New candidates for chromospherically young, kinematically old objects

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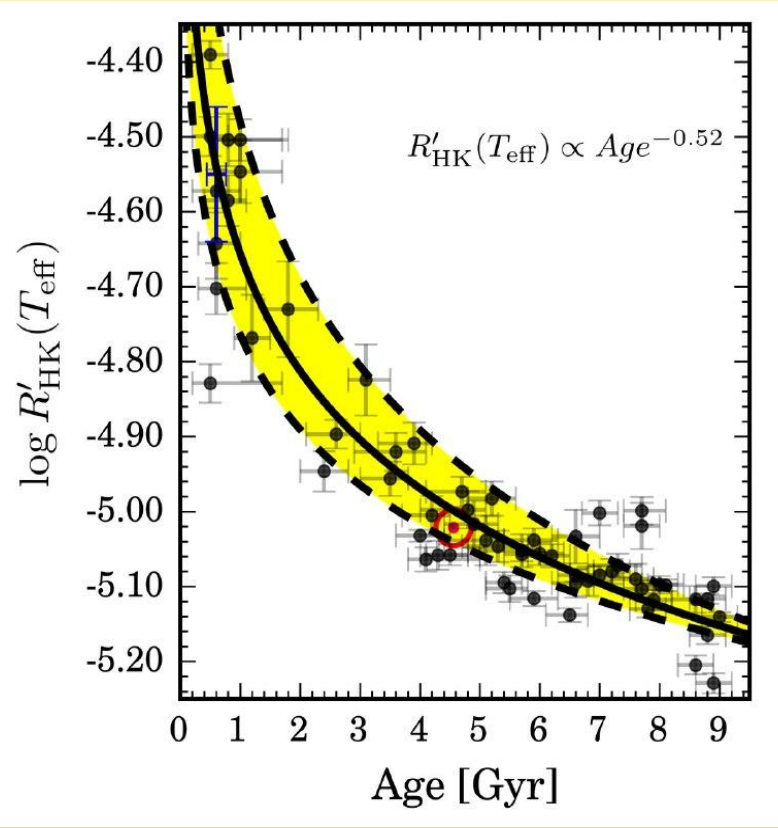
MW-Gaia WG2 School – September 21, 2021

Activity and velocities

Temporal evolution



Lorenzo-Oliveira+18

Chromospheric activity decreases with time

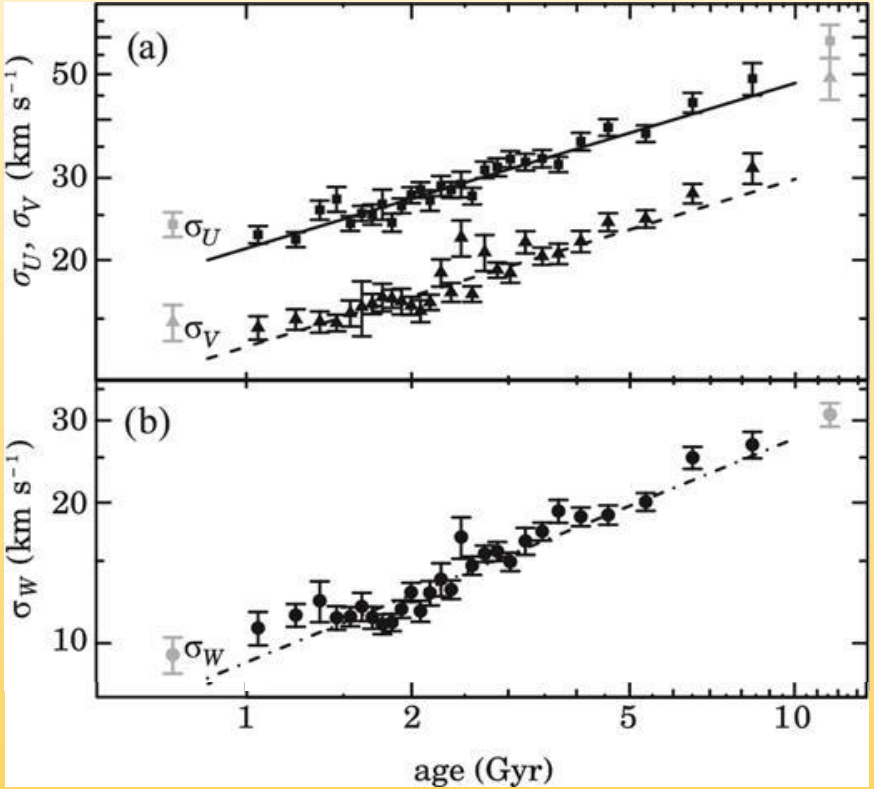
(Wilson, 1963; Wilson & Skumanich, 1964)

