

Observational signatures of lithium depletion in the metal-poor globular cluster NGC6397



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Globular Cluster NGC 6397
(ESO/MPI 2.2-m + WFI)

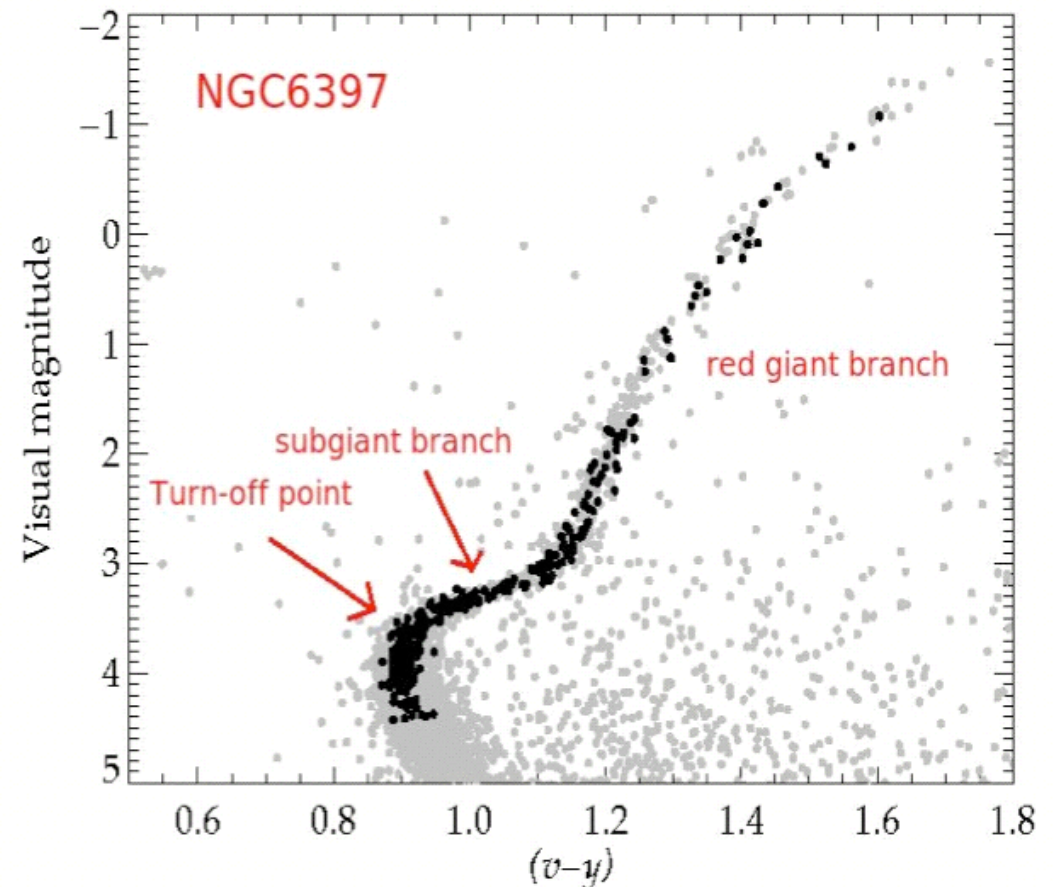
ESO PR Photo 25a/09 (17 August 2009)

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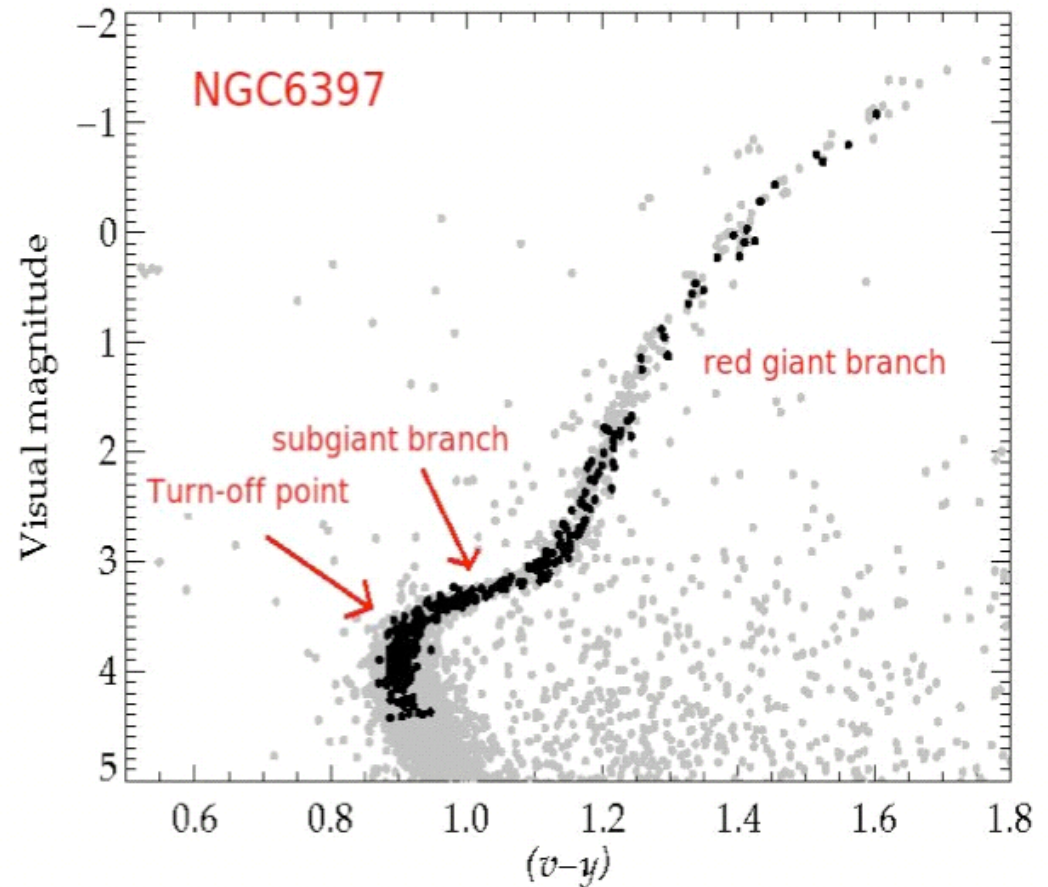
Project

