Yunnan Observatories,
Chinese Academy of Sciences

A new route to massive sdOs —— CE ejection from AGB Stars

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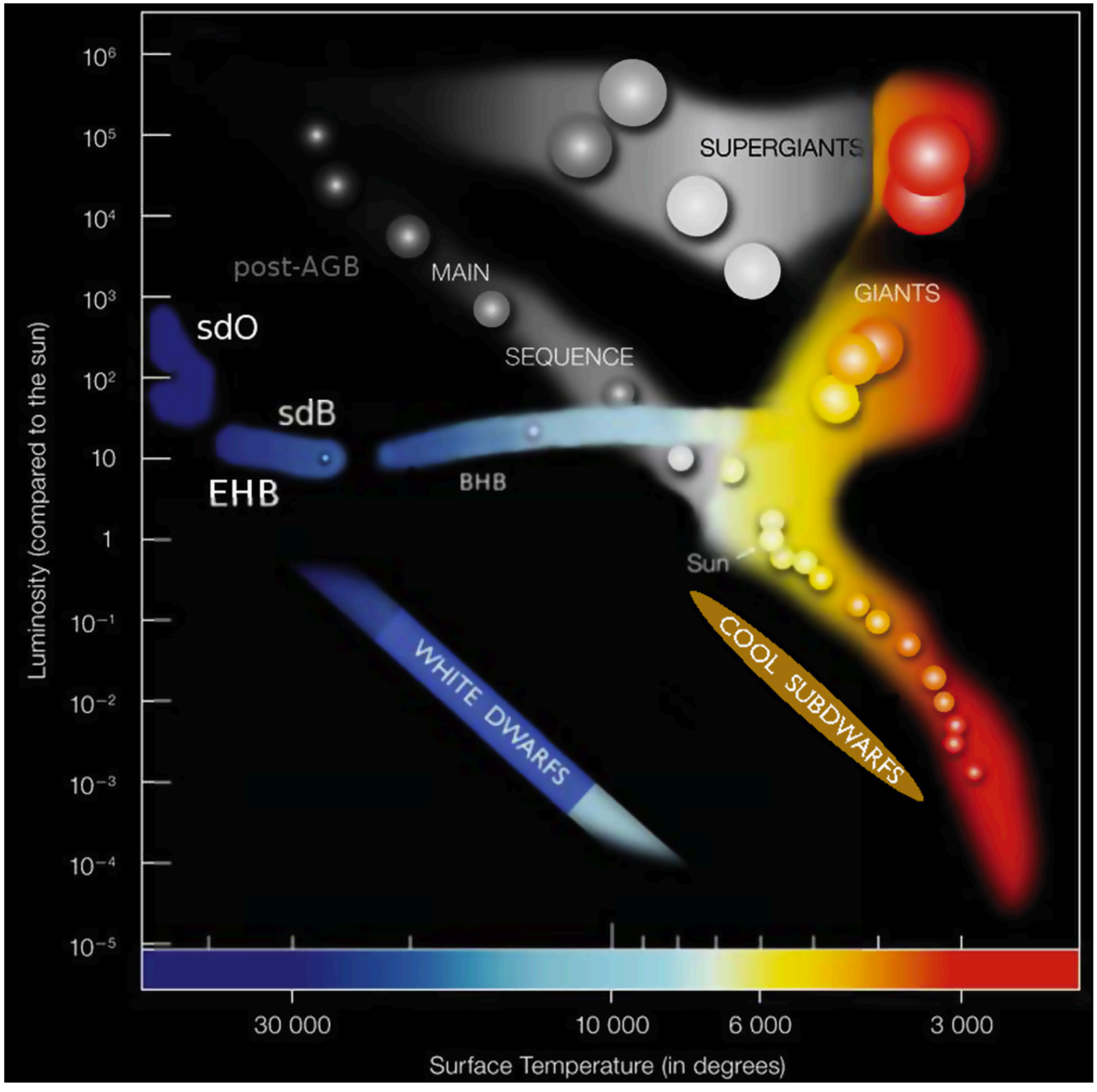
Collaborators: Xuefei Chen, Jiangdan Li, Zhanwen Han

