INSTITUTO DE ASTROFÍSICA
FACULTAD DE FÍSICA

MILLENNIUM INSTITUTE OF ASTROPHYSICS

Lithium as a chemical signature of planet engulfment

Claudia Aguilera Gómez

Pontificia Universidad Católica de Chile
Instituto Milenio de Astrofísica, Chile

Julio Chanamé, Marc Pinsonneault, Joleen Carlberg, Matías Jones

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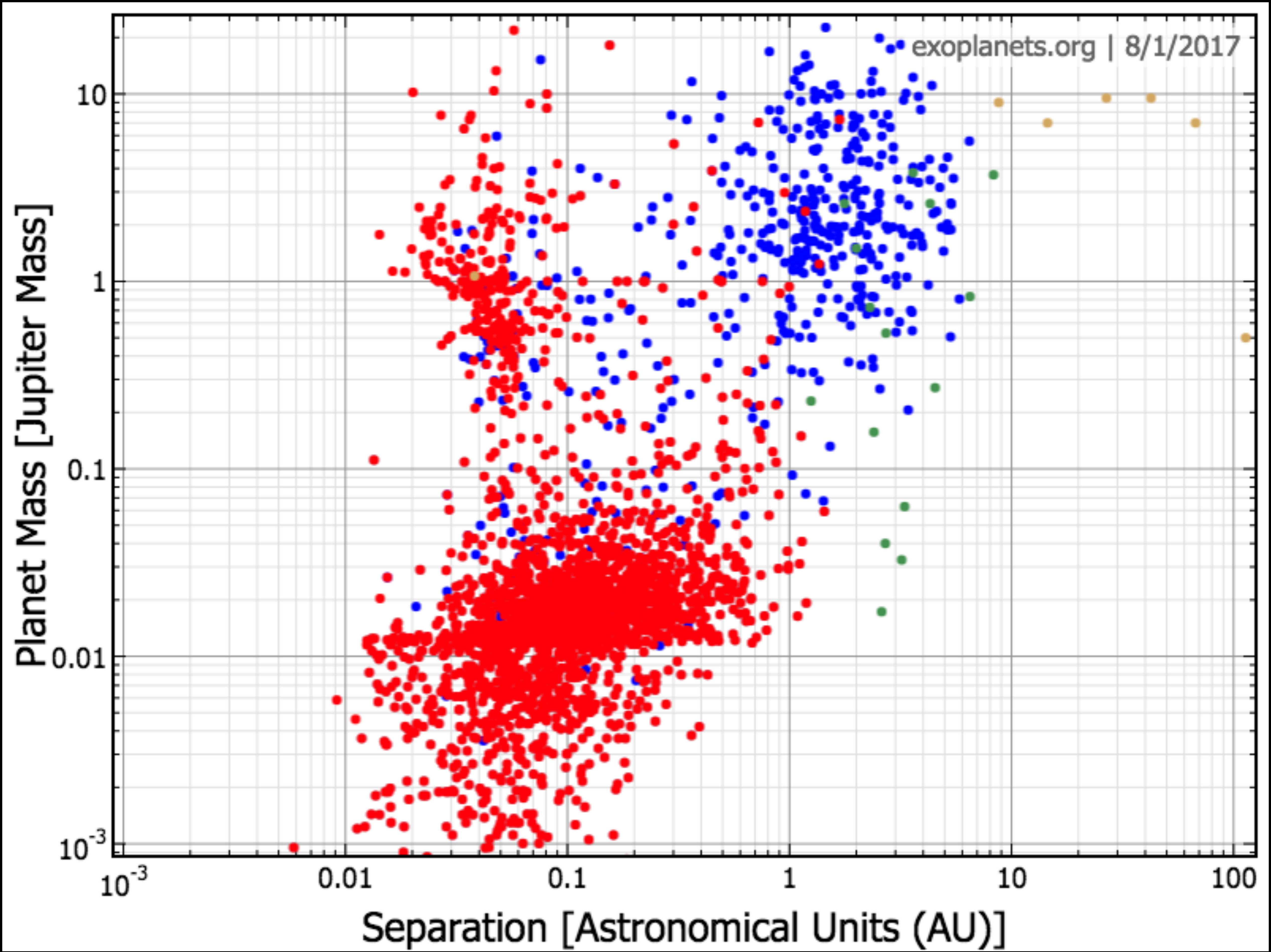
exoplanets.org | 8/1/2017
Planet Mass [Jupiter Mass]
10
1
0.1
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10^{-3}
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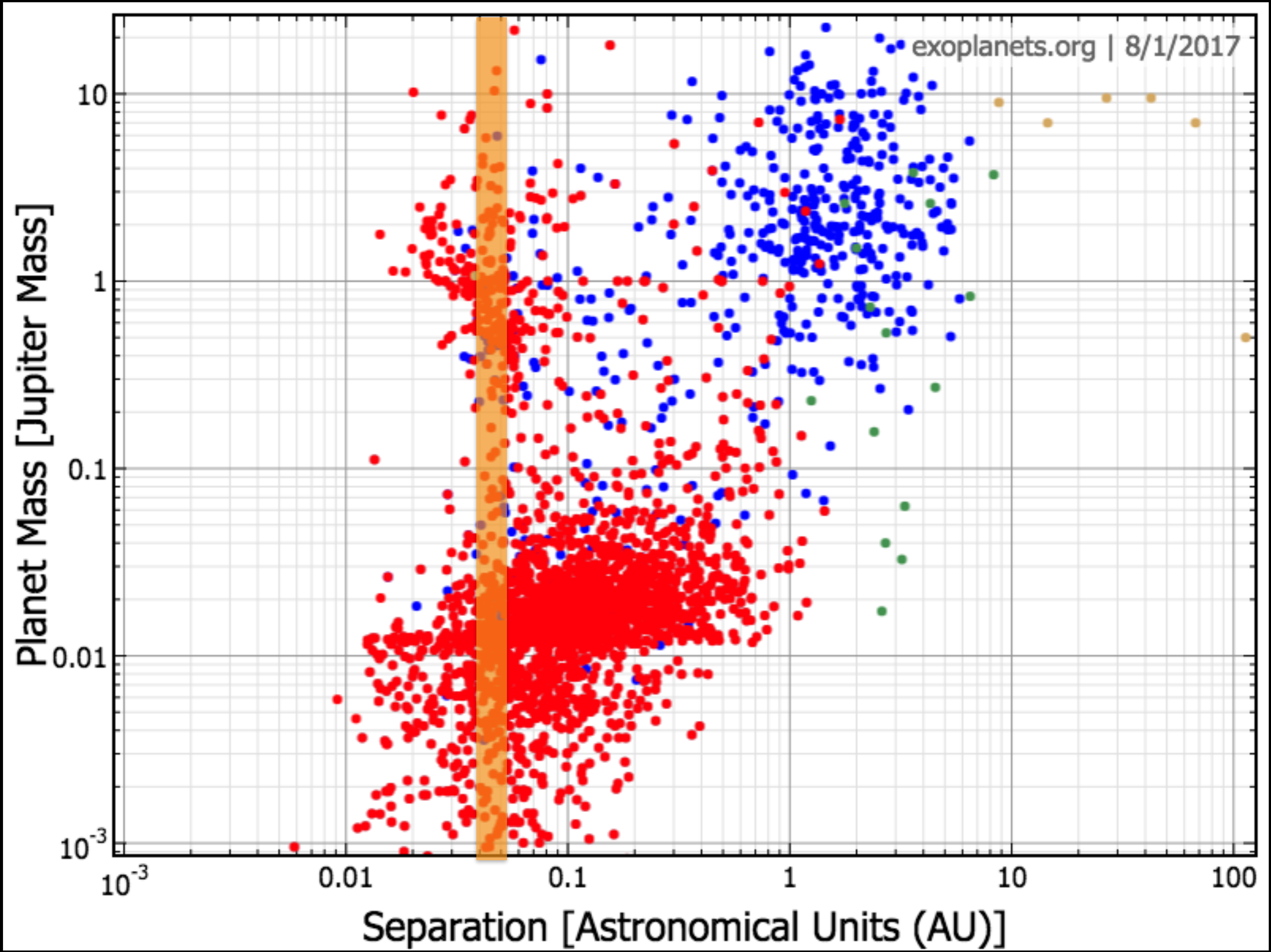
1
10
100
Separation [Astronomical Units (AU)]

10 R☉



exoplanets.org | 8/1/2017
Planet Mass [Jupiter Mass]
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1
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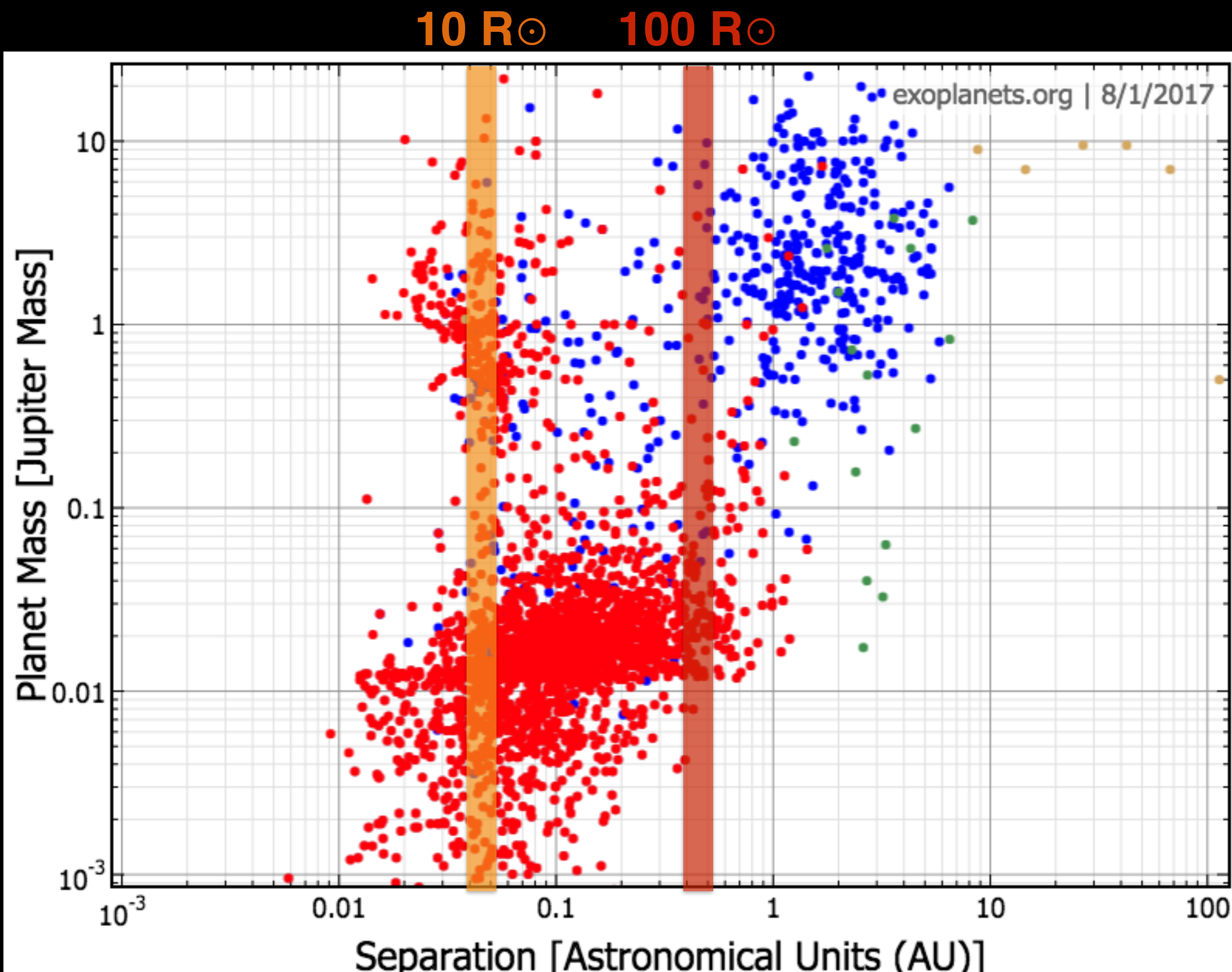
1
10
100
Separation [Astronomical Units (AU)]