- VLT/FLAMES observations:
 - Li 670.7nm @ R=20 000
 - > 300 stars - dwarfs, subgiants and red giants
- Questions:
 - How does lithium vary with evolutionary phase ?
 - Existence and origin of significant scatter?
- Goals:
 - To constrain models of stellar structure and evolution
 - Ultimately, to find a plausible depletion mechanism, which could solve the primordial Li discrepancy



Analysis

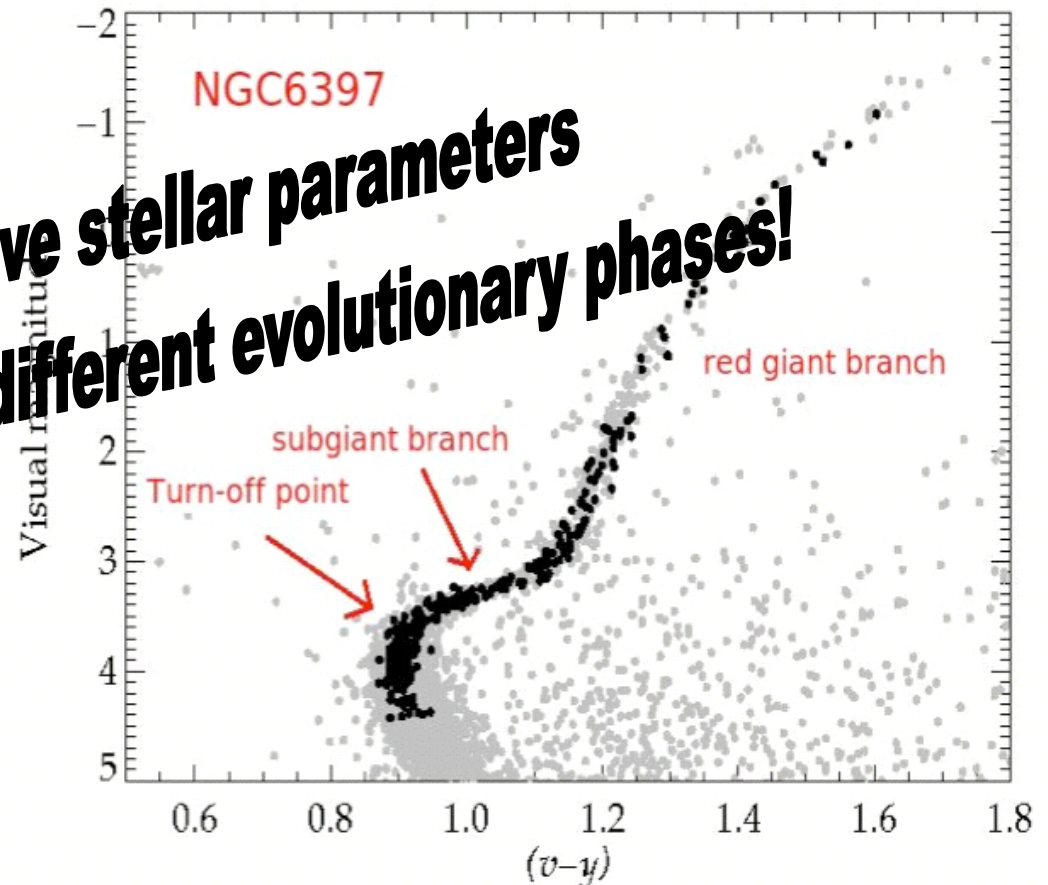
- Photometric stellar parameters:
 - Cluster fiducials suppress artificial scatter caused by photometric error, differential reddening.
 - Synthetic colour calibration (Önehag et al 2009)
 - IRFM calibration (Casagrande et al 2009)