Intense chromospheric activity:

young stars

Activity and **velocities**

Temporal evolution



Almeida-Fernandes&Rocha-Pinto18 (adapted)

Diffusion of stellar orbits

(Wielen, 1977)

High dispersions (anomalous velocities):

old stars

CYKOS objects

Objects both active (~young) and “fast” (~old)?

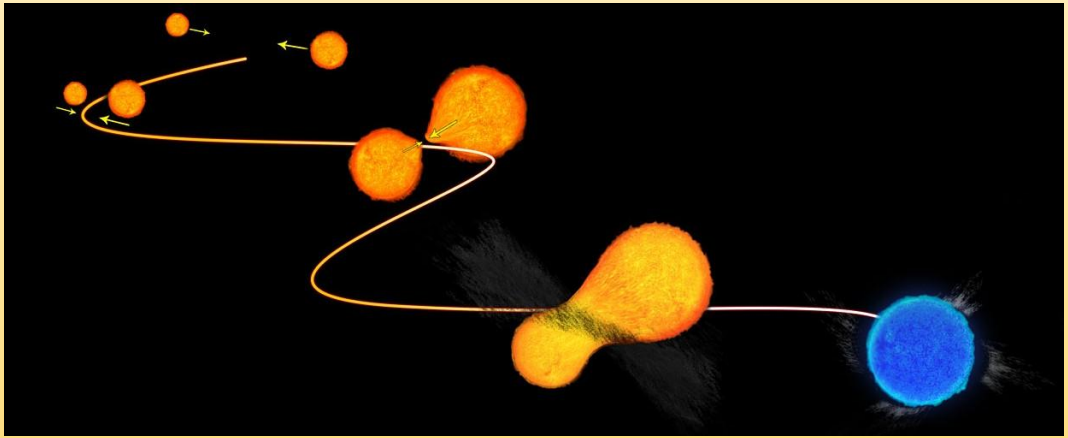
Chromospherically **Y**oung

Kinematically **O**ld

CYKOS objects

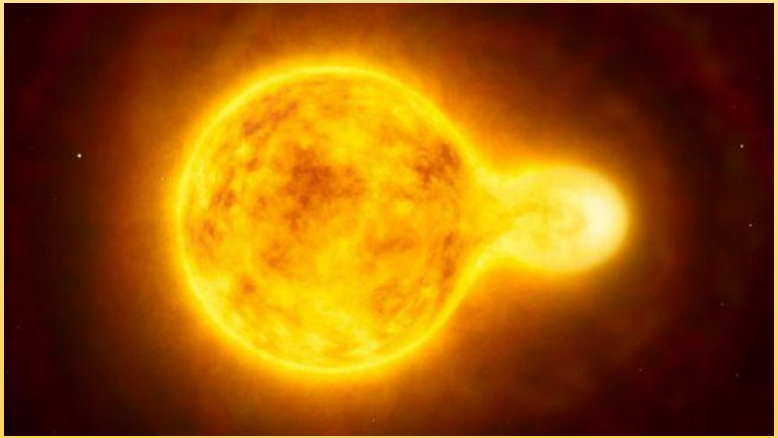
Formation hypothesis

Short-period binaries coalescence (Poveda+96)