10 R⊙
100 R⊙
exoplanets.org | 8/1/2017
Planet Mass [Jupiter Mass]
10
1
0.1
0.01
10^{-3}
Separation [Astronomical Units (AU)]
10^{-3}
0.01
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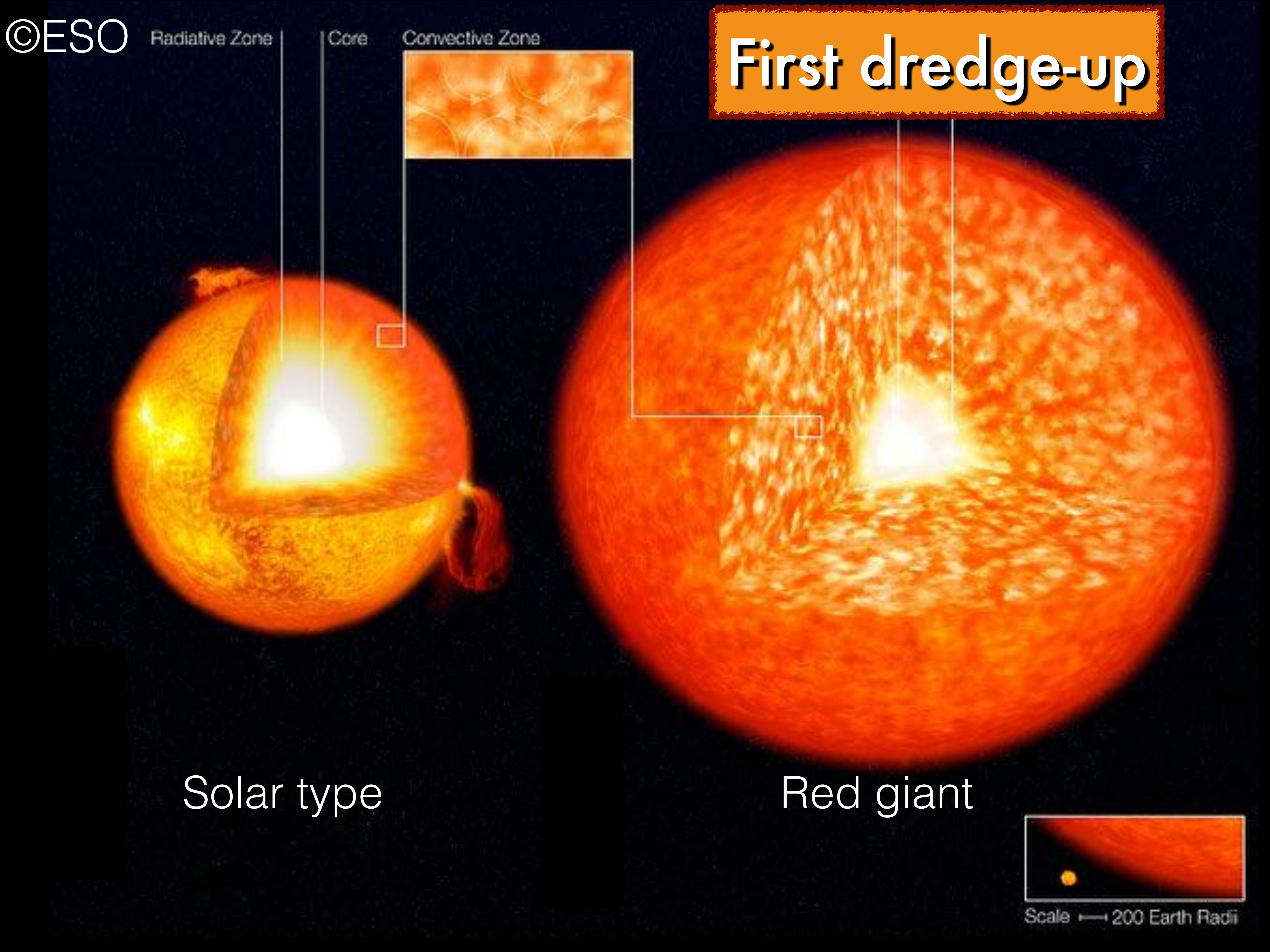
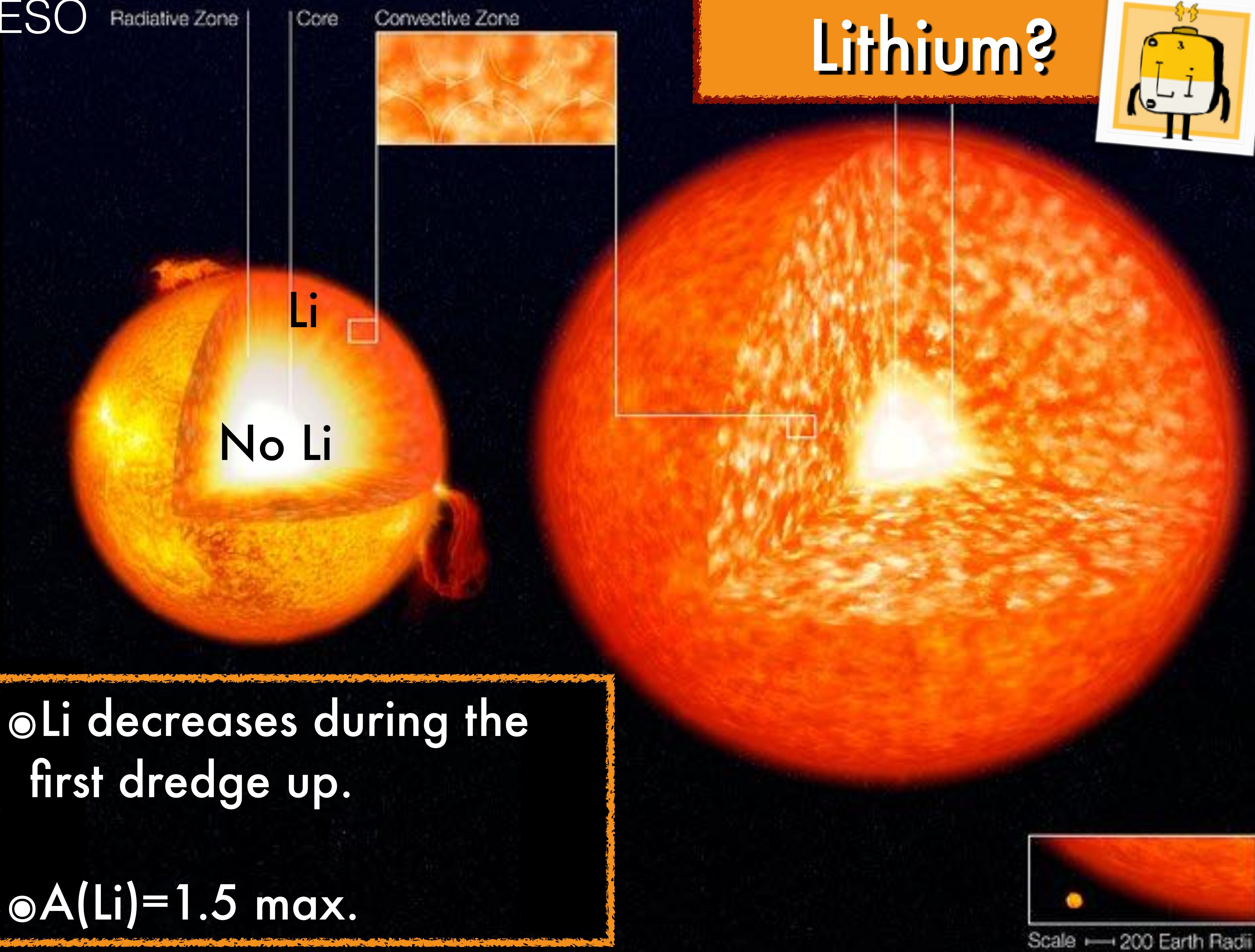
1
10
100


©ESO
Radiative Zone
Core
Convective Zone
First dredge-up
Solar type
Red giant
Scale 200 Earth Radii

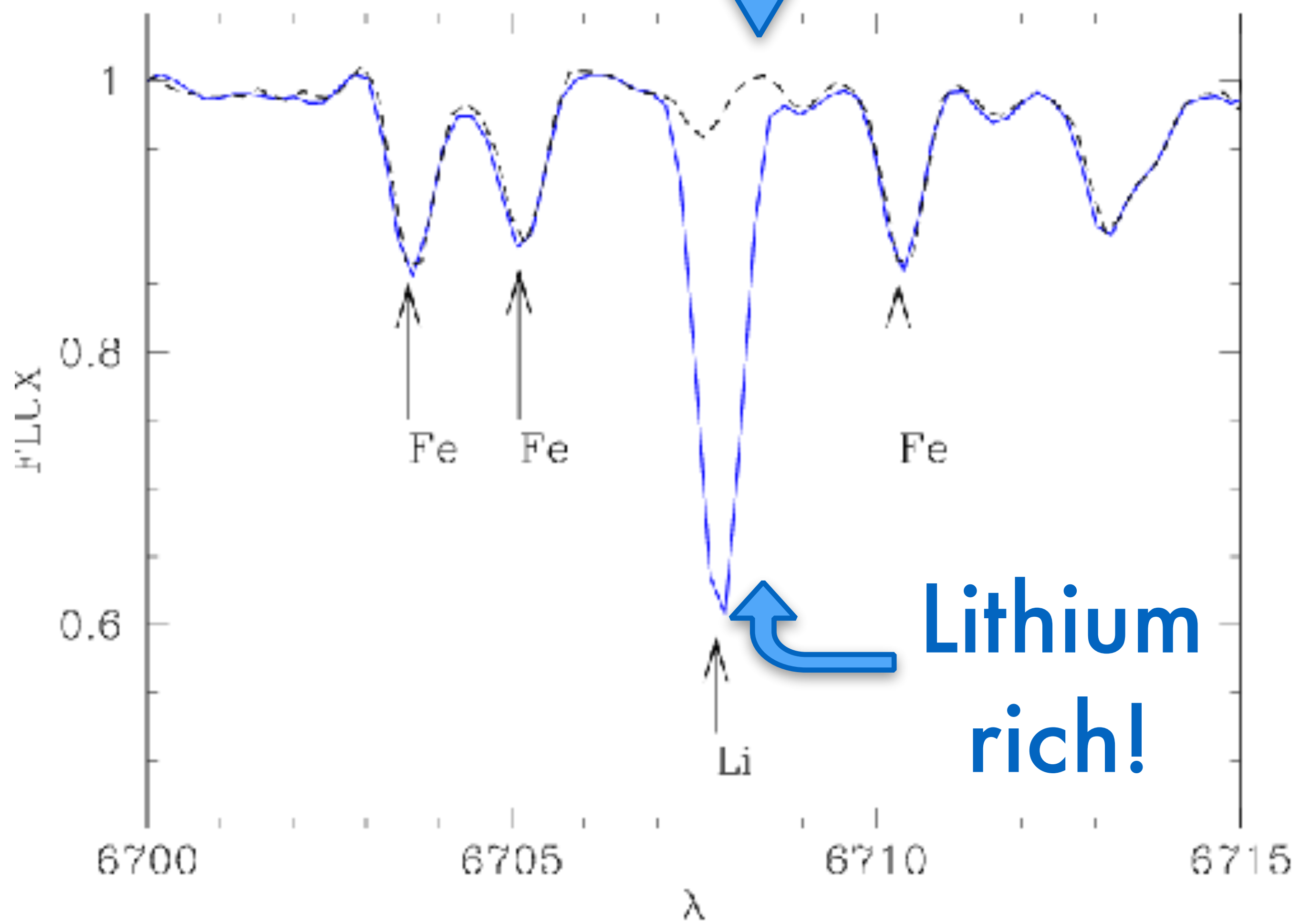
Lithium?



- Li decreases during the first dredge up.
- A(Li)=1.5 max.

