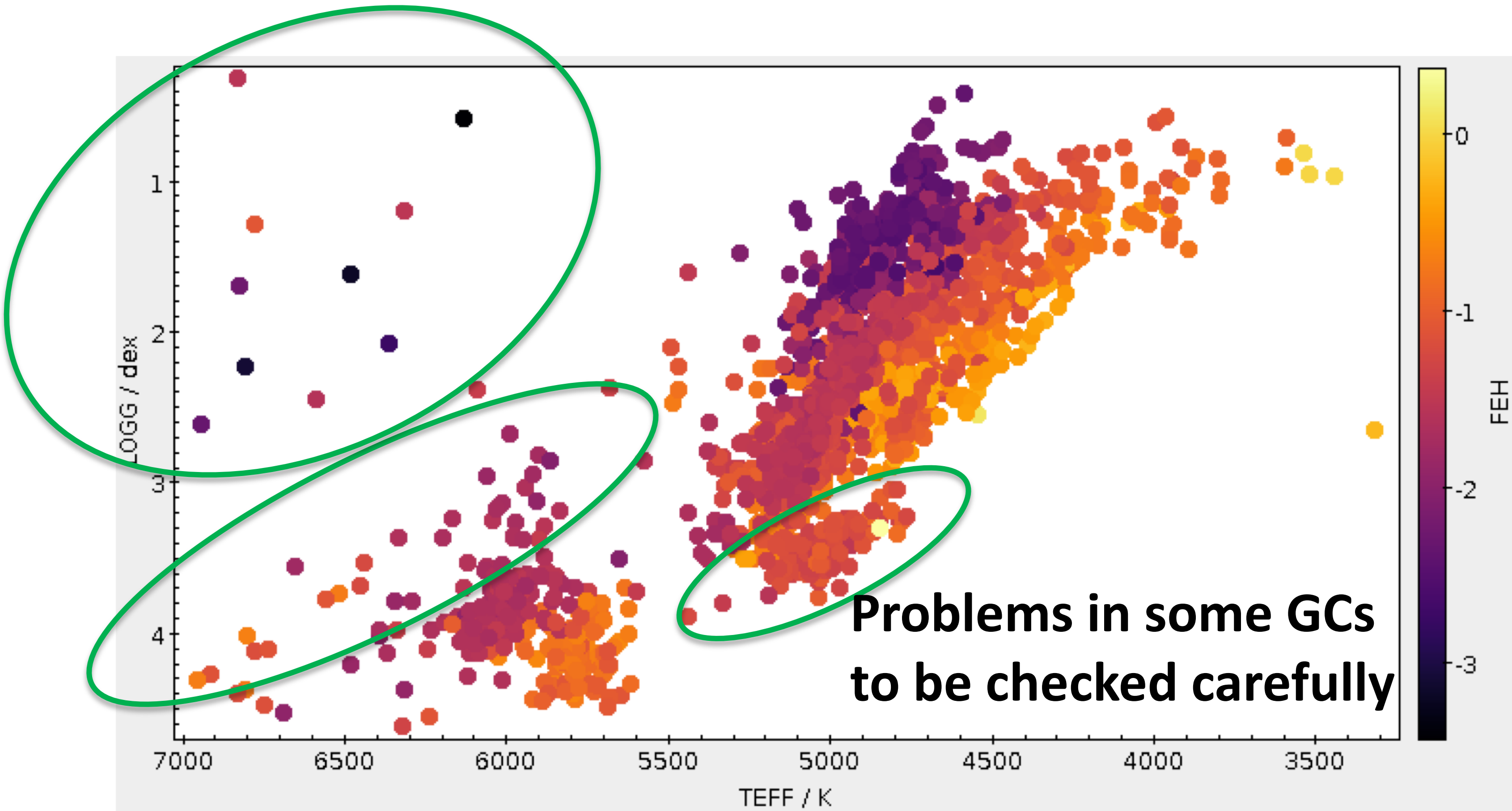