Litomysl · 2024 Sep.11

I. Background – hot subdwarfs



Heber 2016, PASP

Extreme Horizontal Branch:
He-burning core +
Thin hydrogen envelope

Temperature:
20000K– 80000K

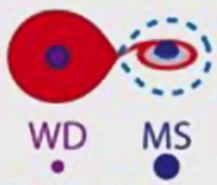
Spectra type:
sdB/sdO

I. Background – hot subdwarfs

a

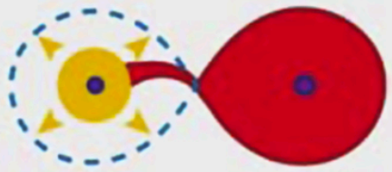
Stable RLOF + CE channel
(mass ratio < 1.2 – 1.5)

Stable RLOF

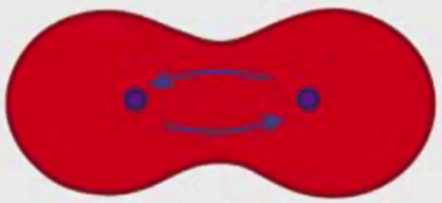


Wide binary

Unstable RLOF



Common envelope



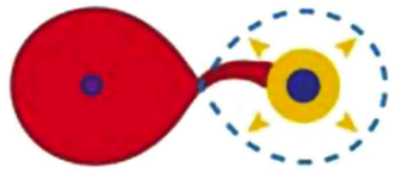
Short-period sdB binary

P_{orb} = 0.1 – 10 days
M_{sdB} = 0.40 – 0.49 $M_\odot$

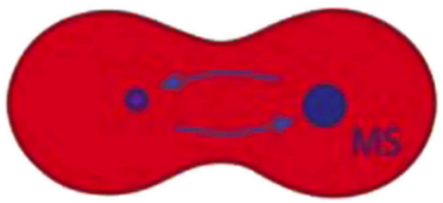
b

CE-only channel
(mass ratio > 1.2 – 1.5)

Unstable RLOF



Common envelope



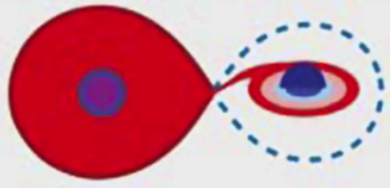
Short-period sdB binary

P_{orb} = 0.1 – 10 days
M_{sdB} = 0.40 – 0.49 $M_\odot$

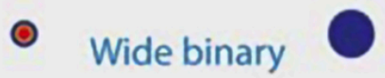
c

Stable RLOF channel
(mass ratio < 1.2 – 1.5)

Stable RLOF near tip of RGB



sdB with MS/SG companion



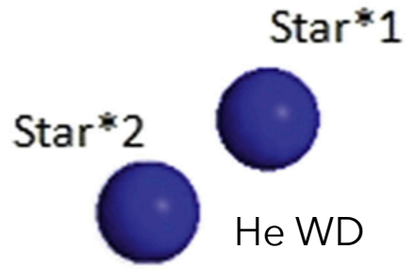
Wide binary

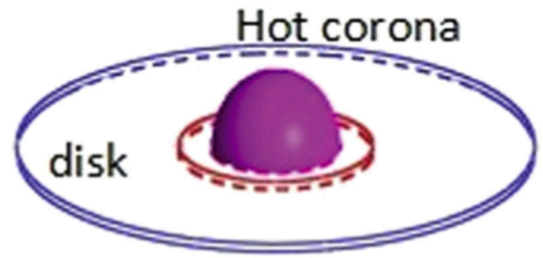
P_{orb} = 10 – 500 days
M_{sdB} = 0.30 – 0.45 $M_\odot$