Lithium Rich Red Giants

Lithium-"poor" - Most of the giants



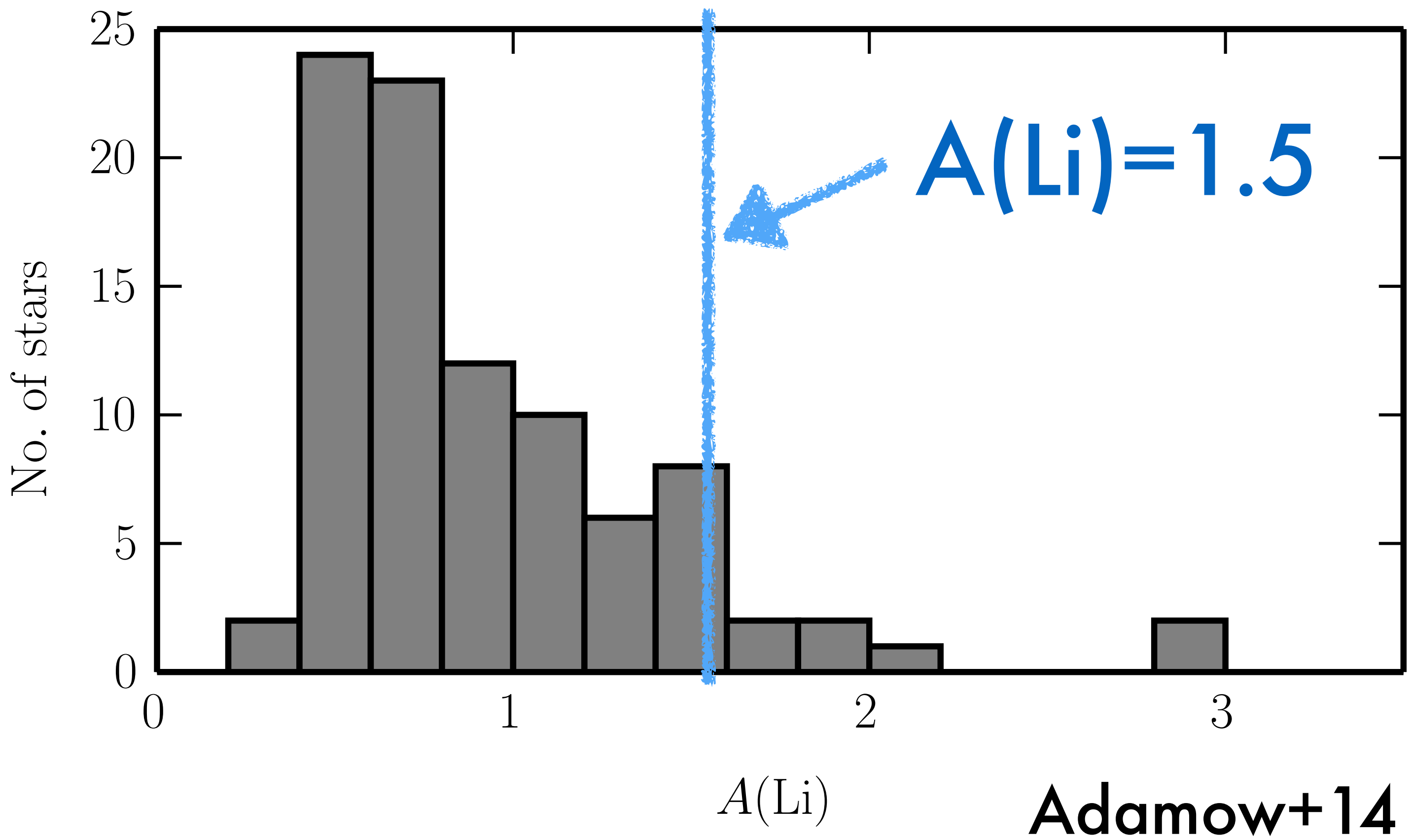
Lithium rich!

Anthony-Twarog+13

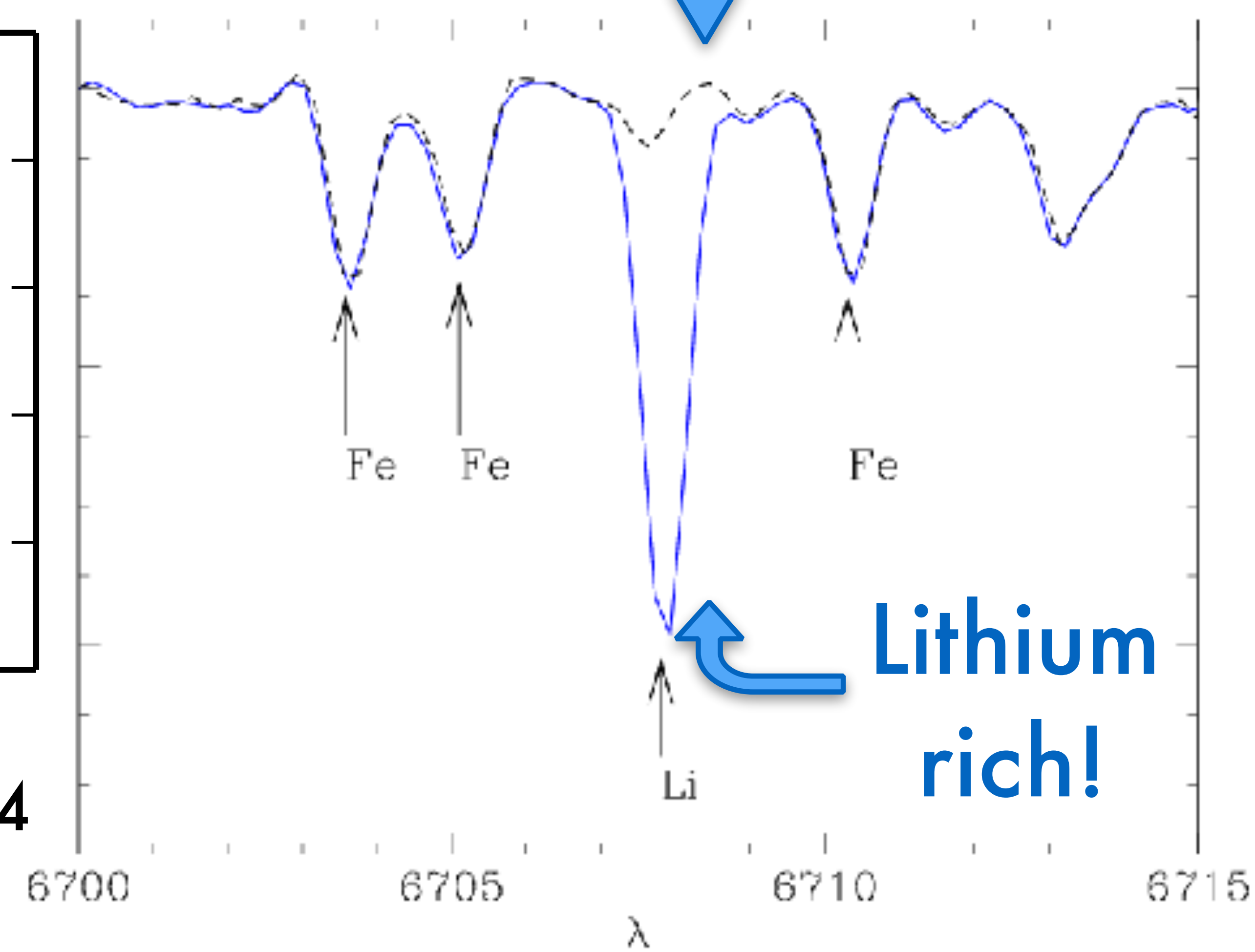
* A(Li)>1.5
* Small percentage of the population.

Lithium Rich Red Giants

Lithium-“poor” - Most of the giants



Adamow+14



Anthony-Twarog+13

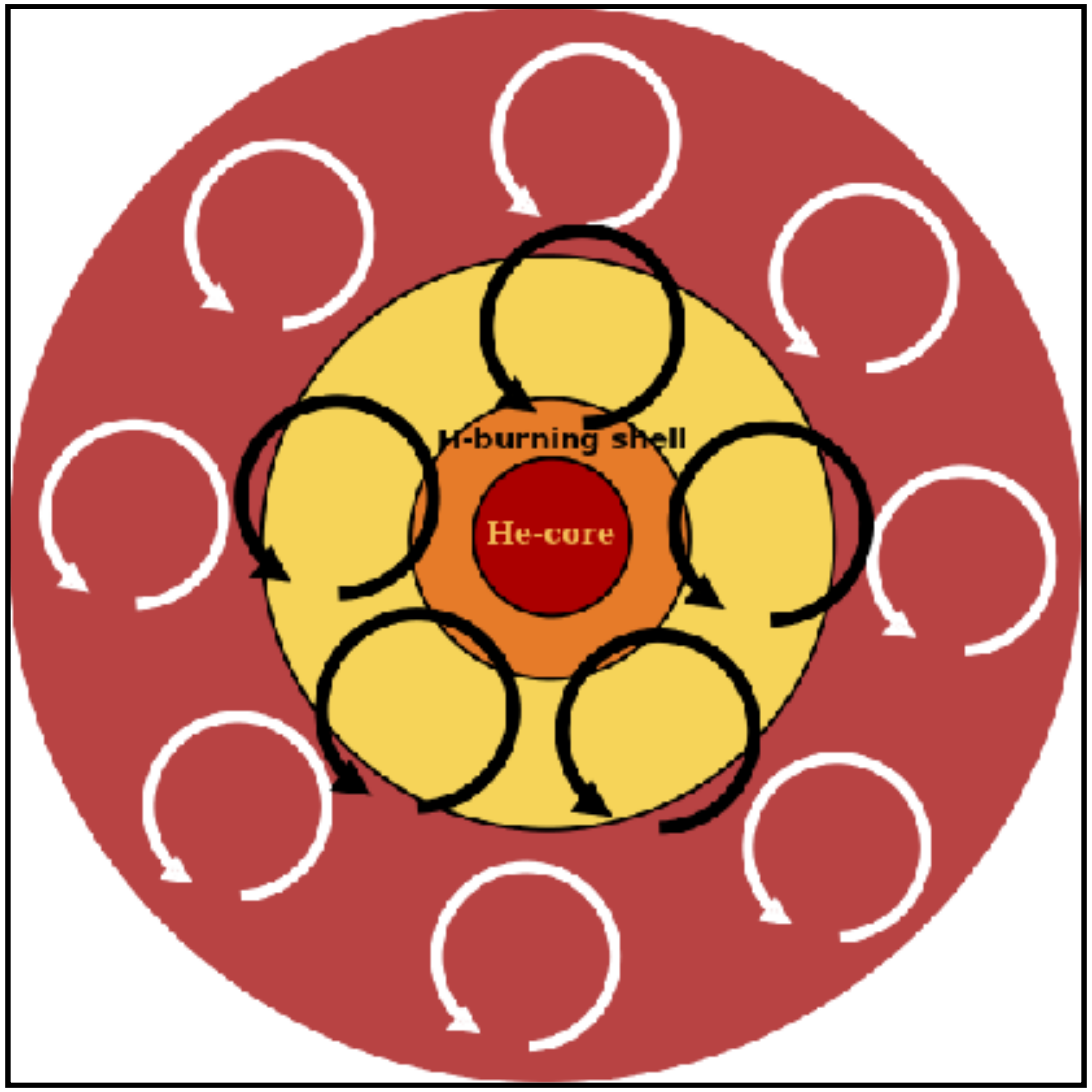
- A(Li)>1.5
- Small percentage of the population.