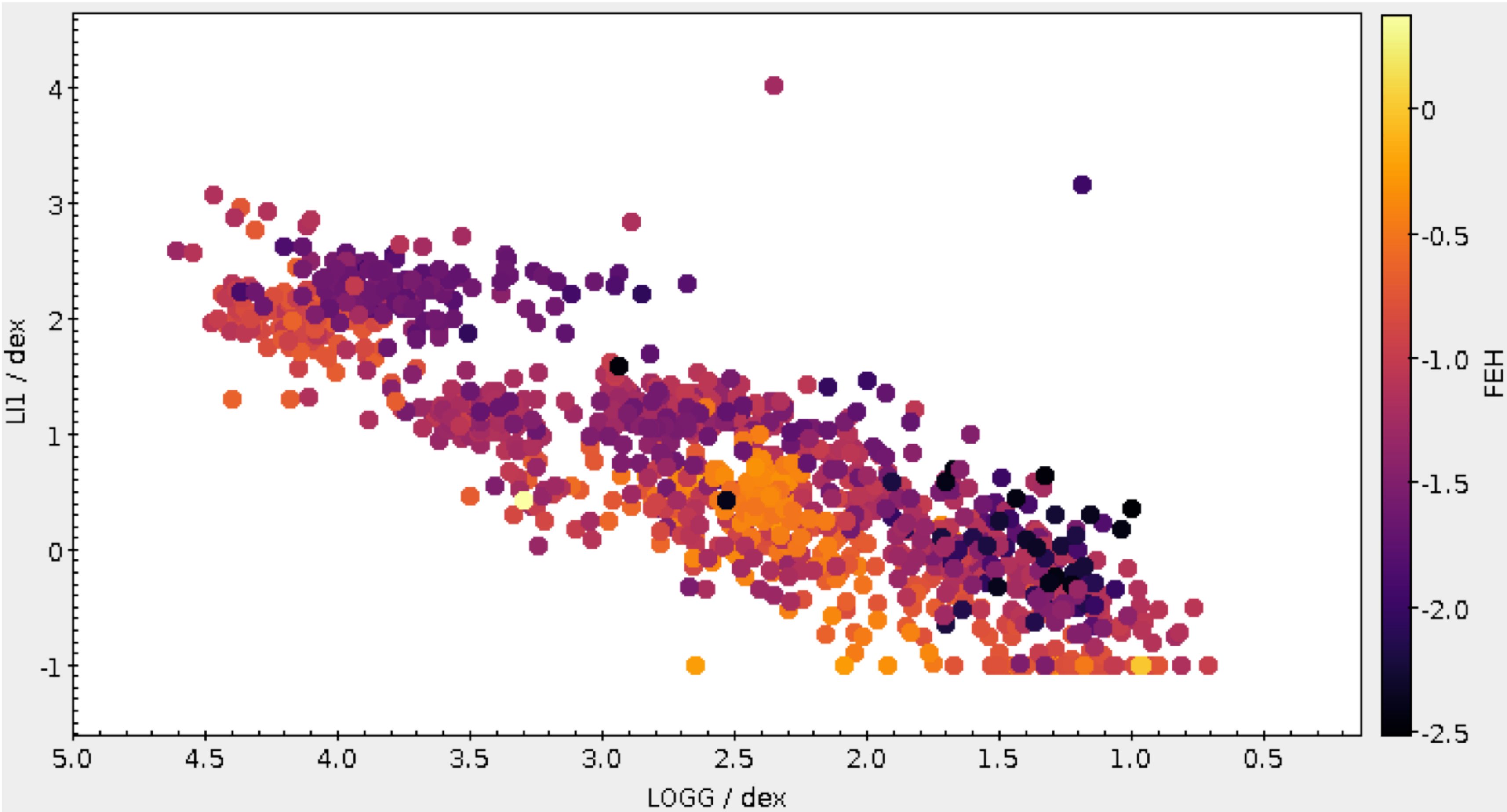