Podsiadlowski et al. 2008

d

Merger channel





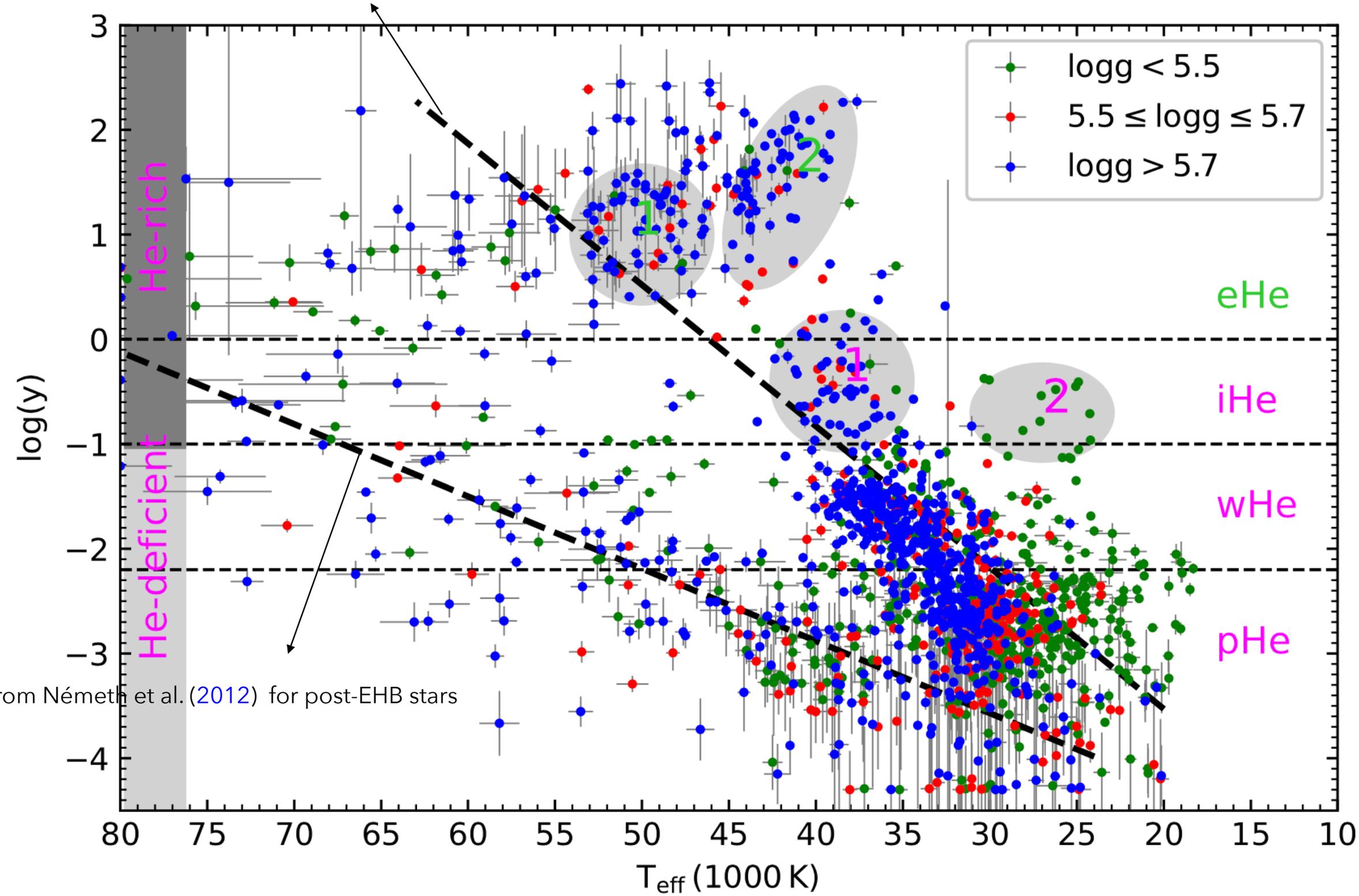
Centre helium burning

Zhang&Jeffery 2012

I. Background – hot subdwarfs

from Edelmann et al. (2003) for EHB stars

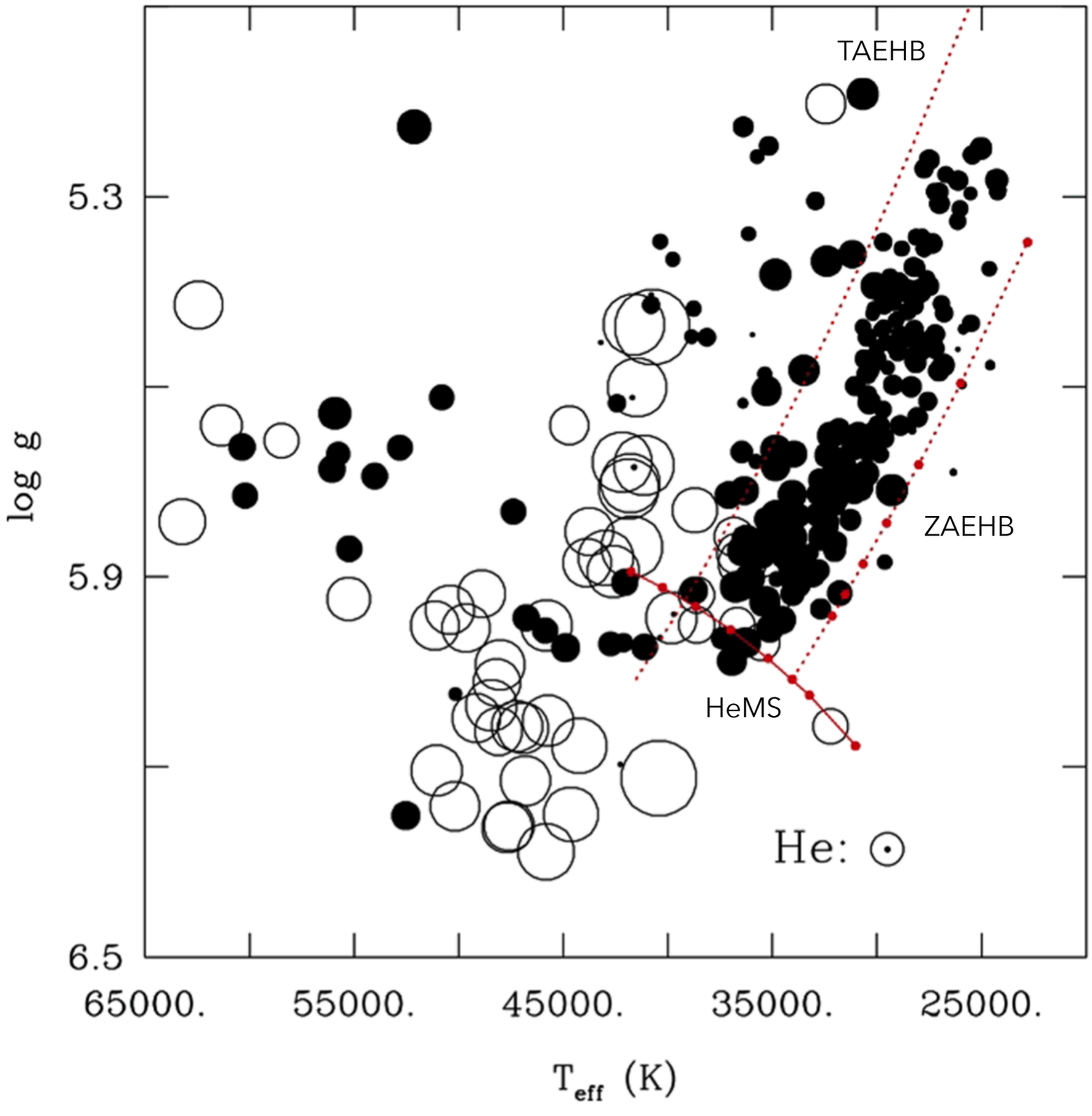
He abundance distribution