Suggested explanations

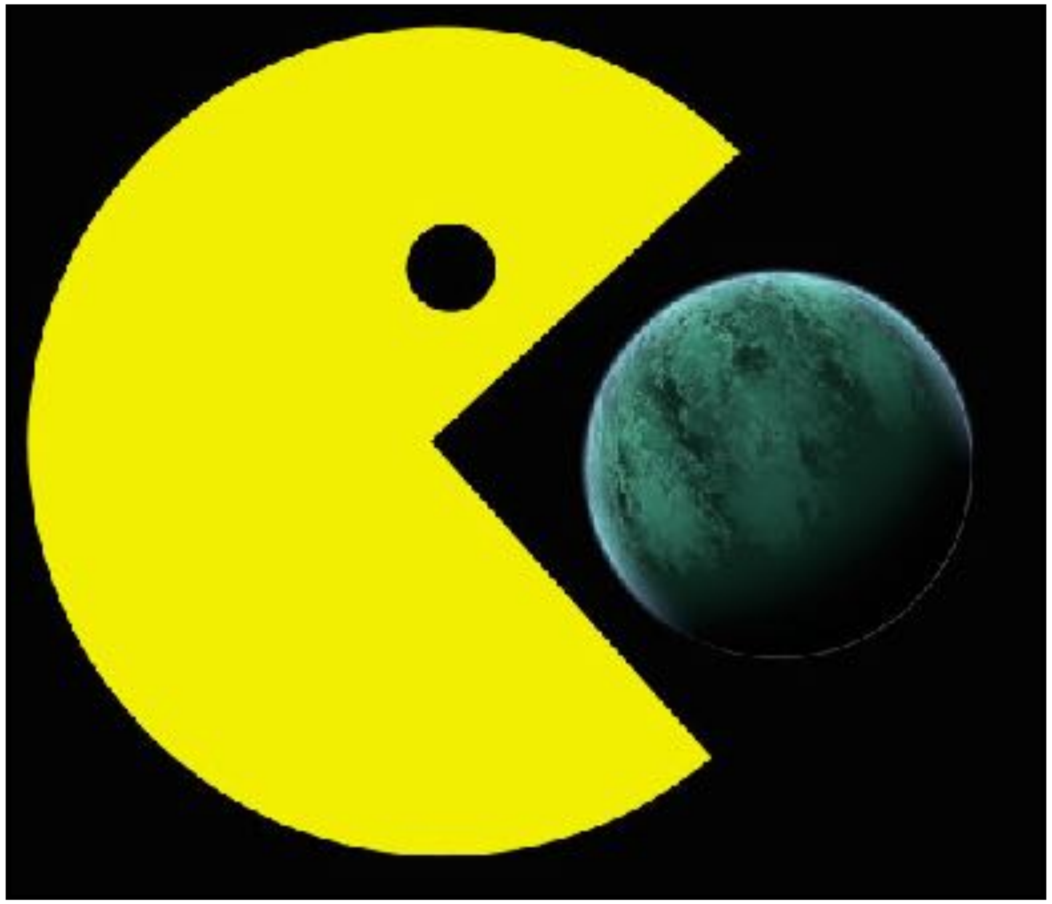
Non-canonical physics needed!

Internal Mechanisms

Lithium production + Mixing



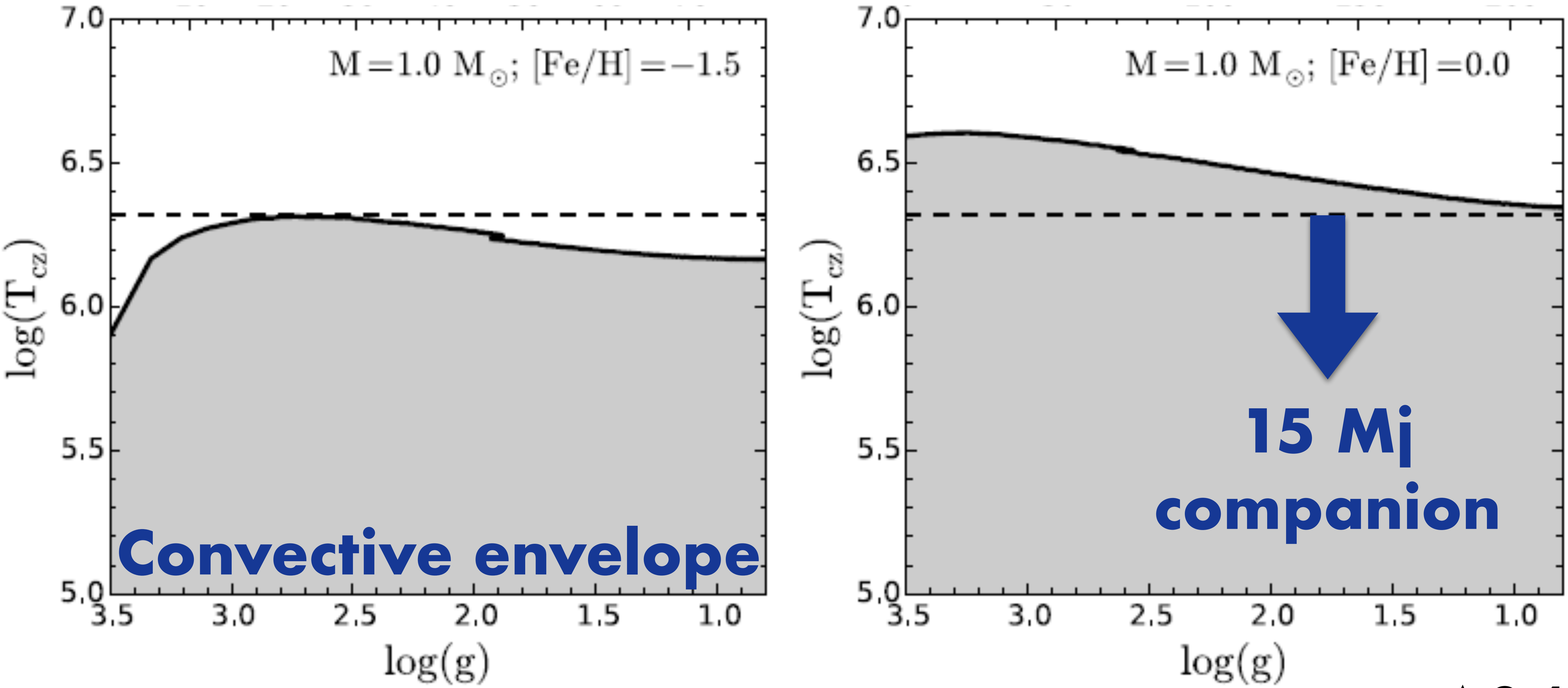
External Mechanisms



Need external object:
Planet? Brown dwarf?

Planet or brown dwarf engulfment

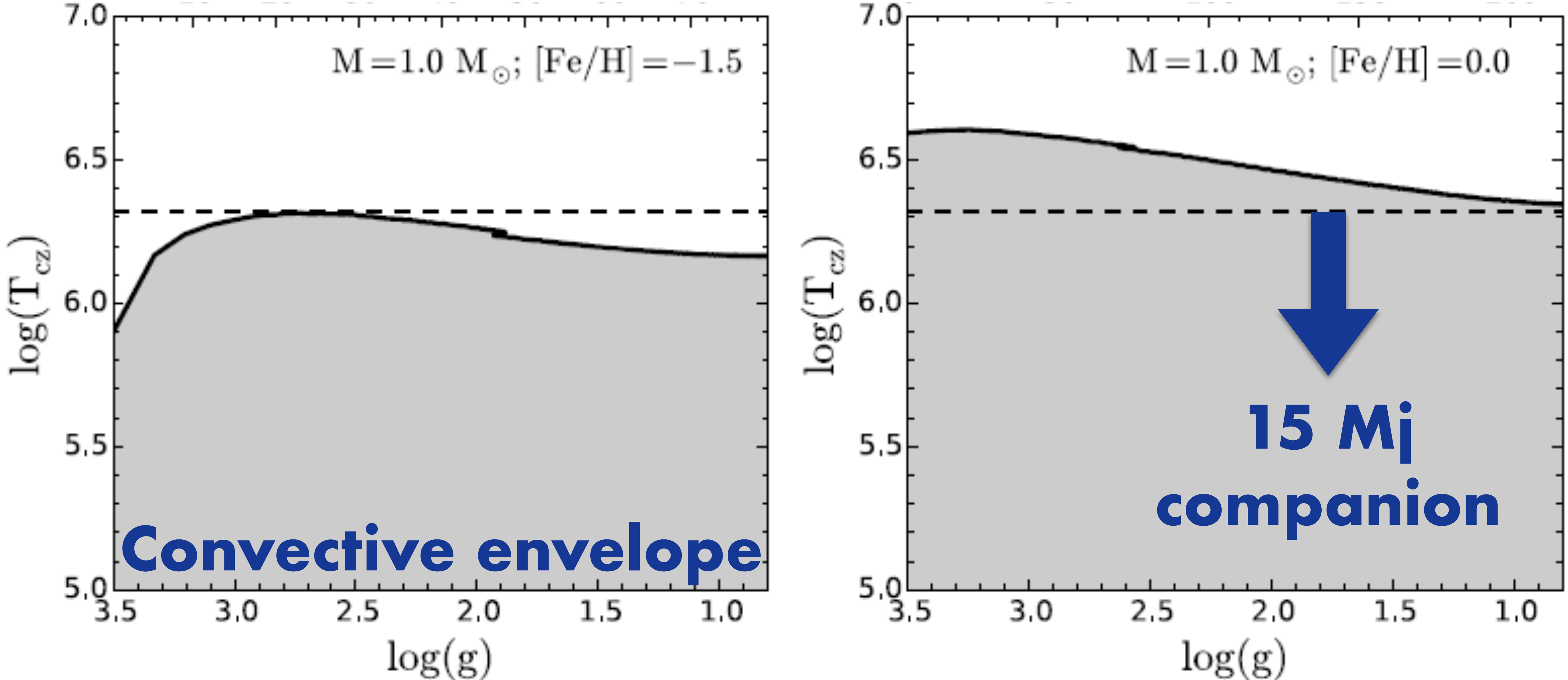
Point of substellar companion dissipation