NASA/ESA

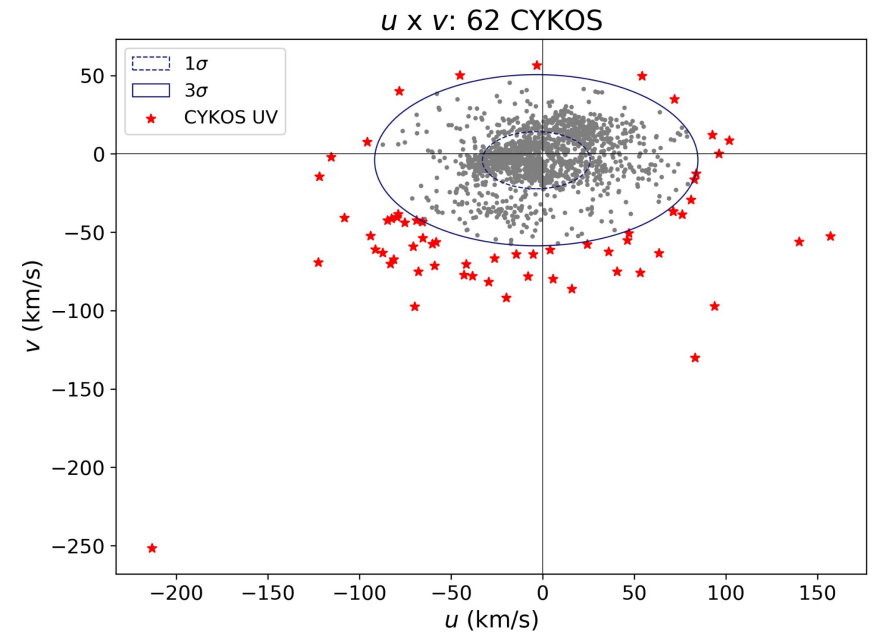
Science photo library

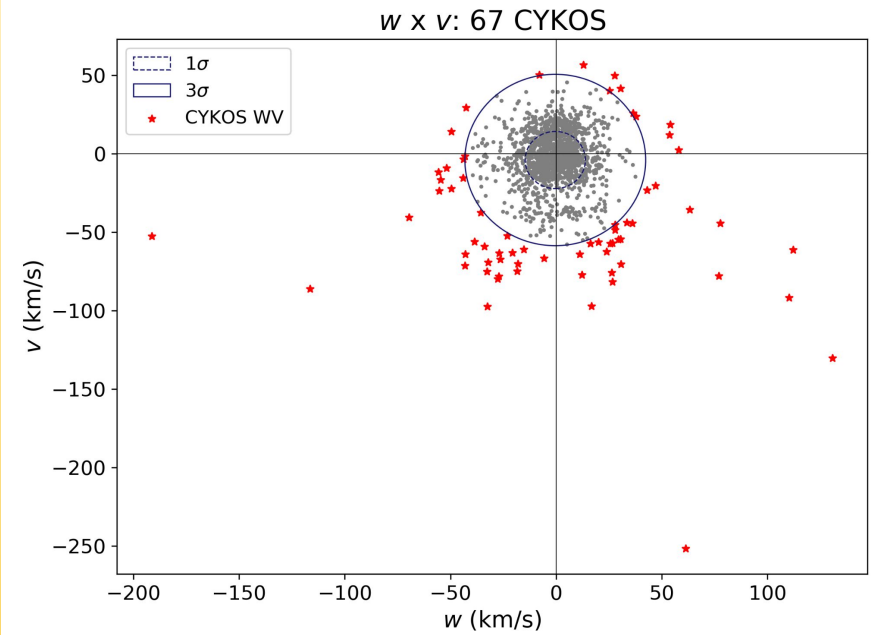


Mass and angular momentum accretion (Jeffries+96)