from Németh et al. (2012) for post-EHB stars

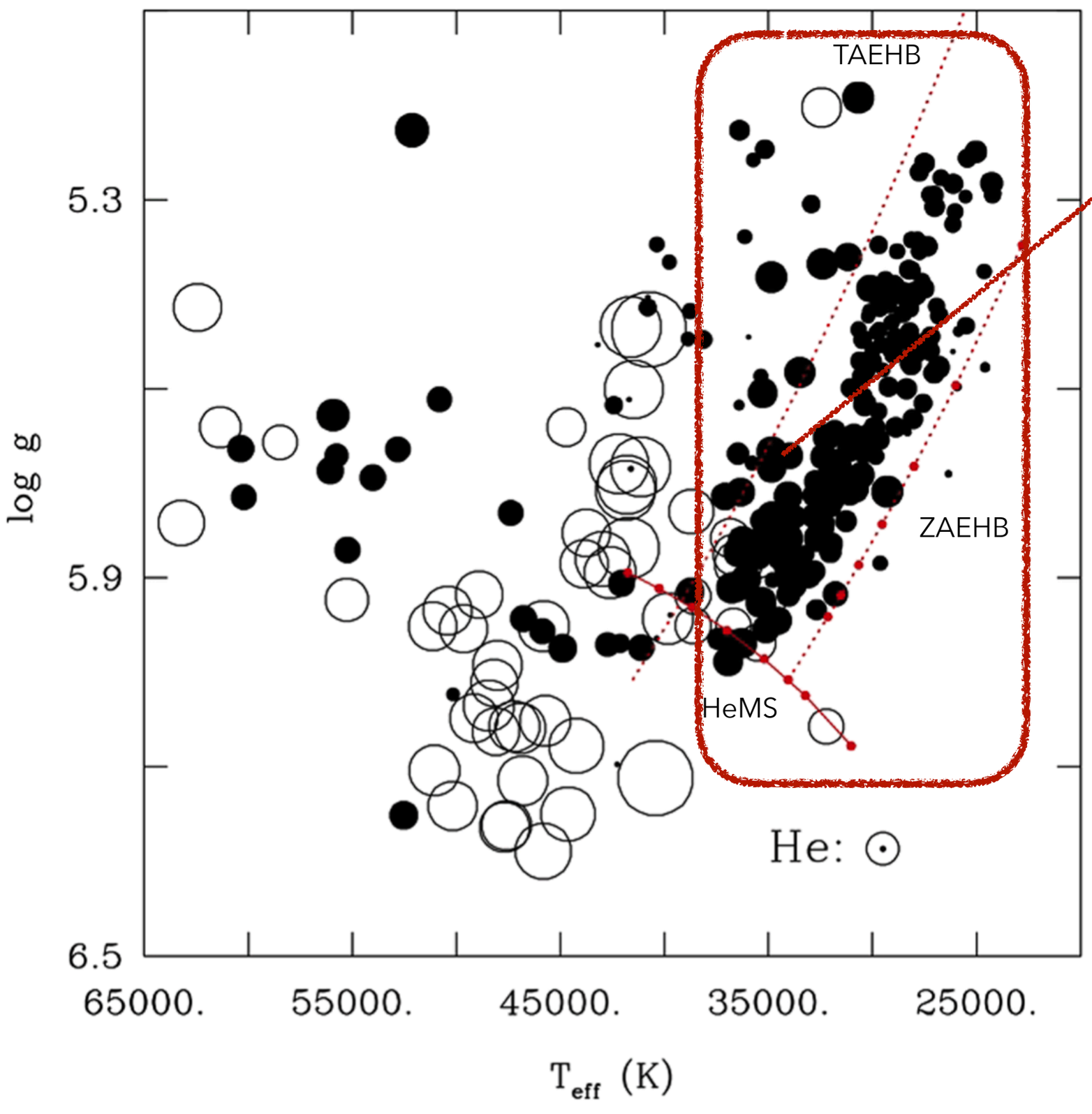
Luo,Y et al. 2021

I. Background – hot subdwarfs



Latour et al. (2014)

I. Background – hot subdwarfs



Most sdBs have He-poor atmosphere.

Latour et al. (2014)