A-G+16

Planet or brown dwarf engulfment

Point of substellar companion dissipation



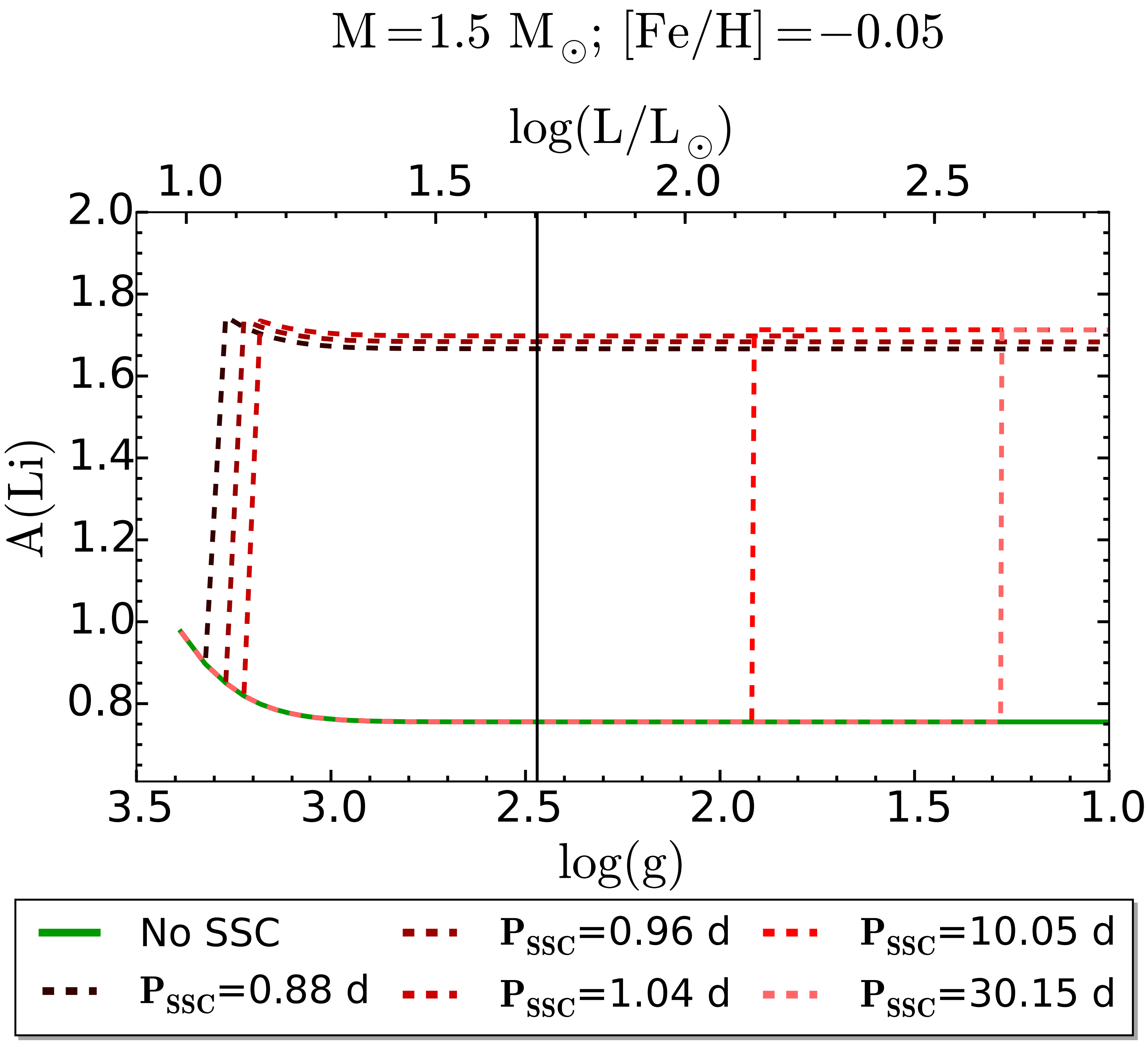
A-G+16

To produce Li enrichment:
M<15 Jupiter masses

Planet or brown dwarf engulfment

Surface Li abundance

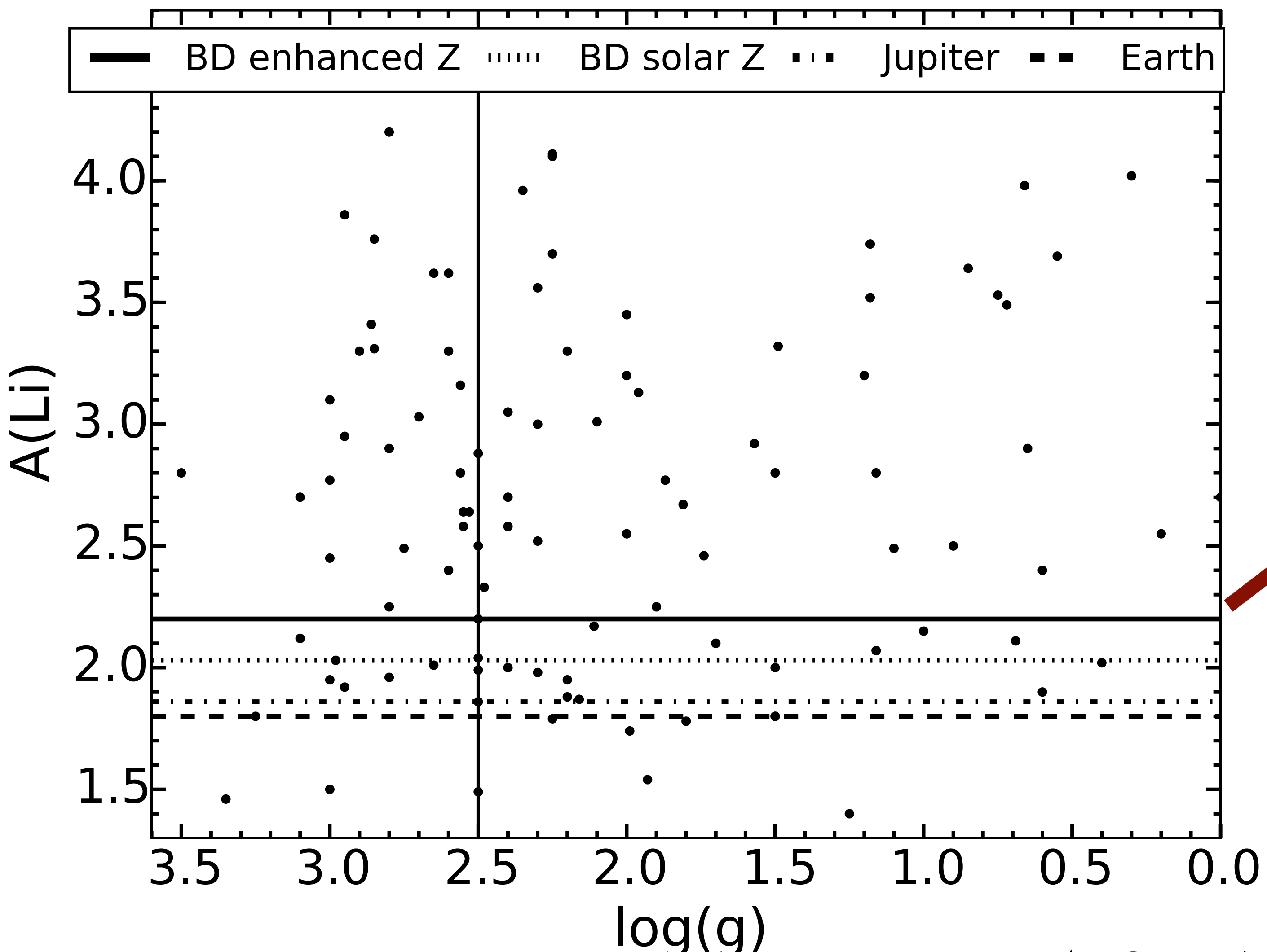
- Li abundance depends on stellar properties
- Increases Li after engulfment
- Planet period does not affect



A-G+16

Planet or brown dwarf engulfment

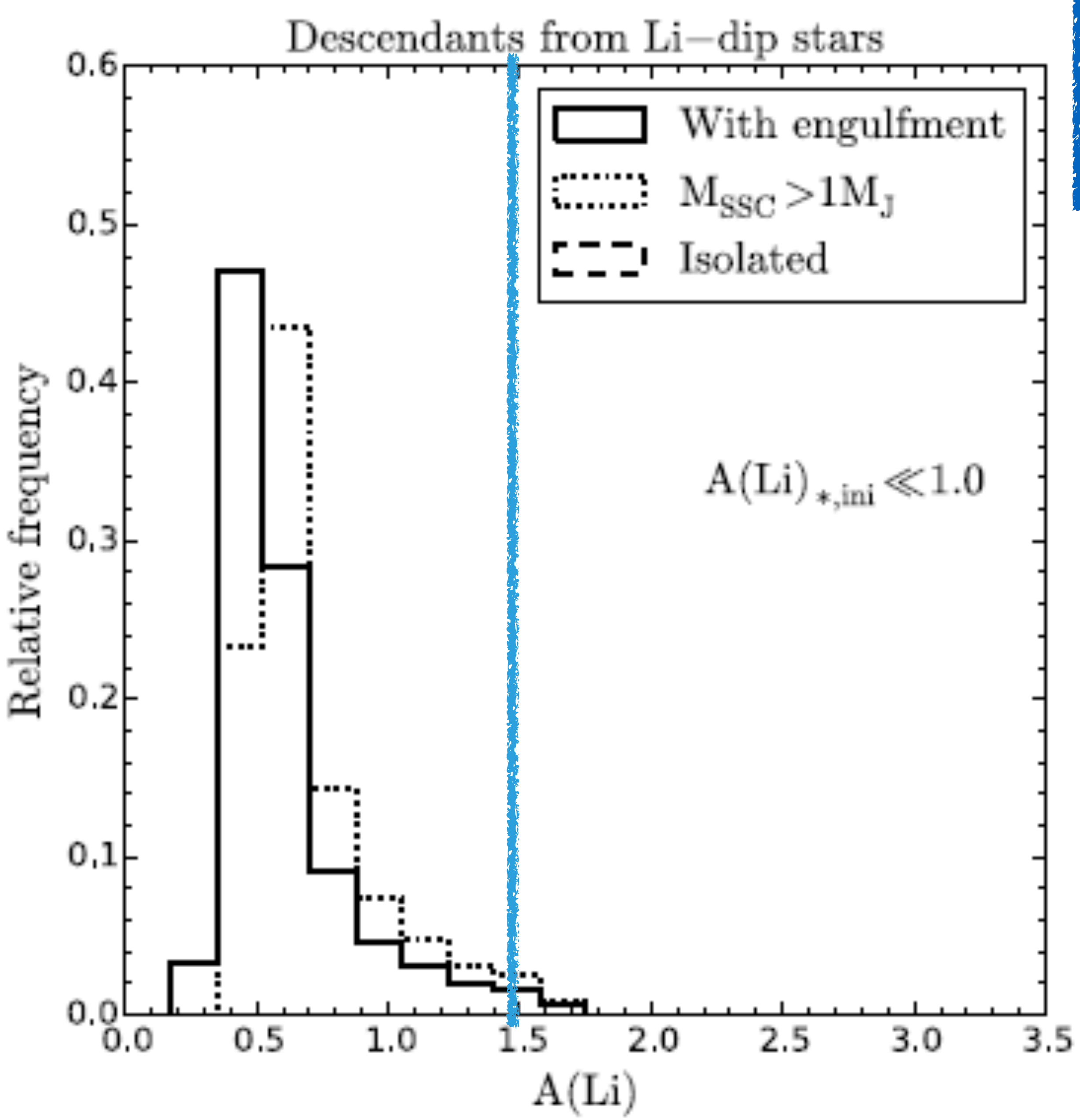
Maximum Li enrichment

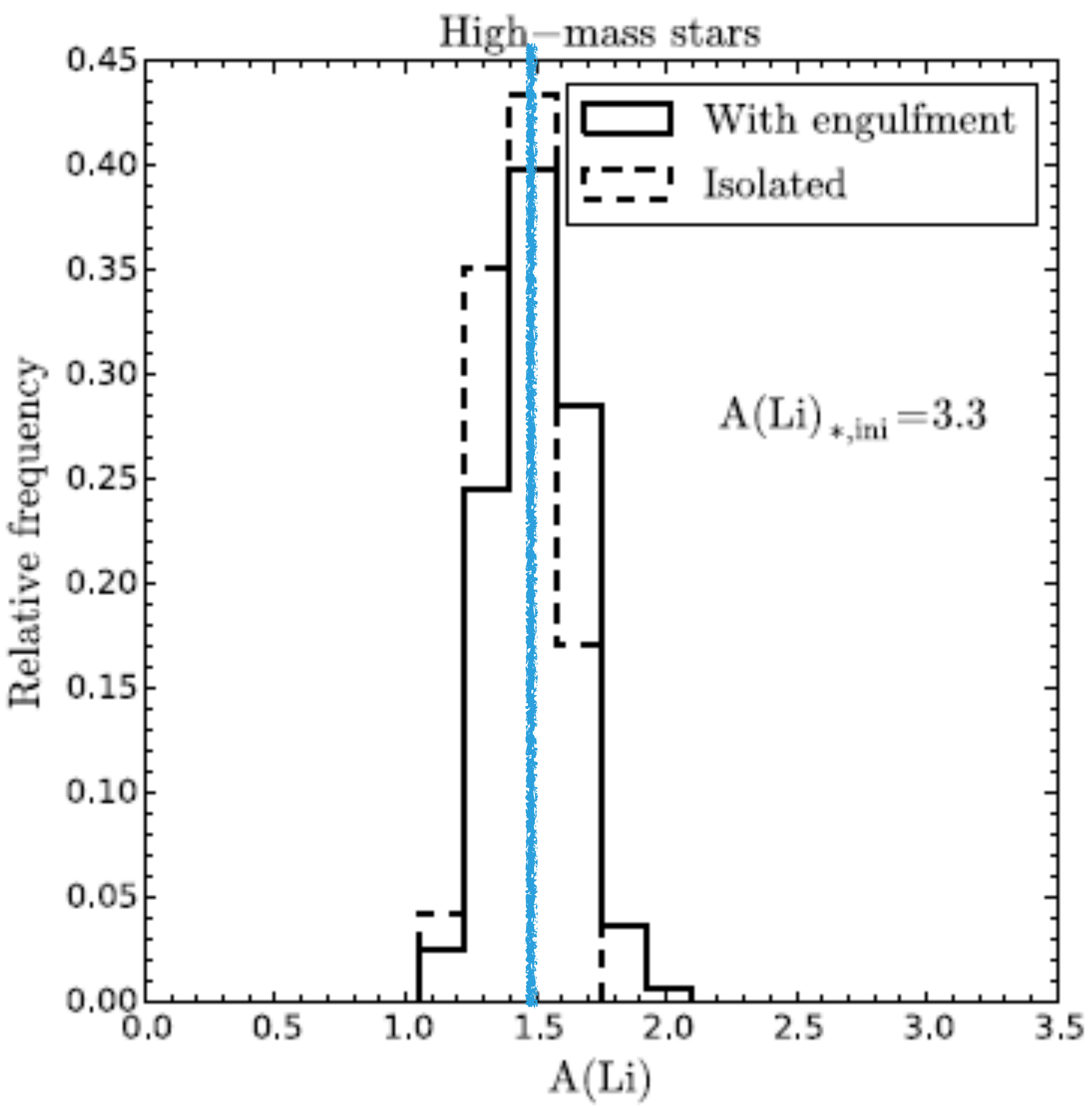


A-G+16

- Engulfment increases Li.
- Maximum enrichment: A(Li)=2.2
- Promising scenario to explain some Li-rich giants.