Analysis

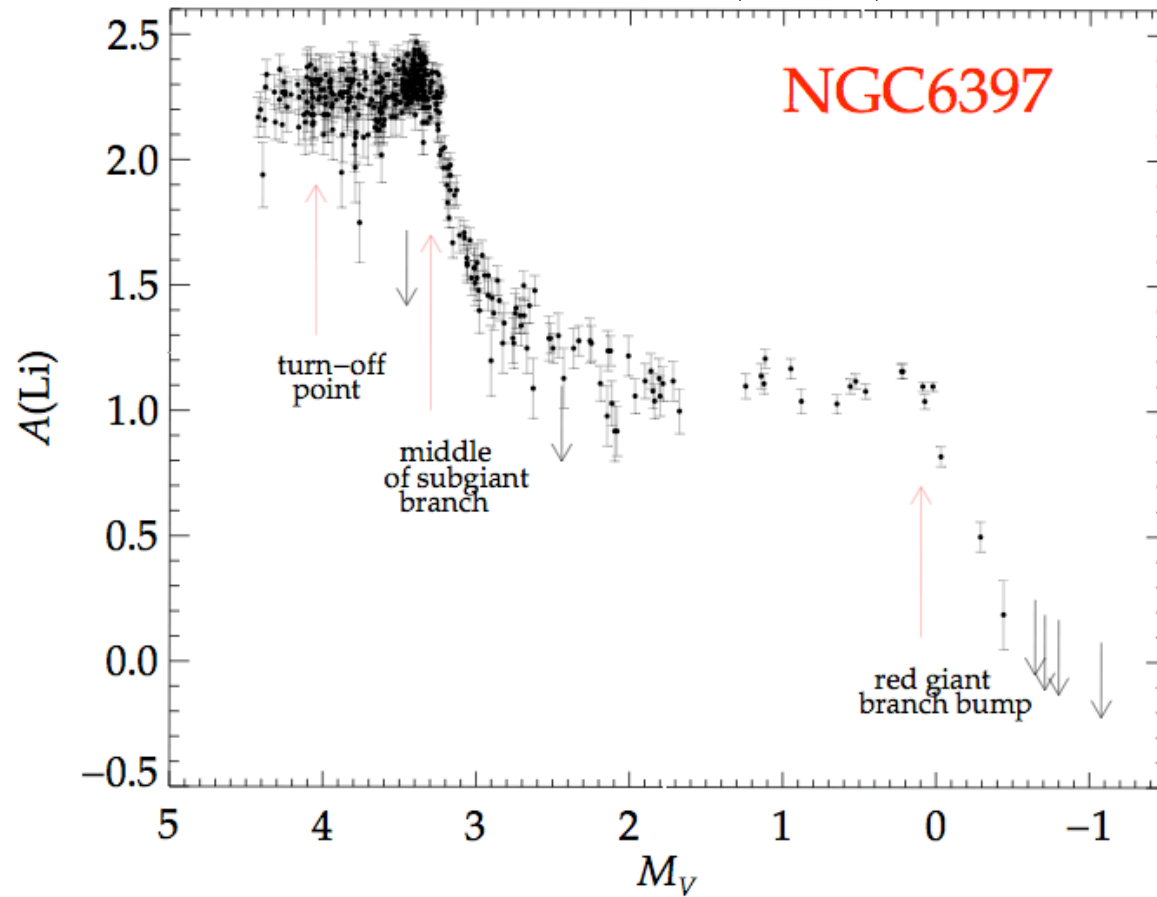
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Accurate relative stellar parameters for groups of stars in different evolutionary phases!