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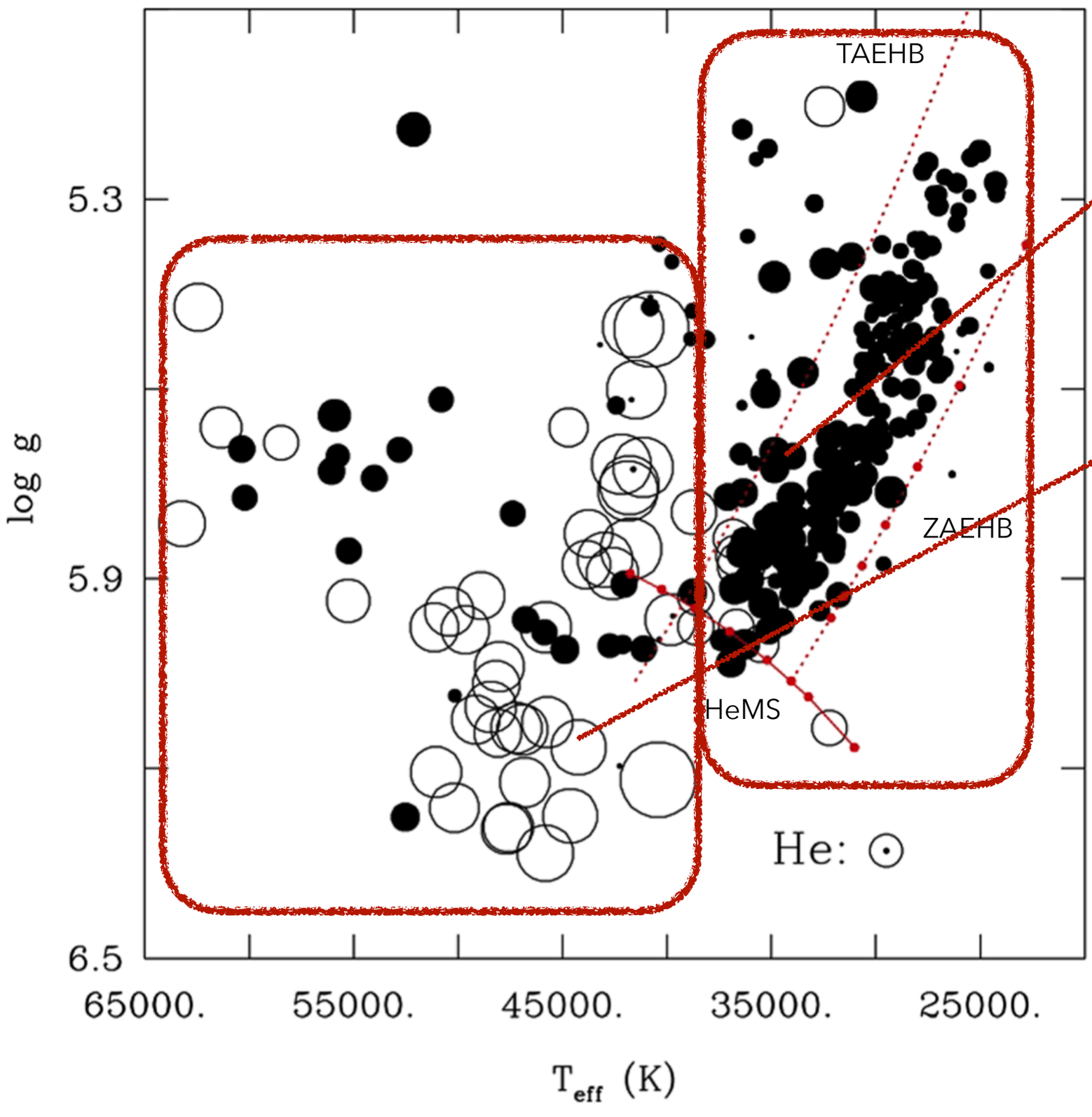
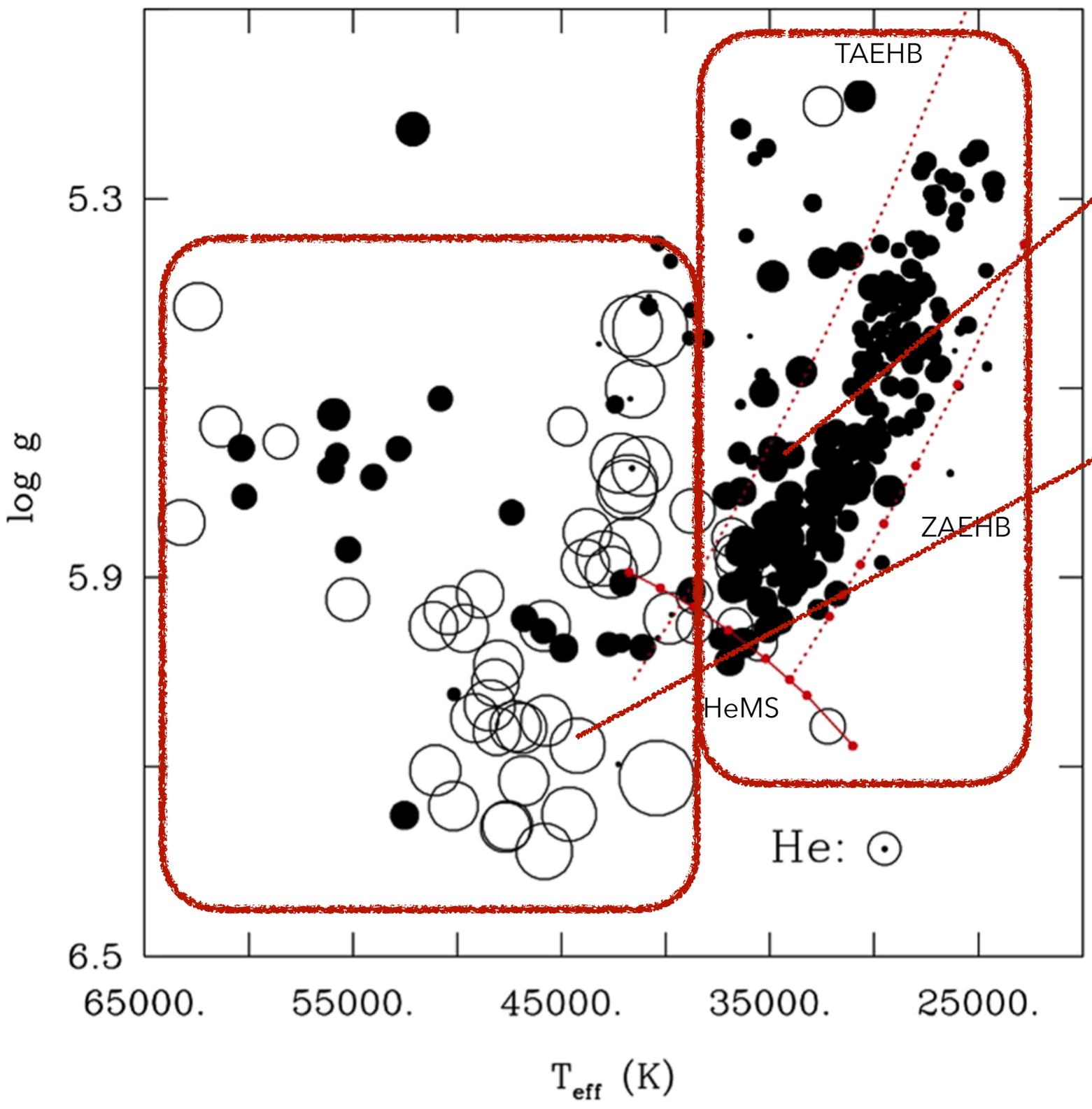