CYKOS objects

Space velocities diagrams



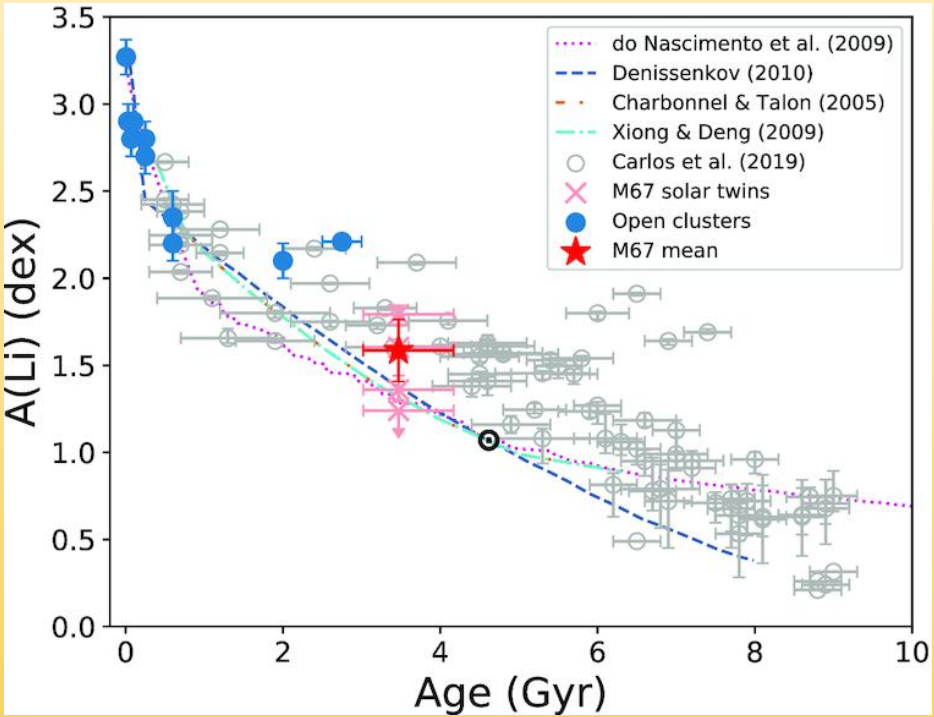


u x v and/or ***w x v***: 92 CYKOS (84 FGK)

Lithium and observations

Temporal evolution

Carlos+20



Depletion by mixture effects

(Greenstein & Richardson, 1951; Herbig 1965)

No or a small amount of lithium:

old stars

Lithium and **observations**

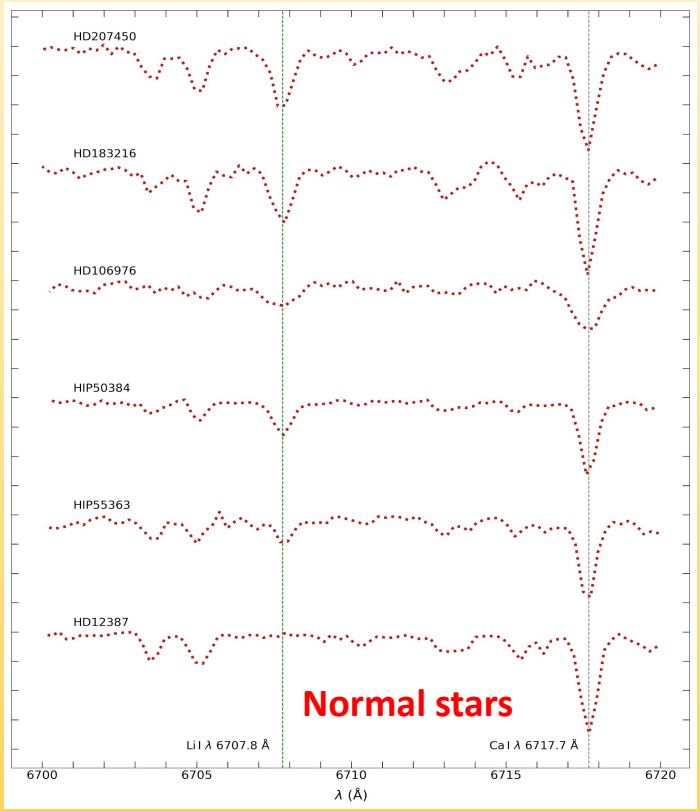
Spectra observed at Pico dos Dias observatory (1.6 m Perkin-Elmer telescope)