The big picture

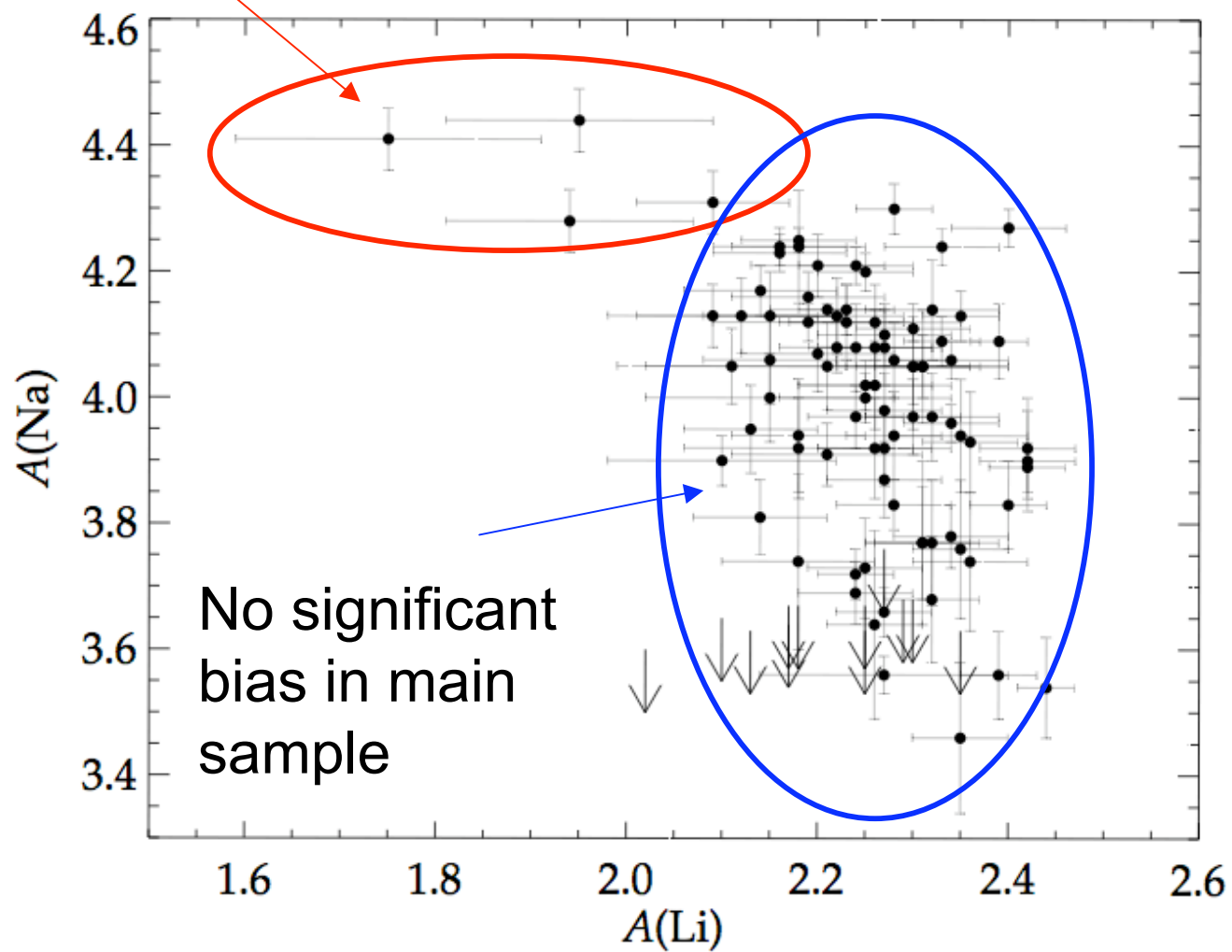
$$A(\text{Li}) = \log\left(\frac{N(\text{Li})}{N(\text{H})}\right) + 12$$



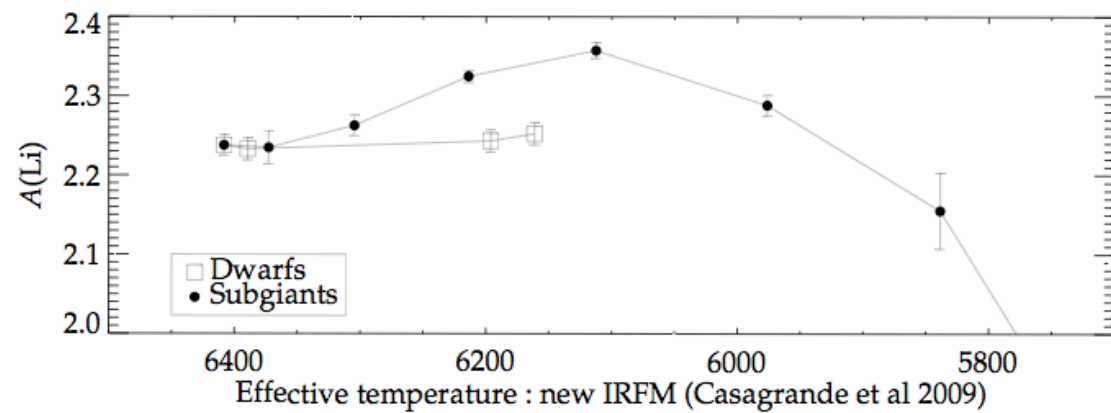
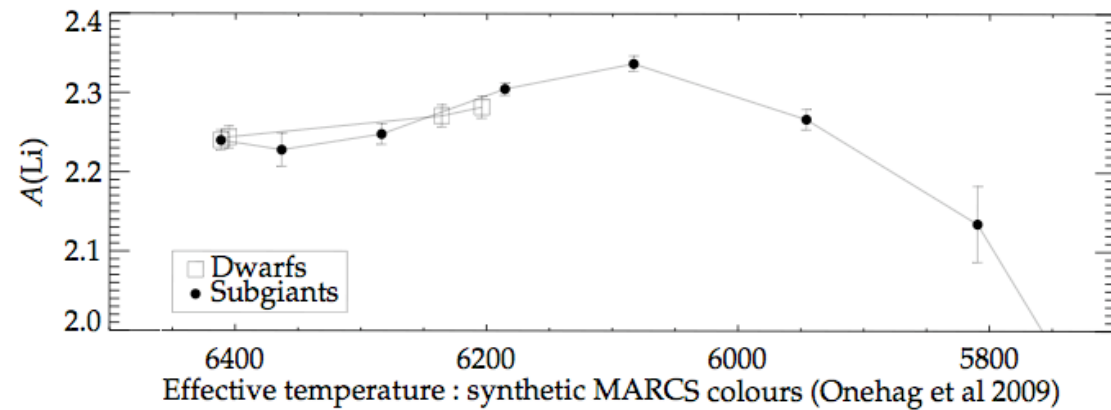
The thickness of the Spite Plateau