Most sdBs have He-poor atmosphere.

Many sdOs have He-rich atmosphere.

Latour et al. (2014)

I. Background – hot subdwarfs



Latour et al. (2014)

Most sdBs have He-poor atmosphere.

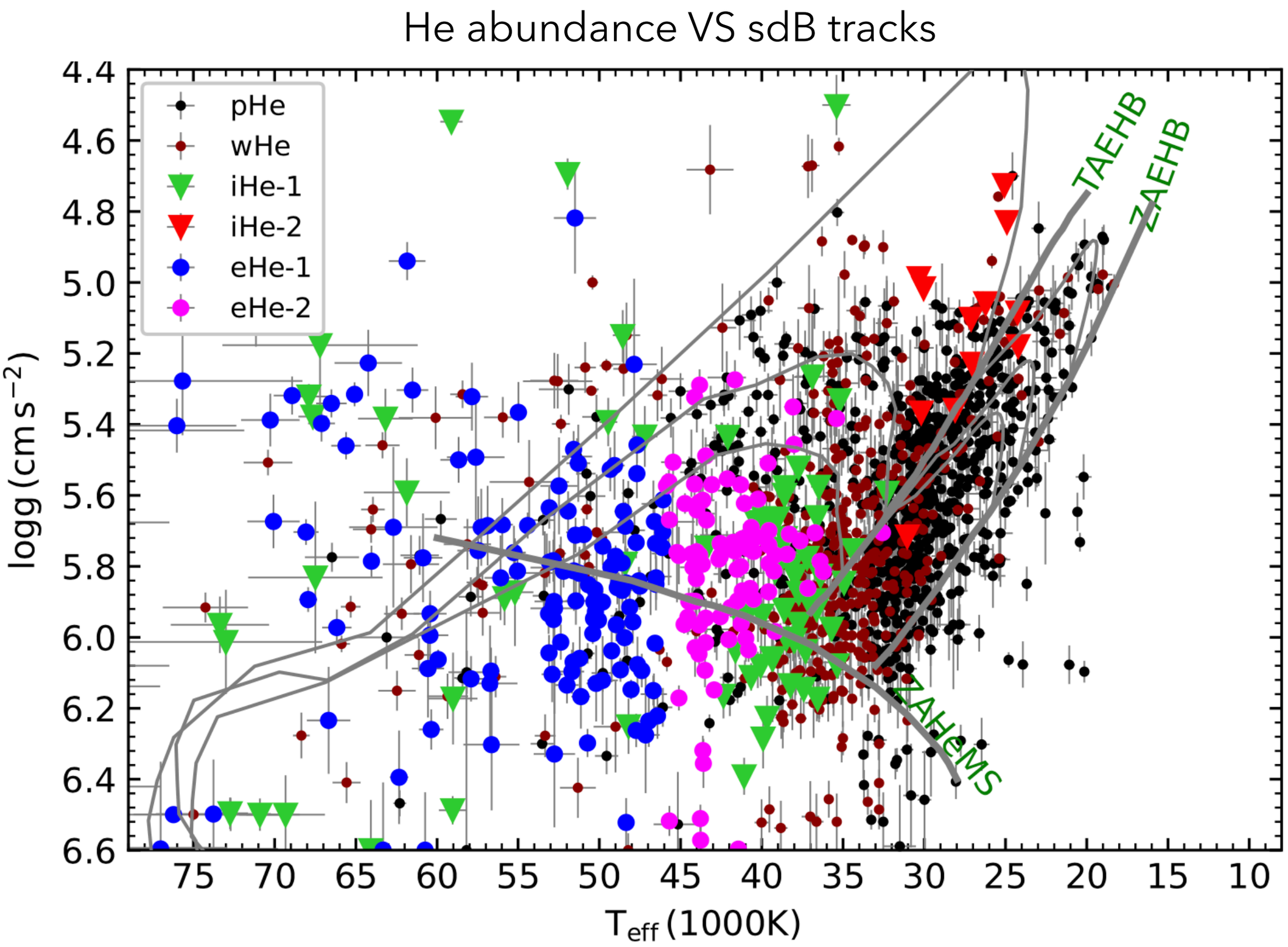
+

Many sdOs have He-rich atmosphere.