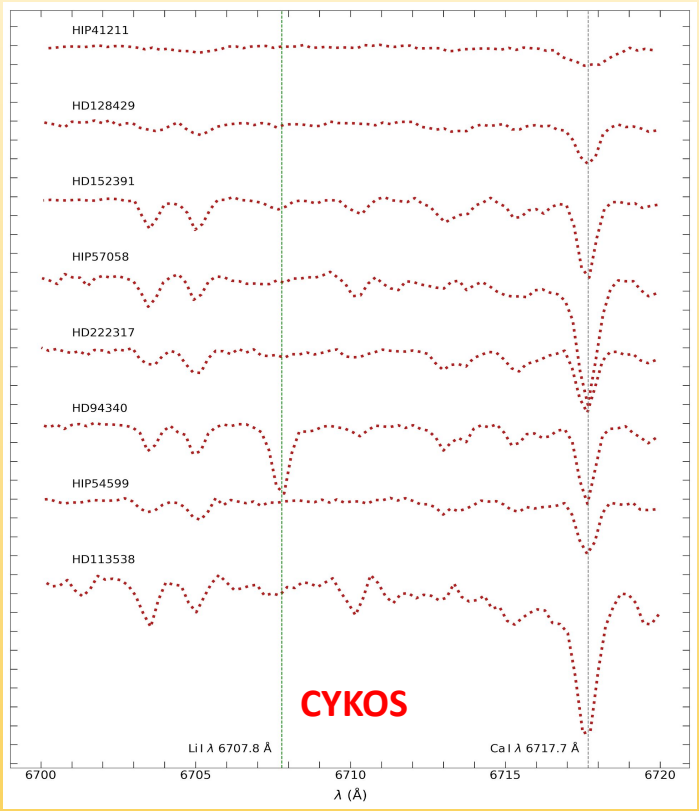
- R ~ 13000
- S/R: ≳100

Archive spectra from ESO-HARPS (La Silla)