- What can explain the existence of lithium-deficient un-evolved stars?
 - Binarity?
 - Rapid rotators?
 - Intra-cluster pollution?
- Field: Ryan 2002,
see poster by L.Elliot
- NGC6752: Pasquini et al 2005
47 Tuc: see poster by V. D'Orazi
- Star-to-star scatter : 0.09 dex
 - Consistent with observational errors
 - The true thickness of the plateau, for metal-poor stars with similar stellar parameters ($T_{\text{eff}}, \log(g), [X/H], \text{Mass}$) must be minimal

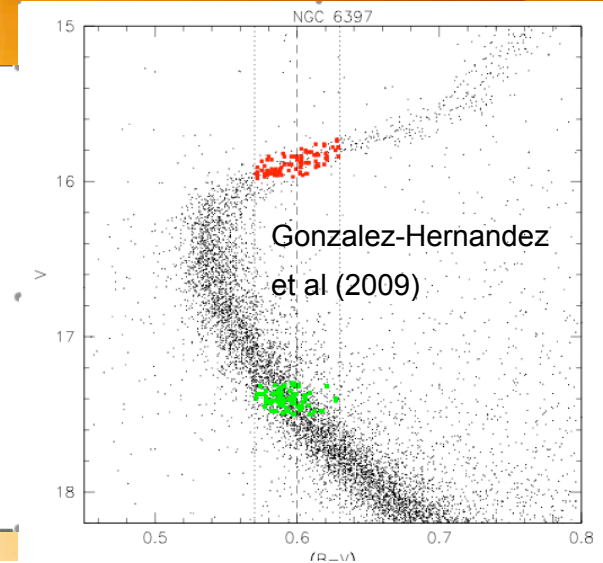
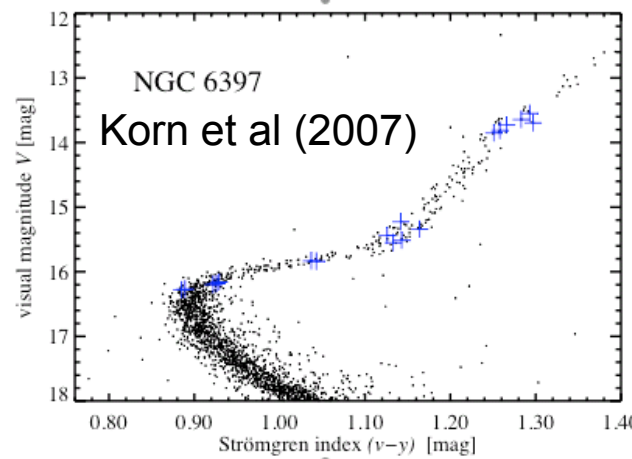
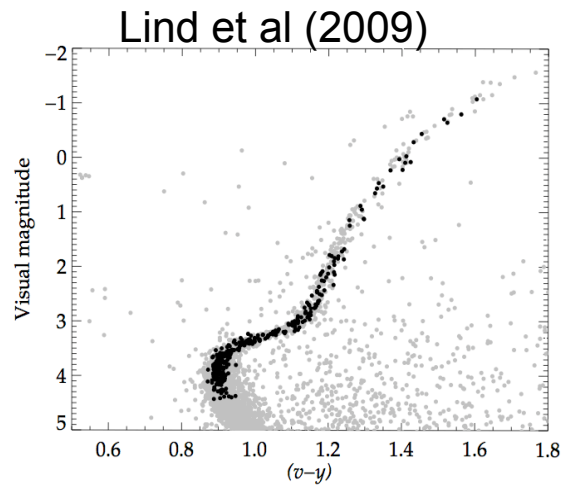
Highly polluted Na-rich, Li-poor stars