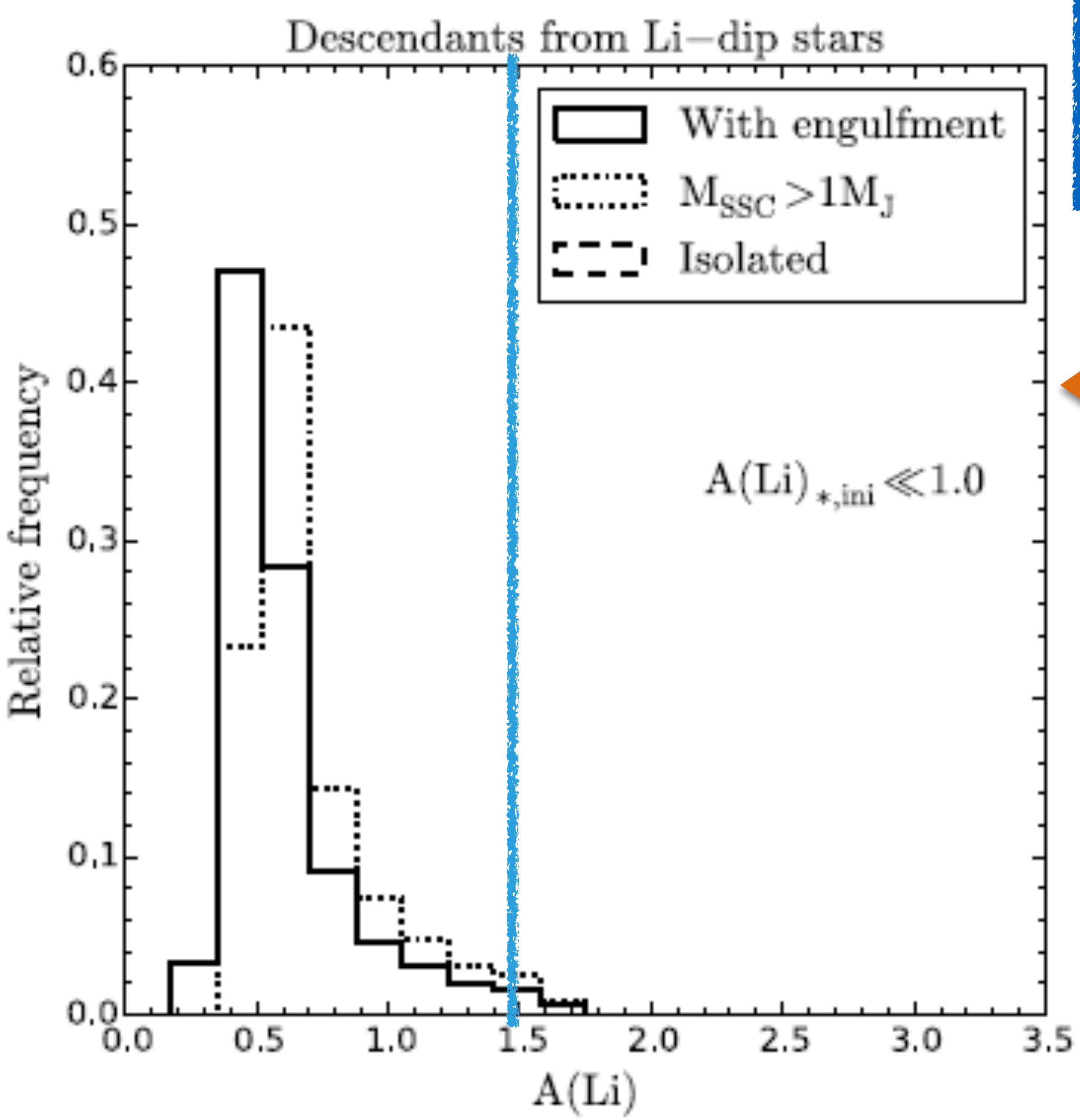
Li abundance distributions



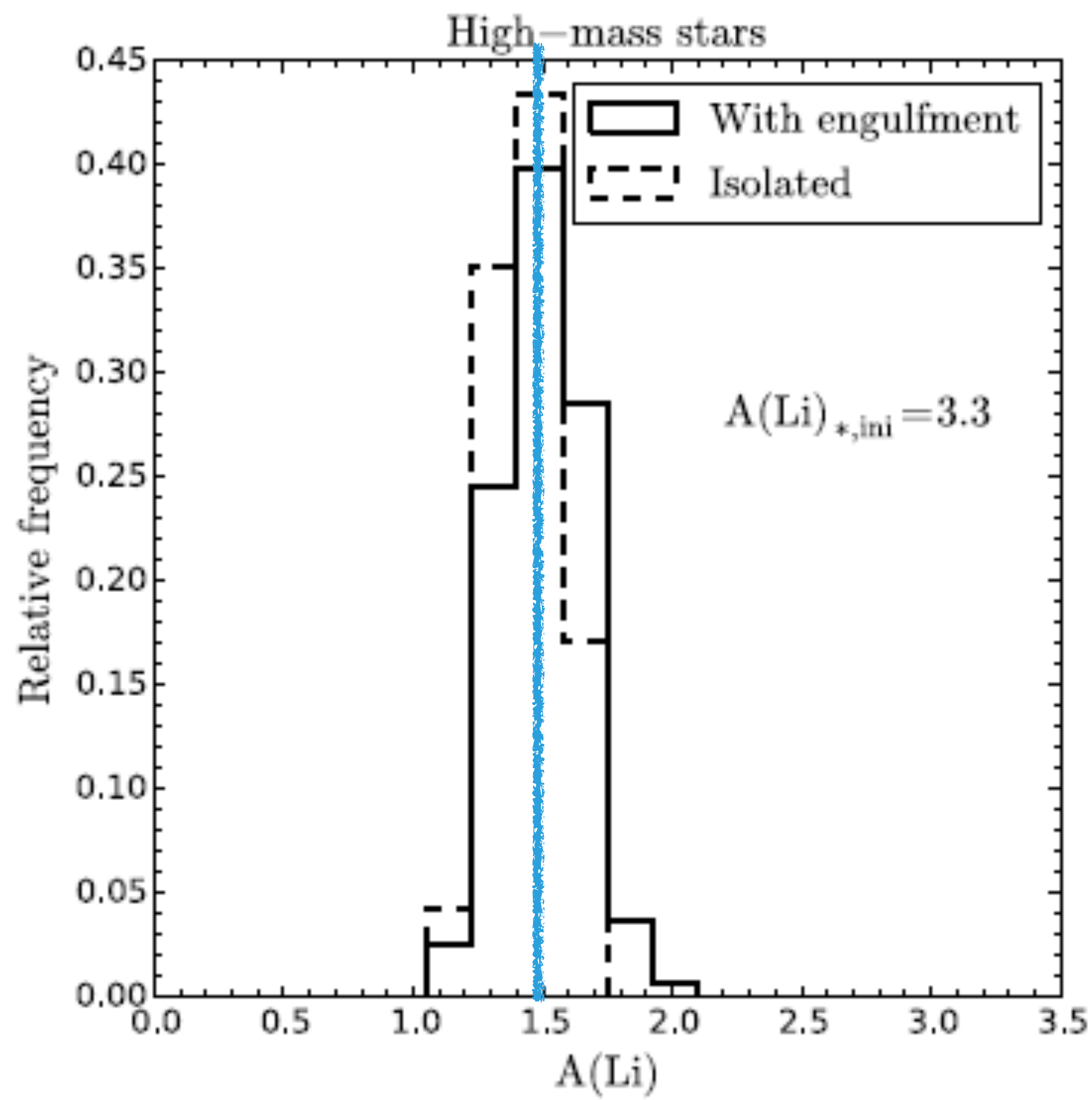


A-G+16

Li abundance distributions



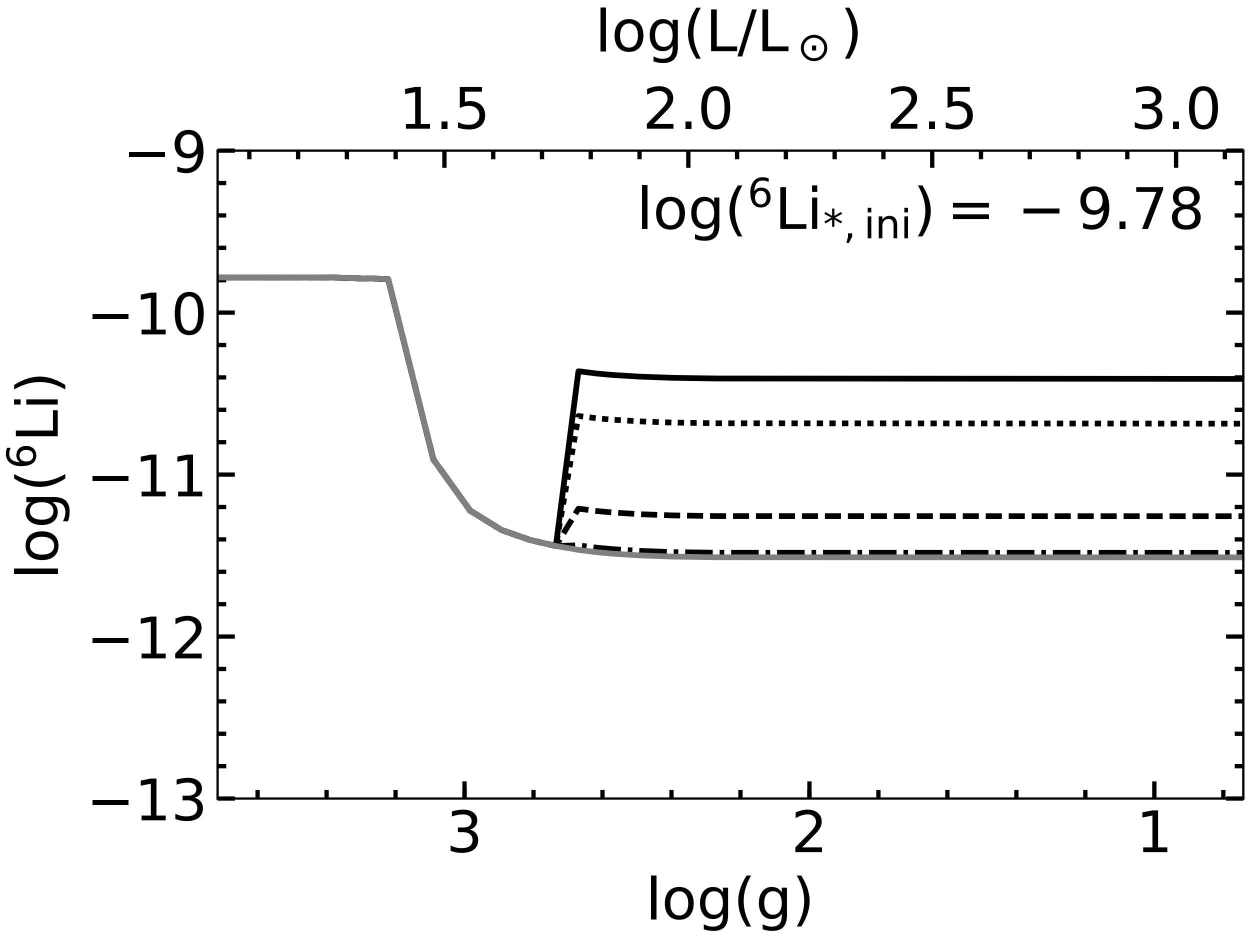
Ideal mass range to test engulfment



Traditional definition of Li-rich giants is misleading!