Li in GCs with GES

Li analysis described in Franciosini+ in prep.



GES gives us the possibility to explore Li for ~1200 stars in a very large sample of GCs.

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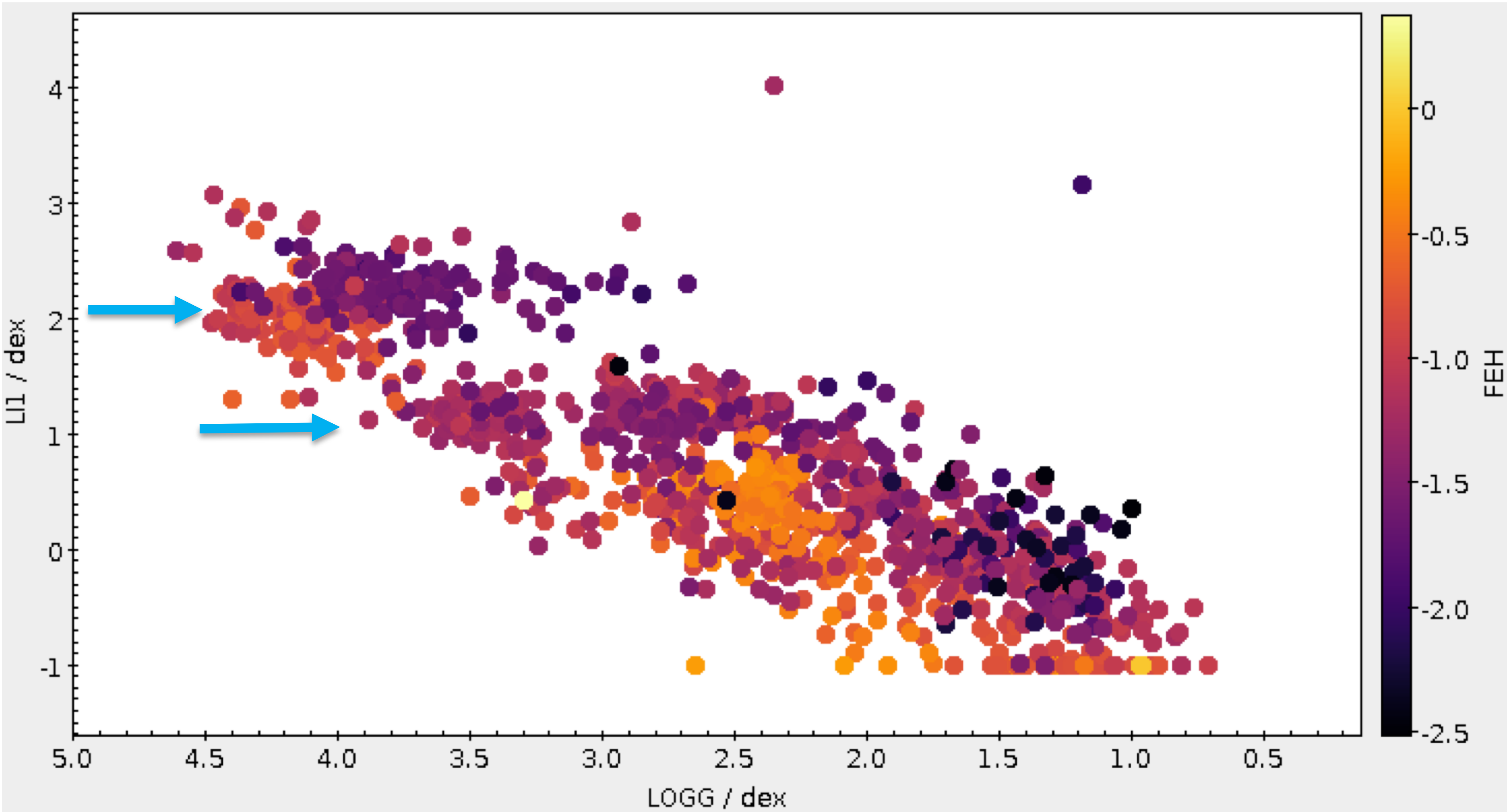