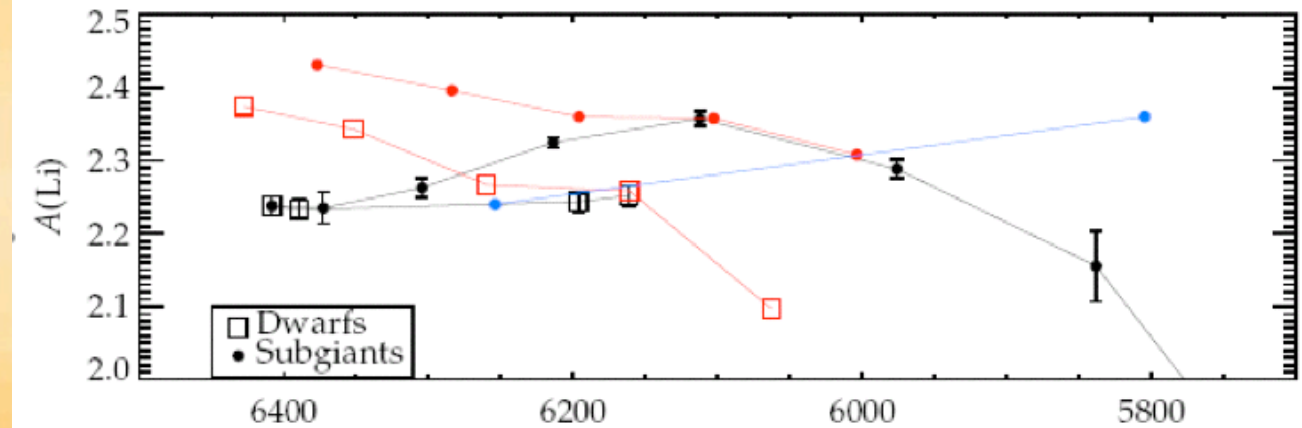
Lithium vs effective temperature I



Lithium vs effective temperature II

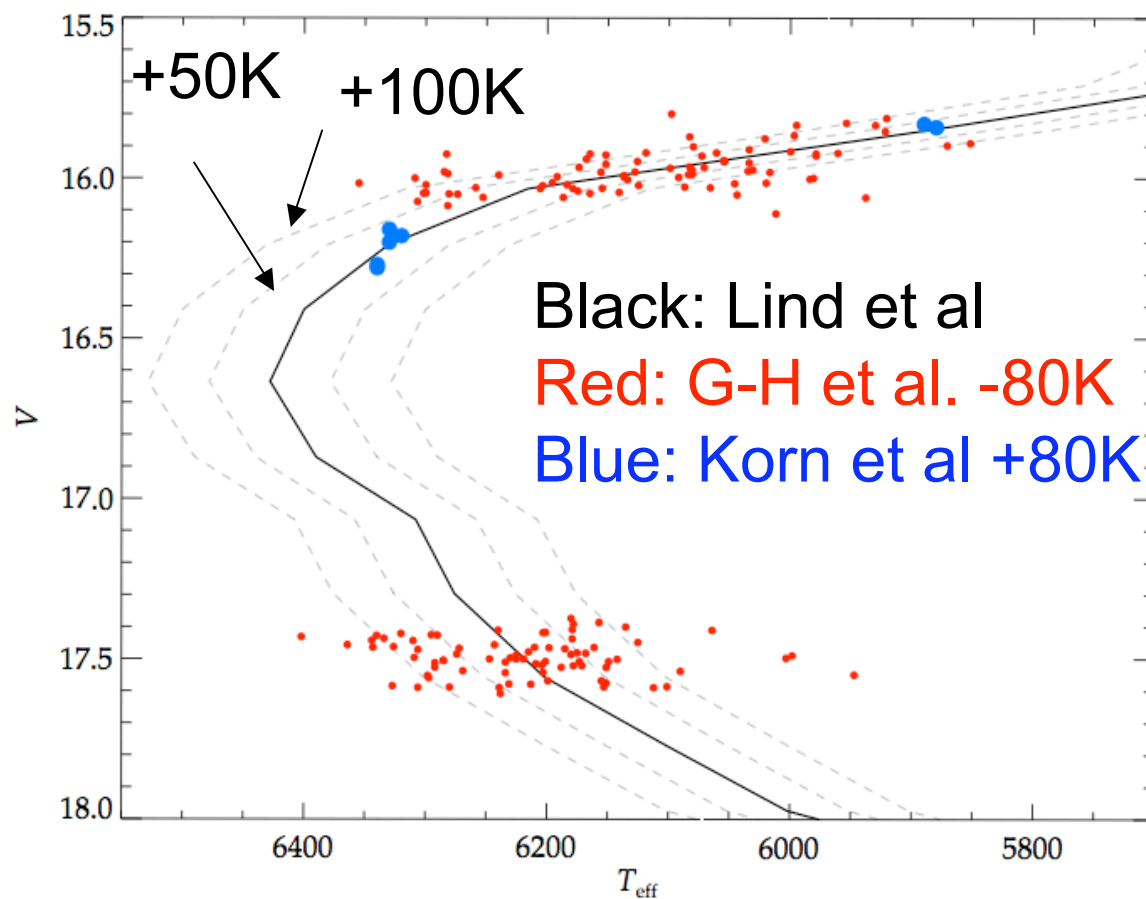


- Lind et al (2009) - 300+170 stars
- Gonzalez-Hernandez et al (2009) - 170 stars
- Korn et al (2007) - 18 stars @ R=47000