A-G+16

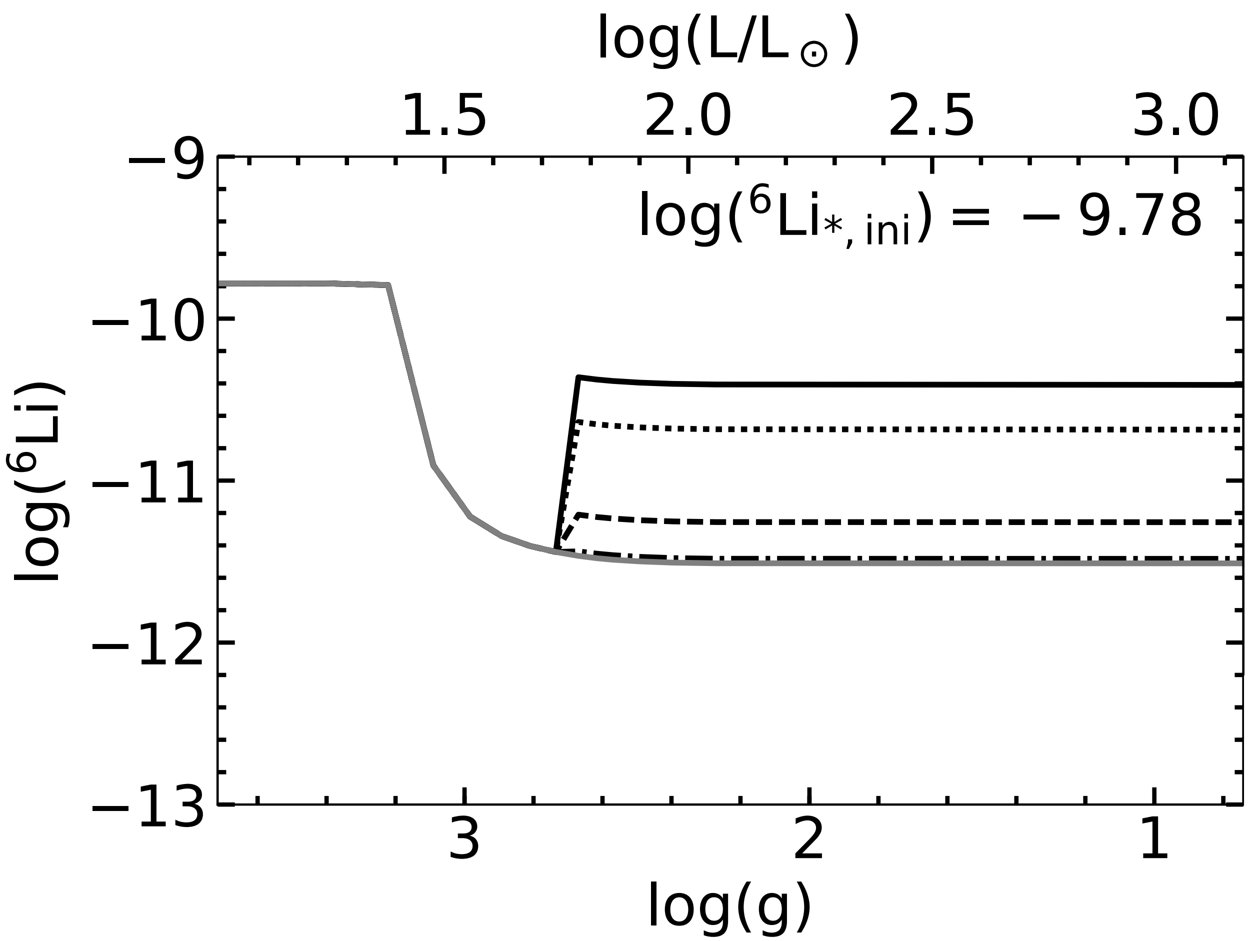
Surface Li-6 abundance



Low metallicities

Similar increase in Li-6 than for Li-7 after engulfment.
It can be preserved up to the tip of the RGB.

Surface Li-6 abundance

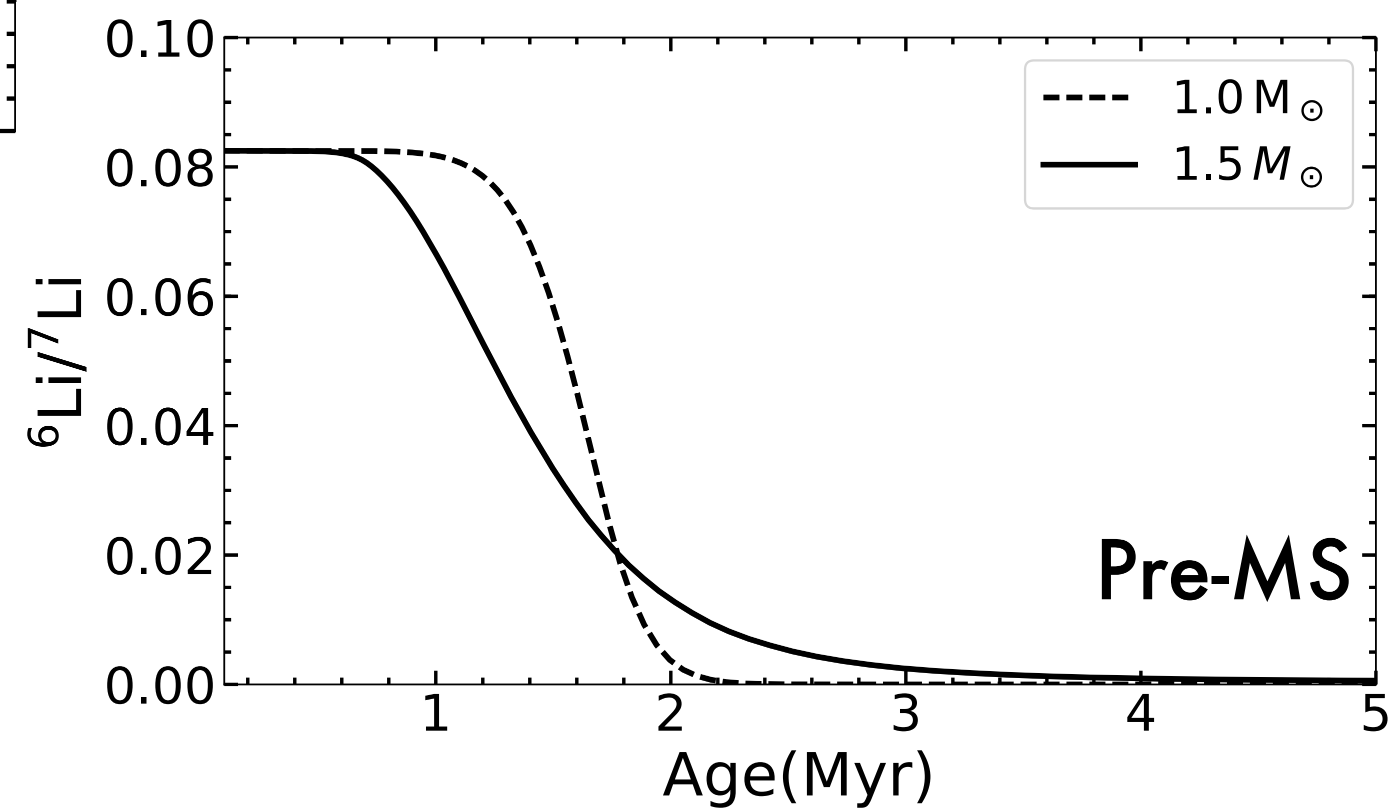


High metallicities

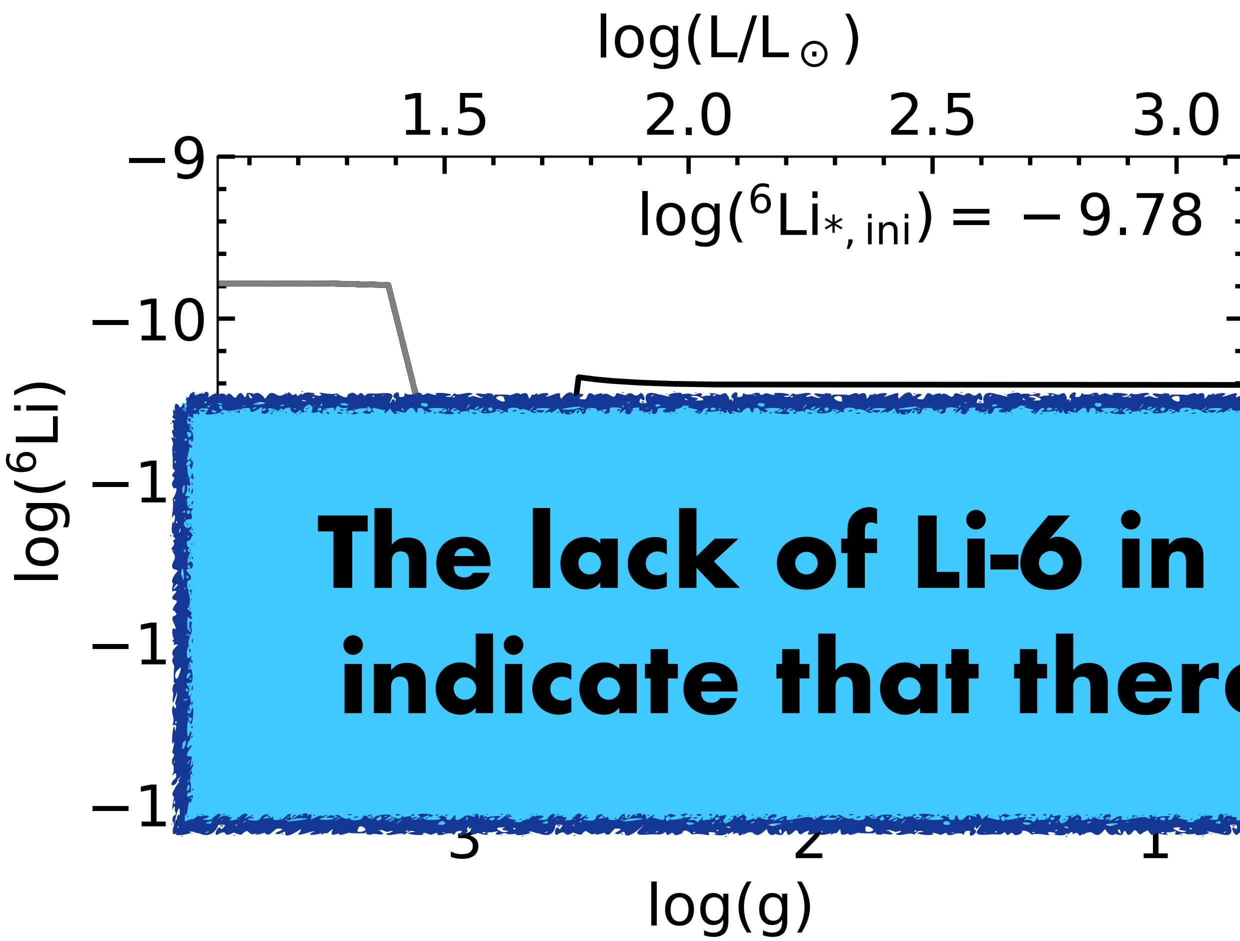
Li-6 is burned!