- R ~ 115000 degraded to R ~ 13000
- S/R: ≳100

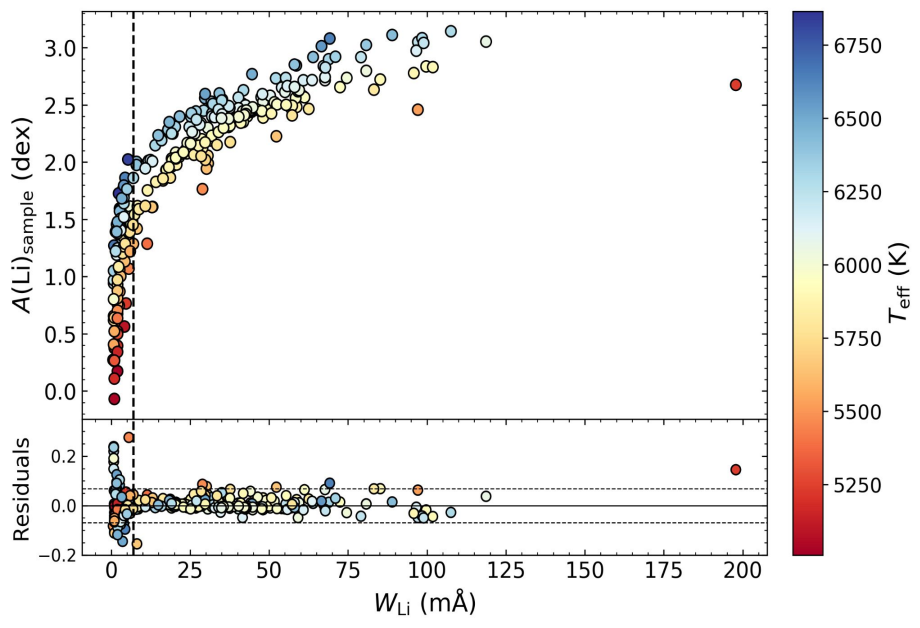
Lithium and observations

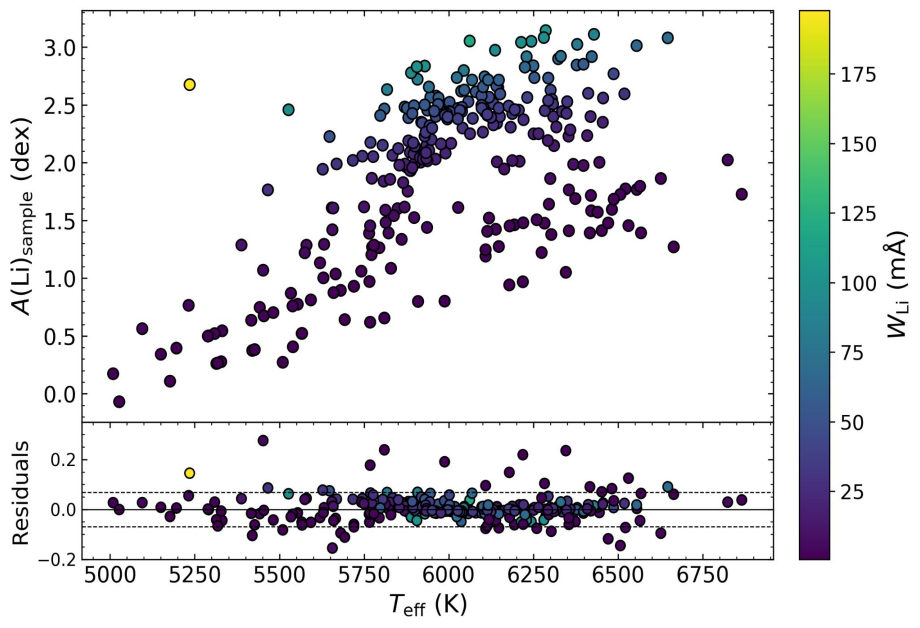




Lithium and observations

Abundances via linear regression: $A(\mathrm{Li}) \leftarrow T_{\mathrm{ef}}, W_{\mathrm{Li}}$

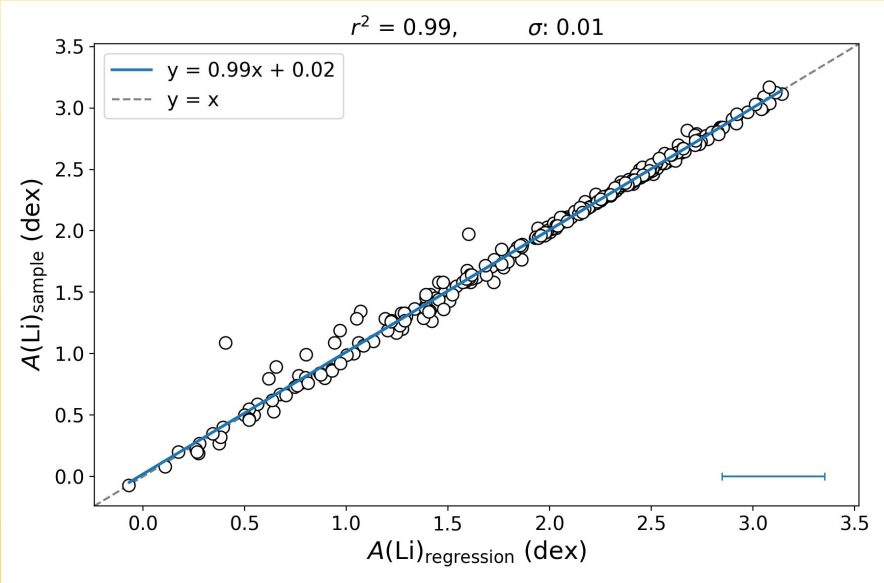


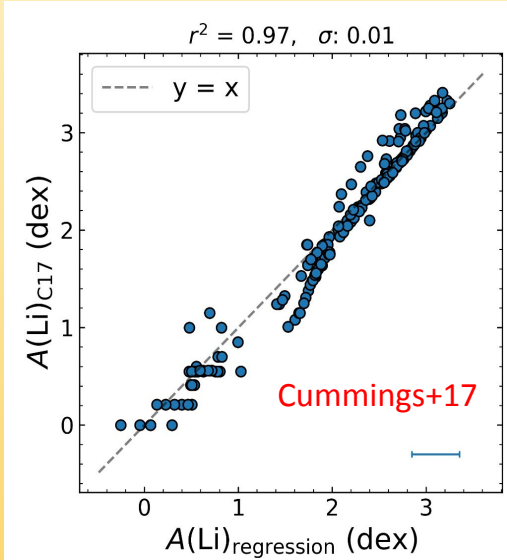


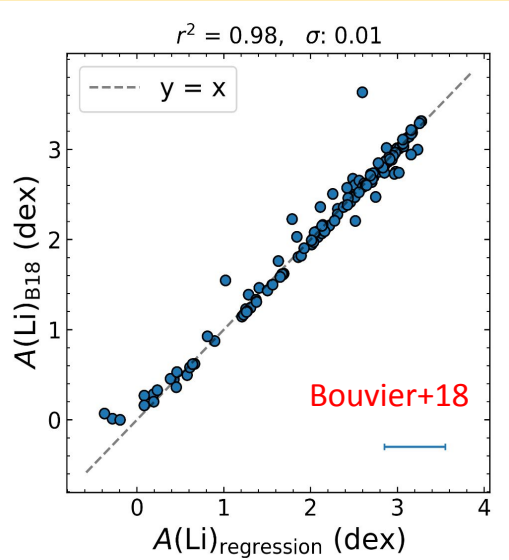
$$A(\mathrm{Li}) \propto T_{\mathrm{ef}},\ T_{\mathrm{ef}}^2,\ W_{\mathrm{Li}},\ \log W_{\mathrm{Li}}$$