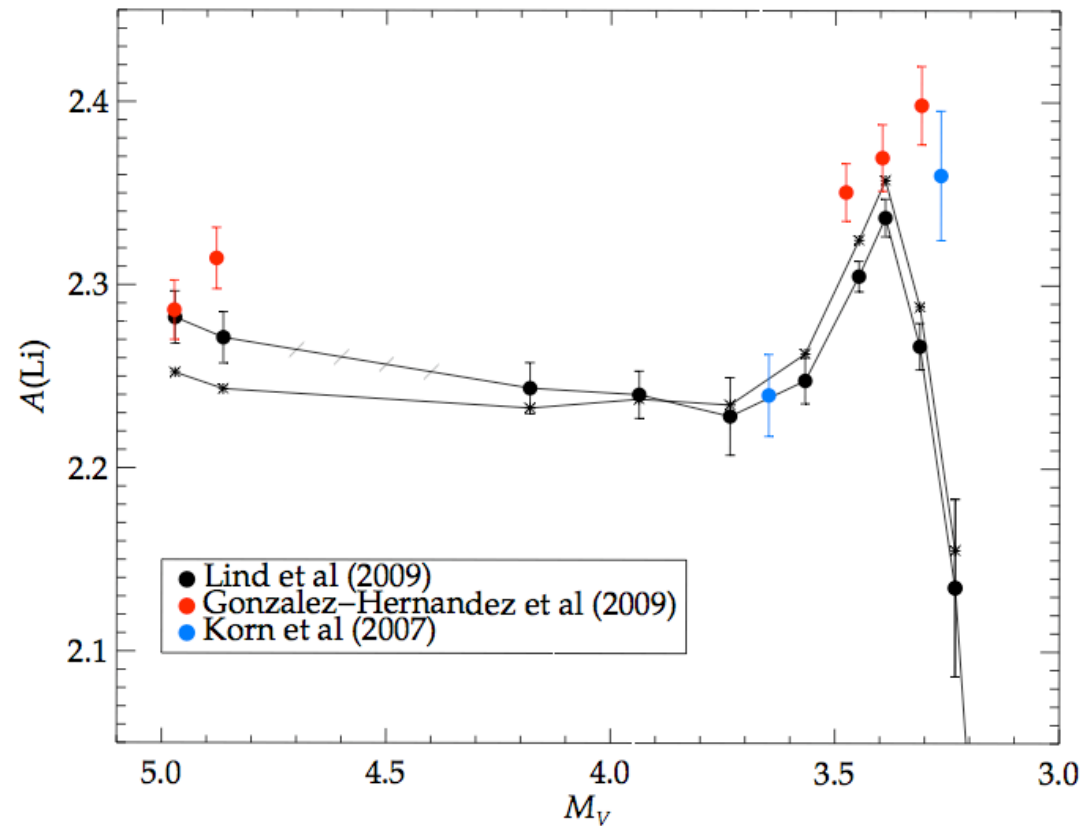


Effective temperature

Lithium vs effective temperature III



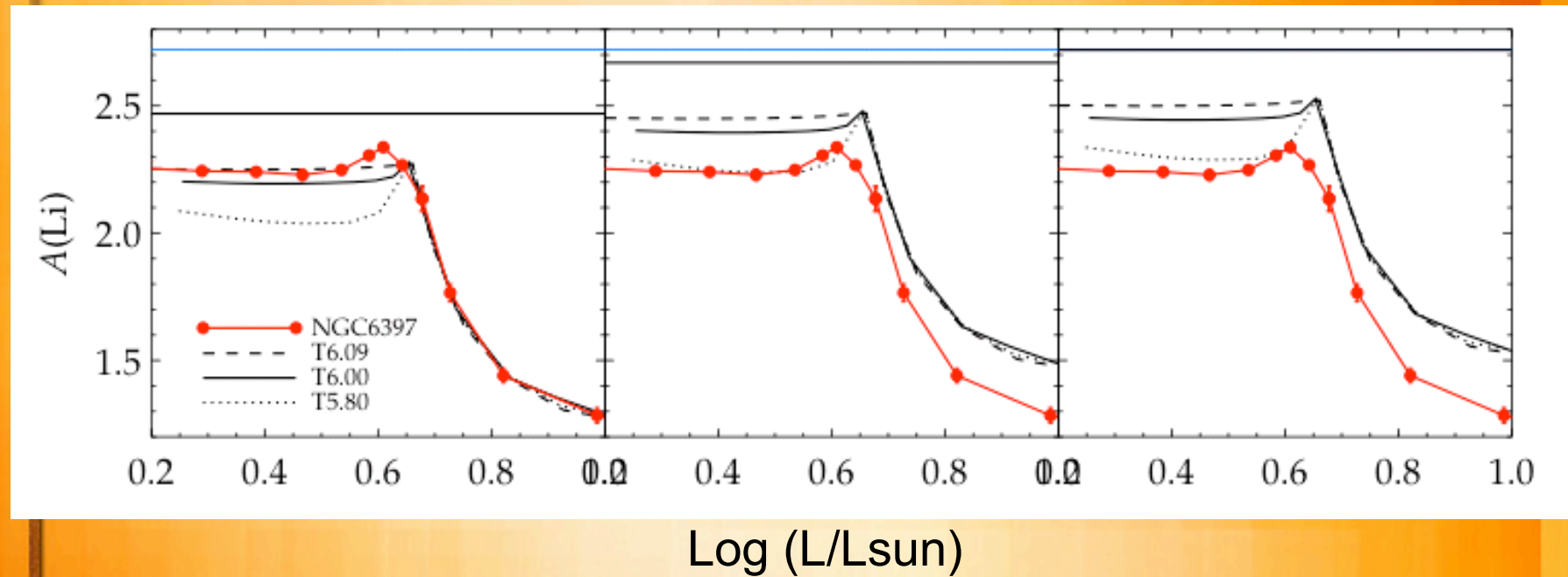
Lithium vs stellar luminosity I



Lithium vs stellar luminosity II

Blue line: WMAP+BBNS

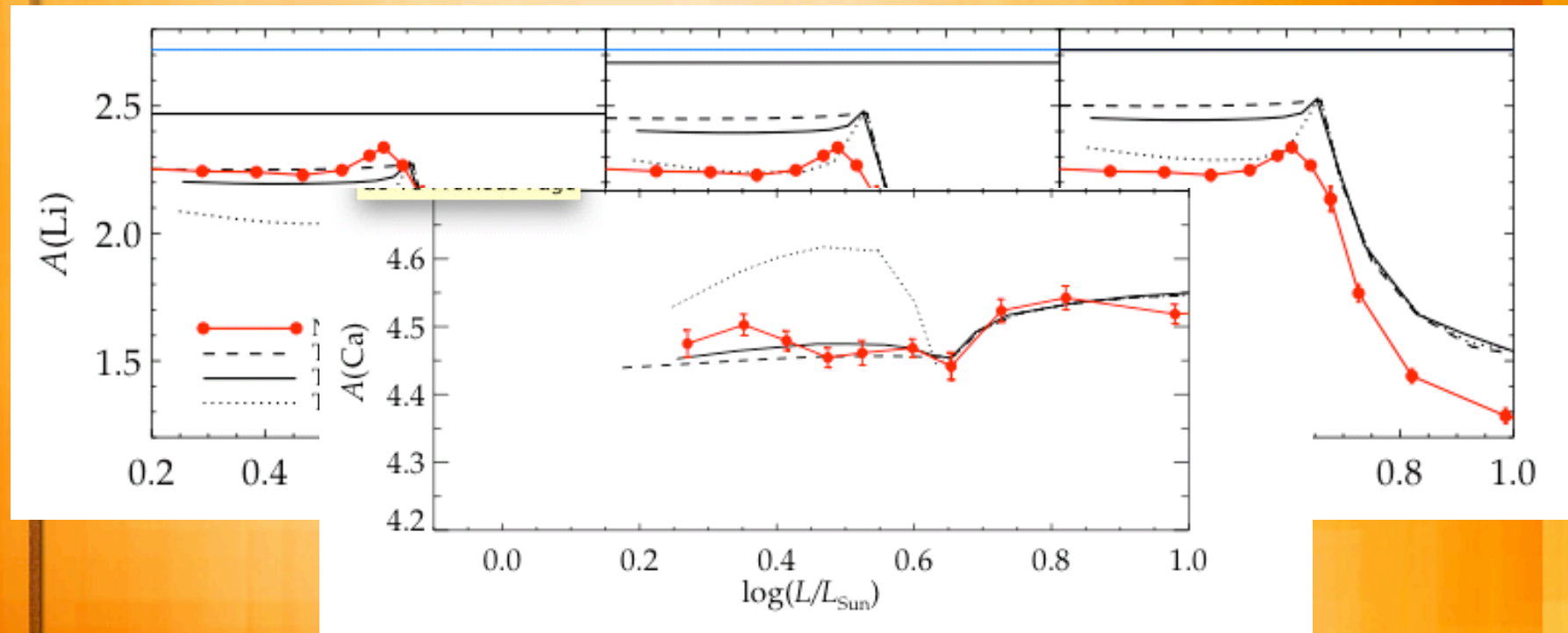
Black line : Initial abundance of Richard et al (2005) model



Lithium vs stellar luminosity II

Blue line: WMAP+BBNS

Black line : Initial abundance of Richard et al (2005) model



Conclusions

- By observing a large number of stars in the metal-poor globular cluster NGC6397, we have found a robust signature of lithium depletion, possibly explained by gravitational settling, moderated by weak turbulence.
- Un-evolved, lithium-deficient stars in GC's can be explained by intra-cluster pollution from a previous generation of stars. Self-enrichment do not introduce significant bias in Li abundance for this cluster.
- For stellar-structure models to have a predictive power regarding the extent of and physics behind lithium depletion from the stellar surface, they should reproduce the detailed behavior of lithium with evolutionary phase as well as the insignificant star-to-star scatter.