Low metallicities

Similar increase in Li-6 than for Li-7 after engulfment.
It can be preserved up to the tip of the RGB.



Surface Li-6 abundance



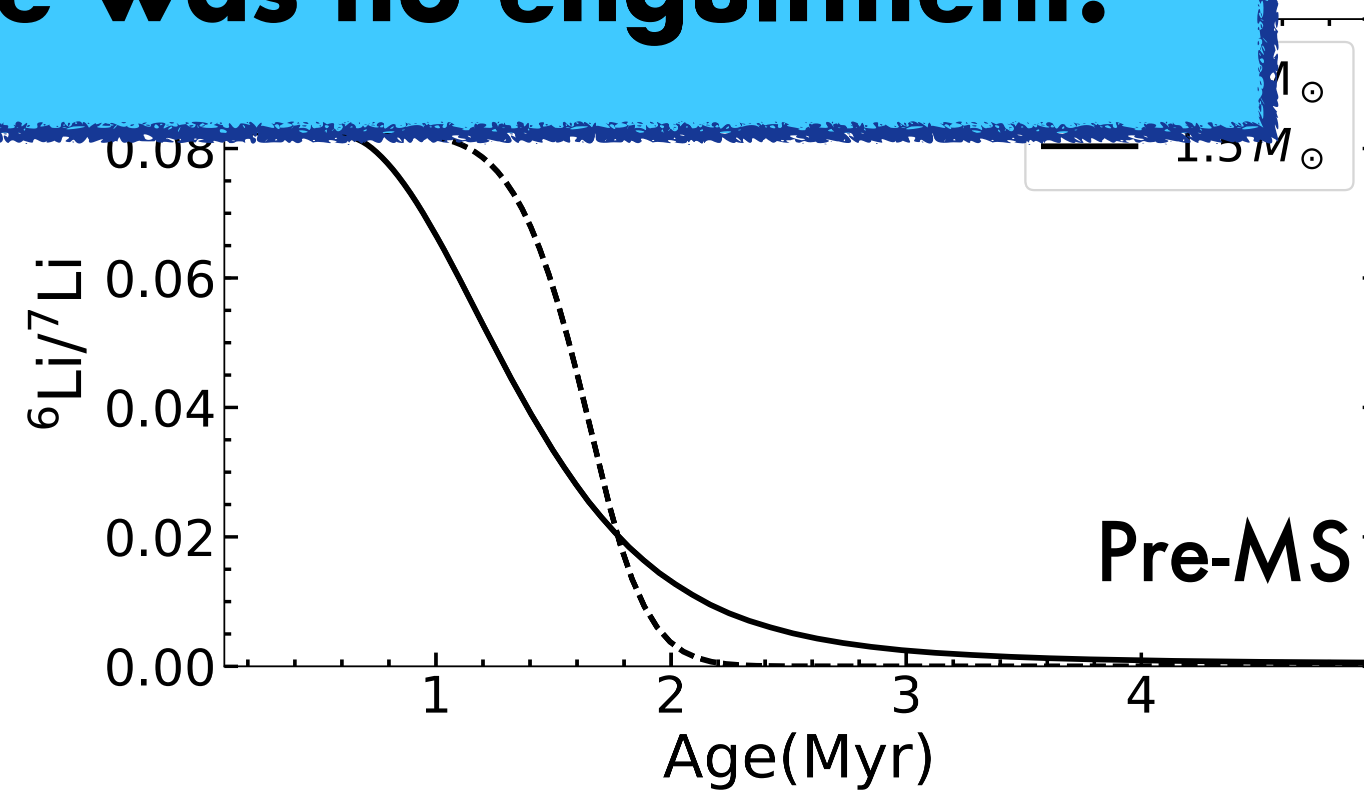
High metallicities

Li-6 is burned!

Low metallicities

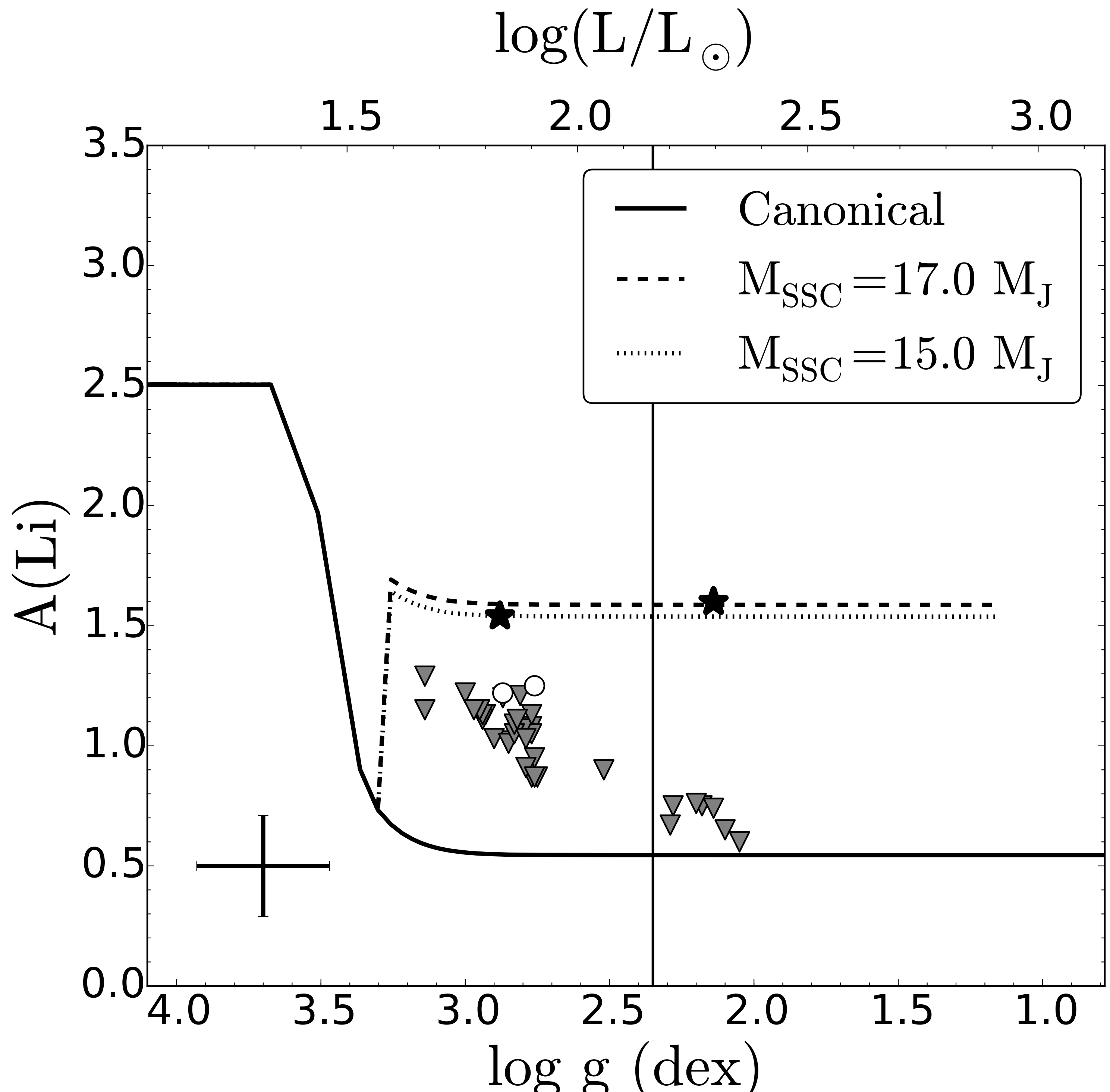
Similar increase in Li-6 than for Li-7 after engulfment.

The lack of Li-6 in Li-rich giants does not indicate that there was no engulfment.



Observational applications

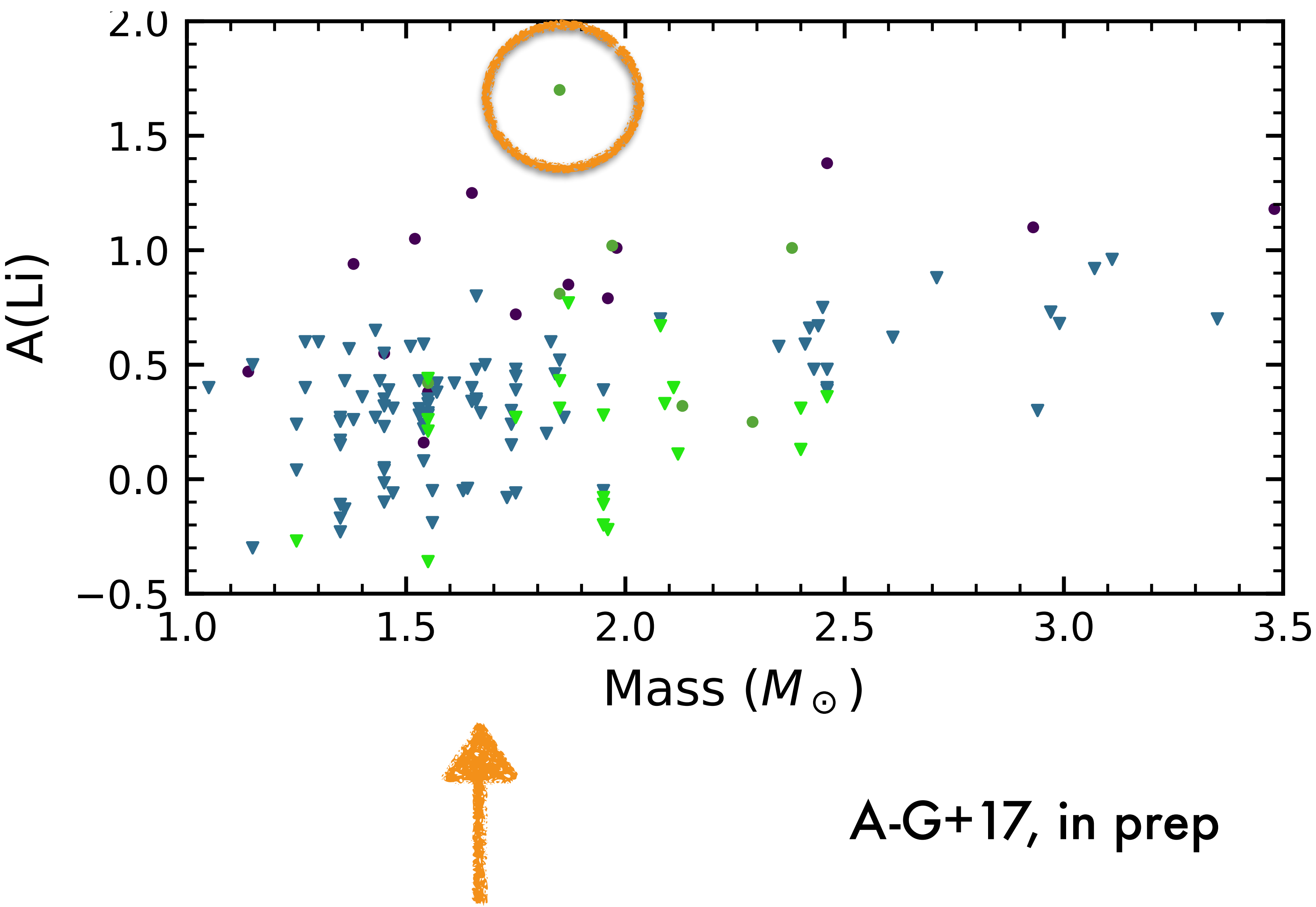
Trumpler 20



A-G+16b

Observational applications

Field giants



- 164 giants
- Part of a planet search program (Jones+11)
- Hipparcos parallaxes

A-G+17, in prep

*Measured masses
*Enriched giant?

Summary

* Only accreted objects of M<15Mj can produce a signal.
* Traditional definition of Li-rich giants is misleading.
* After planet engulfment A(Li)<2.2
* There are some ideal mass ranges and samples to test this scenario.
* The lack of Li-6 in a star does not imply that the star has not engulfed a substellar mass companion.
* Two Li-rich giants found in Trumpler20 could be the product of engulfment.