Lithium and observations

Abundances via linear regression: $A(\mathrm{Li}) \leftarrow T_{\mathrm{ef}}, W_{\mathrm{Li}}$



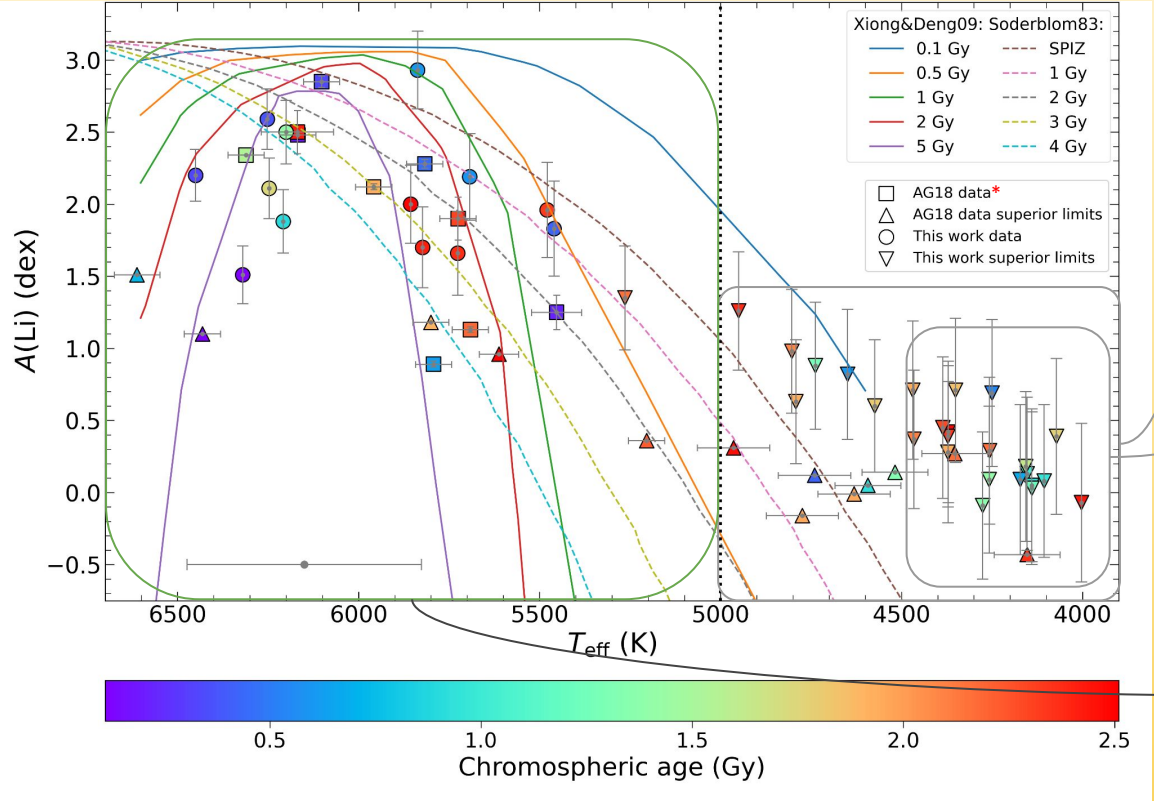




$$A(\mathrm{Li}) \propto T_{\mathrm{ef}},\ T_{\mathrm{ef}}^2,\ W_{\mathrm{Li}},\ \log W_{\mathrm{Li}}$$

Results

Lithium in CYKOS



*AG18: Aguilera-Gómez et al., 2018

4000 K < $T_{\rm eff}$ < 5000 K:
Not covered by current training set

$T_{\rm eff}$ < 4500 K:
Not covered by isochrones

$T_{\rm eff}$ > 5000 K:
18 objects with less lithium than expected (according to CA) considering either set of isochrones

Results

Lithium in CYKOS

After removing binaries, 14 coalesced candidate objects:

- HIP 6159 / HD 7983: II;
- HIP 30158 / HD 44665: I*;
- HIP 31476 / HD 46872: I;
- HIP 42575 / HD 73393: II*;
- HIP 44075 / HD 76932: II;
- HIP 54599 / HD 97089: I;
- HIP 57450 / BD+51 1696: II*;
- HIP 64583 / HD 114837: II;
- HIP 78716 / HD 143846: I*;
- HIP 82588 / HD 152391: I*, II;
- HIP 87062 / BD-08 4501: II;
- HIP 89348 / HD 168151: II;
- HIP 105858 / HD 203608: I, II;
- HIP 108056 / BD+35 4669: II.