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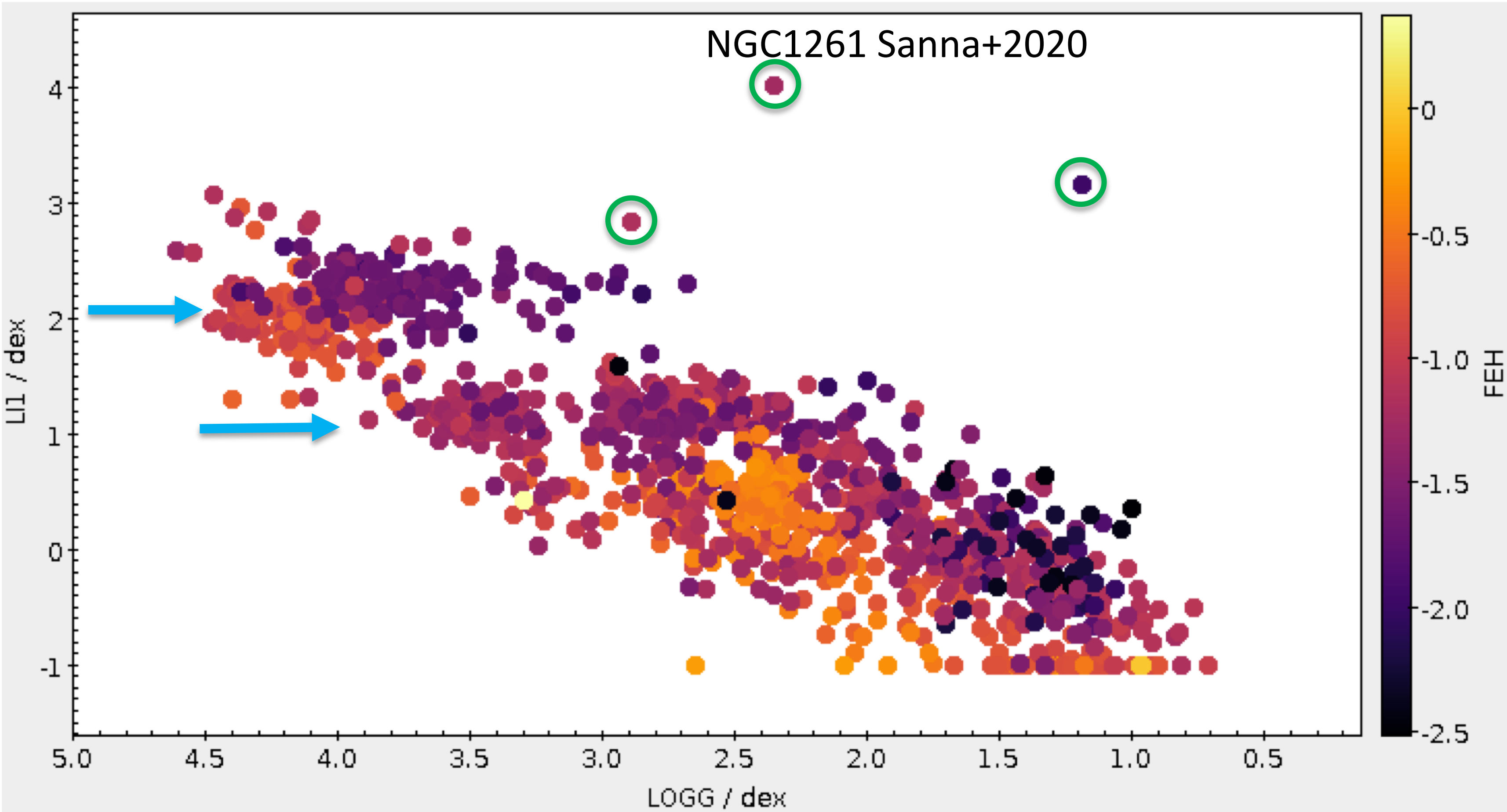

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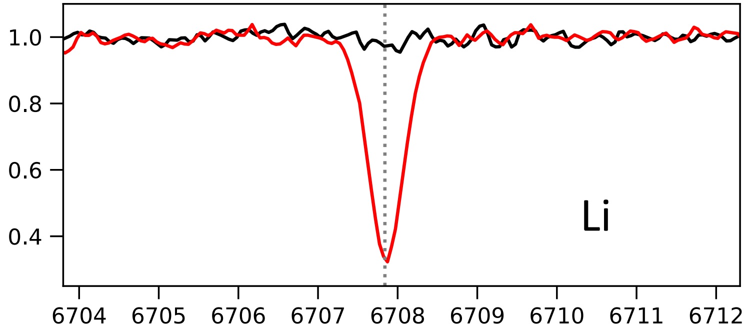
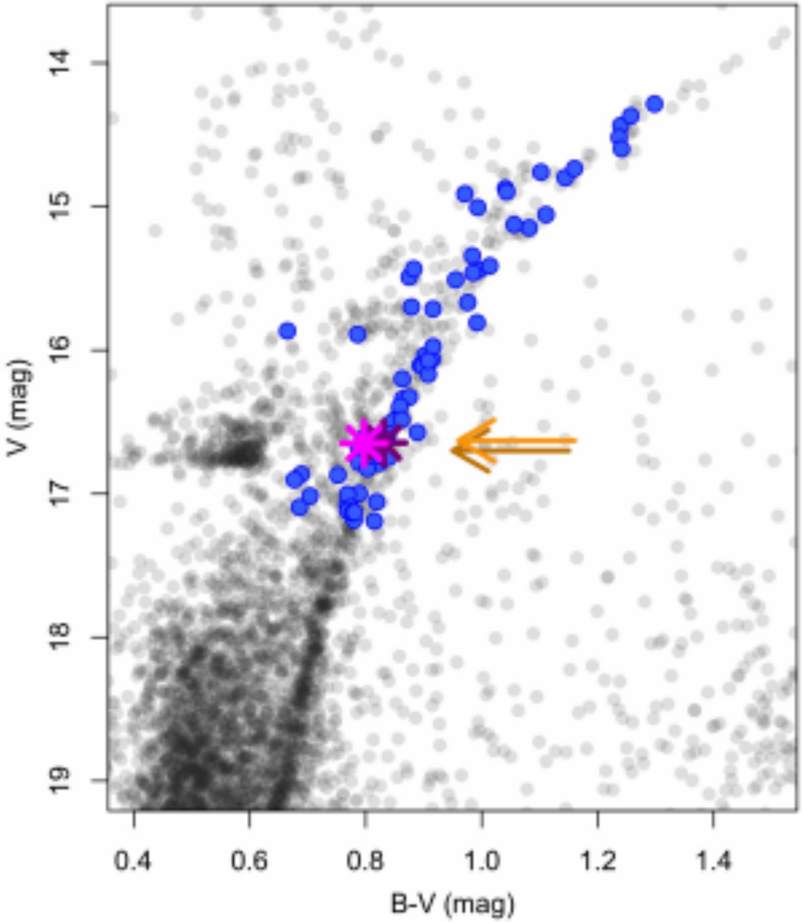
Li-rich GCs stars