I: our data

II: data from AG+18

*: suspects

Results

White dwarf companions?

2013, MNRAS

Where are all the Sirius-like binary systems?

J. B. Holberg,[1]★ T. D. Oswalt,[2] E. M. Sion,[3] M. A. Barstow[4] and M. R. Burleigh[4]

[1]*Lunar and Planetary Laboratory, Sonnett Space Sciences Bld., University of Arizona, Tucson, AZ 85721, USA*
[2]*Florida Institute of Technology, Melbourne, FL 32091, USA*
[3]*Department of Astronomy and Astrophysics, Villanova University, 800 Lancaster Ave., Villanova, PA 19085, USA*
[4]*Department of Physics and Astronomy, University of Leicester, University Road, Leicester LE1 7RH, UK*

HIP 10138 / HD 13445

2020, MNRAS

A new white dwarf companion around the $\Delta\mu$ star GJ 3346

M. Bonavita,[1,2]★ C. Fontanive,[3] S. Desidera,[4] V. D'Orazi,[4] A. Zurlo,[5,6] K. Mužić,[7] B. Biller,[1,2] R. Gratton,[4] D. Mesa[4] and A. Sozzetti[8]

[1]*SUPA, Institute for Astronomy, University of Edinburgh, Blackford Hill, Edinburgh EH9 3HJ, UK*
[2]*Centre for Exoplanet Science, University of Edinburgh, Edinburgh EH9 3HJ, UK*
[3]*Center for Space and Habitability, University of Bern, Gesellschaftsstrasse 6, CH-3012 Bern, Switzerland*
[4]*INAF – Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, I-35121 Padova, Italy*
[5]*Núcleo de Astronomía, Facultad de Ingeniería y Ciencias, Universidad Diego Portales, Av. Ejercito 441 ,8370191 Santiago, Chile*
[6]*Escuela de Ingeniería Industrial, Facultad de Ingeniería y Ciencias, Universidad Diego Portales, Av. Ejercito 441, 8370191 Santiago, Chile*
[7]*CENTRA, Faculdade de Ciências, Universidade de Lisboa, Ed. C8, Campo Grande, P-1749-016 Lisboa, Portugal*
[8]*INAF – Osservatorio Astrofisico di Torino, Via Osservatorio 20, I-10025 Pino Torinese, Italy*

HIP 24874 / HD 34865

Conclusions and perspectives

- 84 FGK CYKOS objects
- Regression for lithium abundances

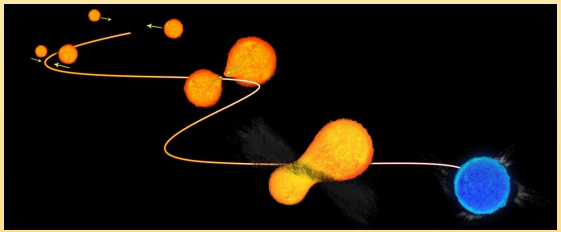
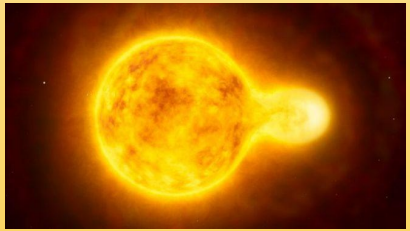


Ilustração: NASA/ESA

- 14 candidates for coalesced

→ Coalescence seems a reasonable scenario!



Science photo library

- 2 binary systems K dwarf + white dwarf

→ Preliminar: accretion also seems reasonable

Conclusions and **perspectives**

- Chemical analysis of CYKOS formed through accretion
  - s process elements: Sr, Y, Zr, Ba...
- Lithium abundances
  - other machine learning techniques
  - additional constraints: mass, metallicity
  - better quality observational data
- Gaia DR3
  - up-to-date astrometric data for nearly 2 billion objects