NGC1261

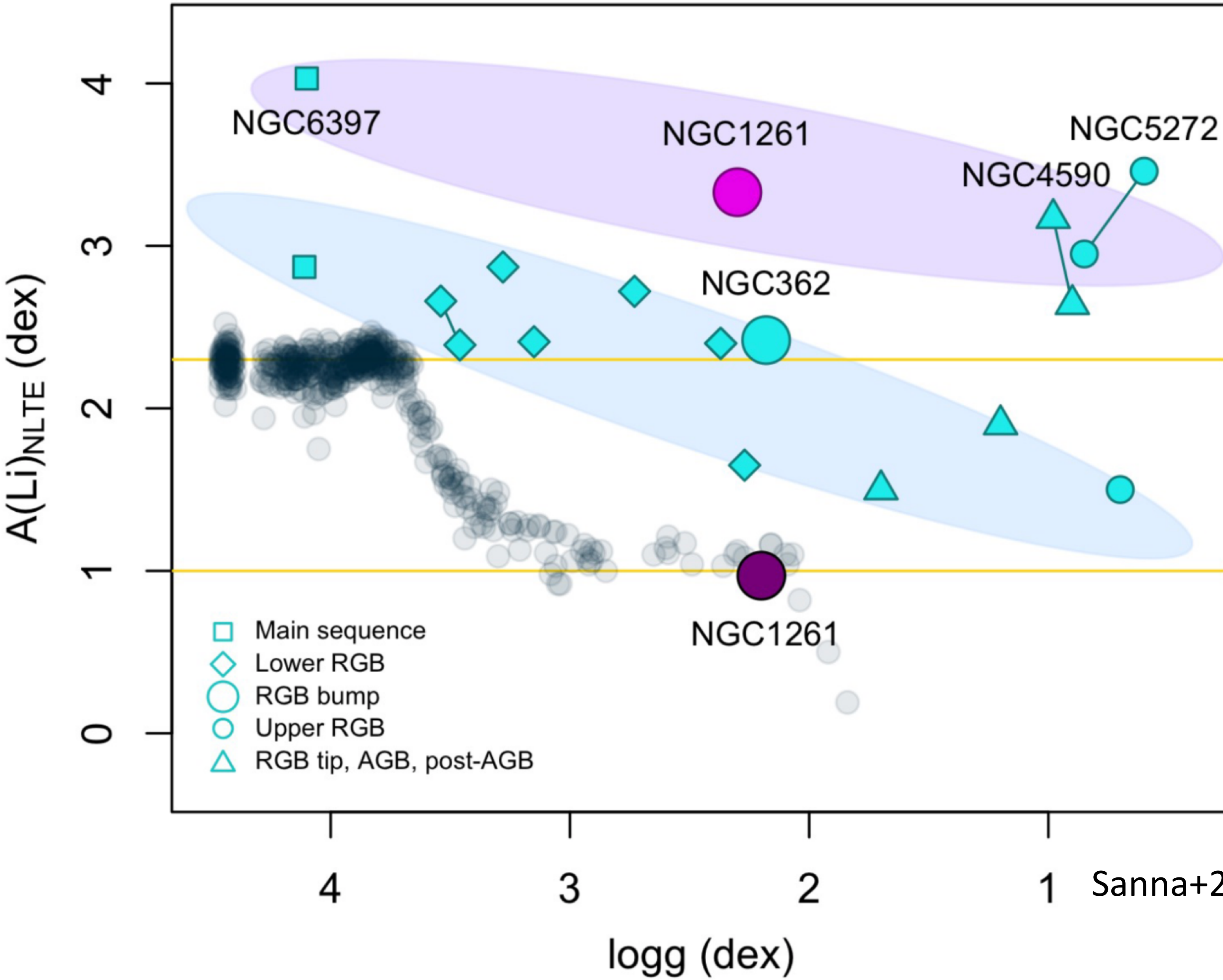


Sanna+2020



Stetson+2019 for photometry

Li-rich GCs stars



Sanna+2020

Li-rich GCs stars

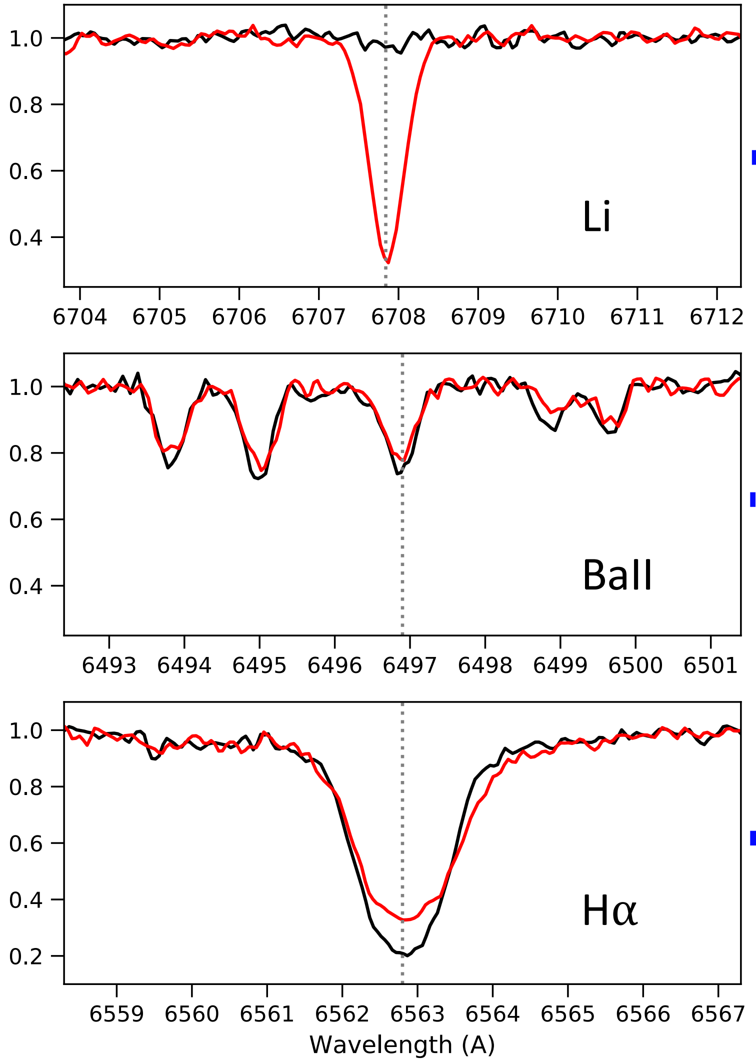
Different mechanisms suggested:

- Contamination from ejecta of novae;
- Accretion of planets and/or brown dwarf;
- Li produced by Cameron-Fowler mechanism in AGB star;
- Contamination from ejecta of super-AGB star;
- Binary system with a massive star;
- Extra mixing process …

but still matter of debate

Li-rich GCs stars

NGC1261



Sanna+2020

Low Li^6/Li_{tot} suggests fresh Li through extra mixing in RGB bump

We suggest new fresh Li through an extra mixing process or pre-existing overabundance due to mass transfer from RGB companion

Hα profile suggests chromospheric activity: not compatible with extra mixing alone.

Conclusions

- GES will provide abundances for several elements (including Li) for hundreds of stars at different evolutionary stages in GCs (but not only in GCs)

- GES will significantly improve our knowledge about Li in GCs

- We need more data and different elements to investigate both MP and Li-rich stars in GCs