?

Different Origins

I. Background – hot subdwarfs



Luo,Y et al. 2021

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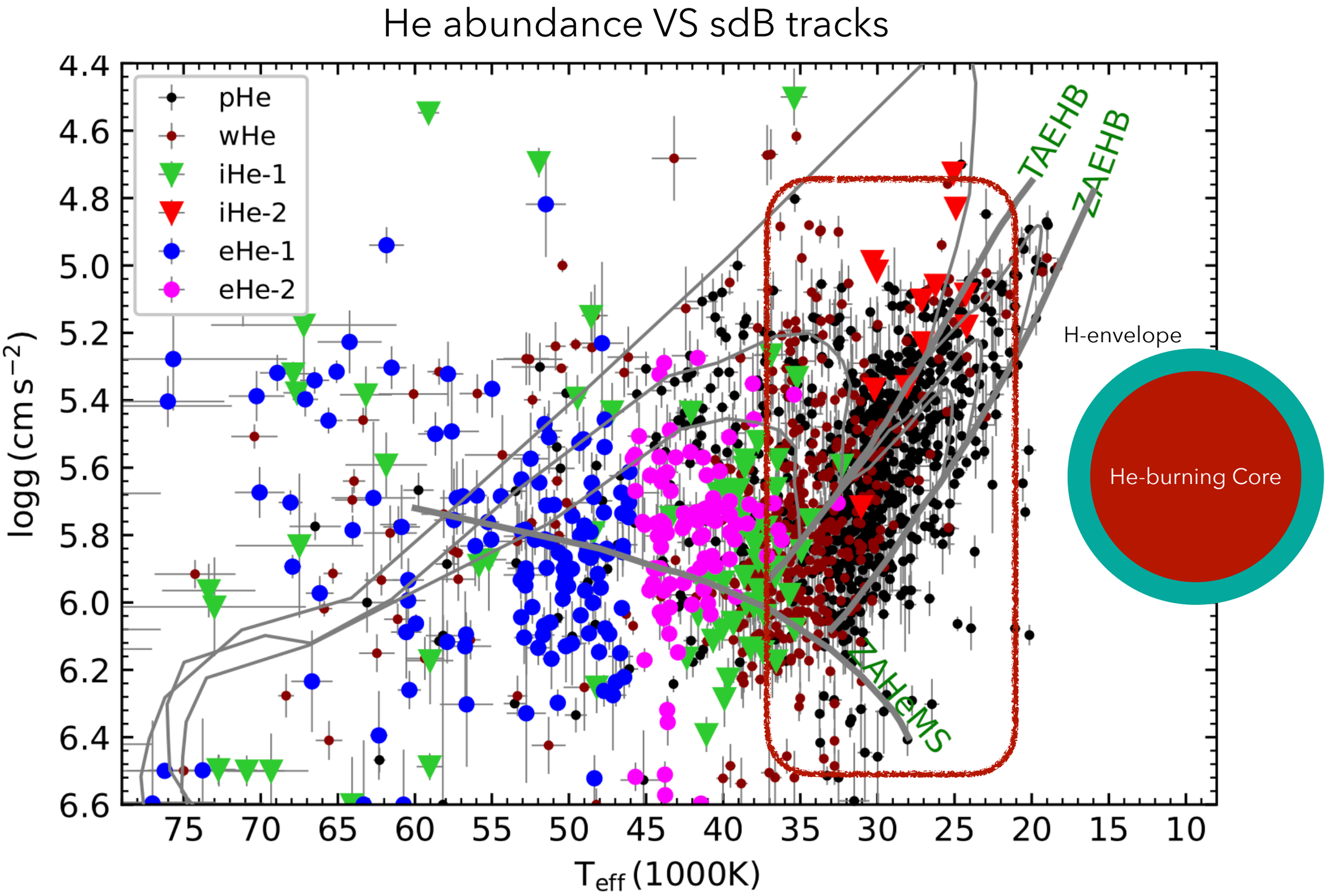
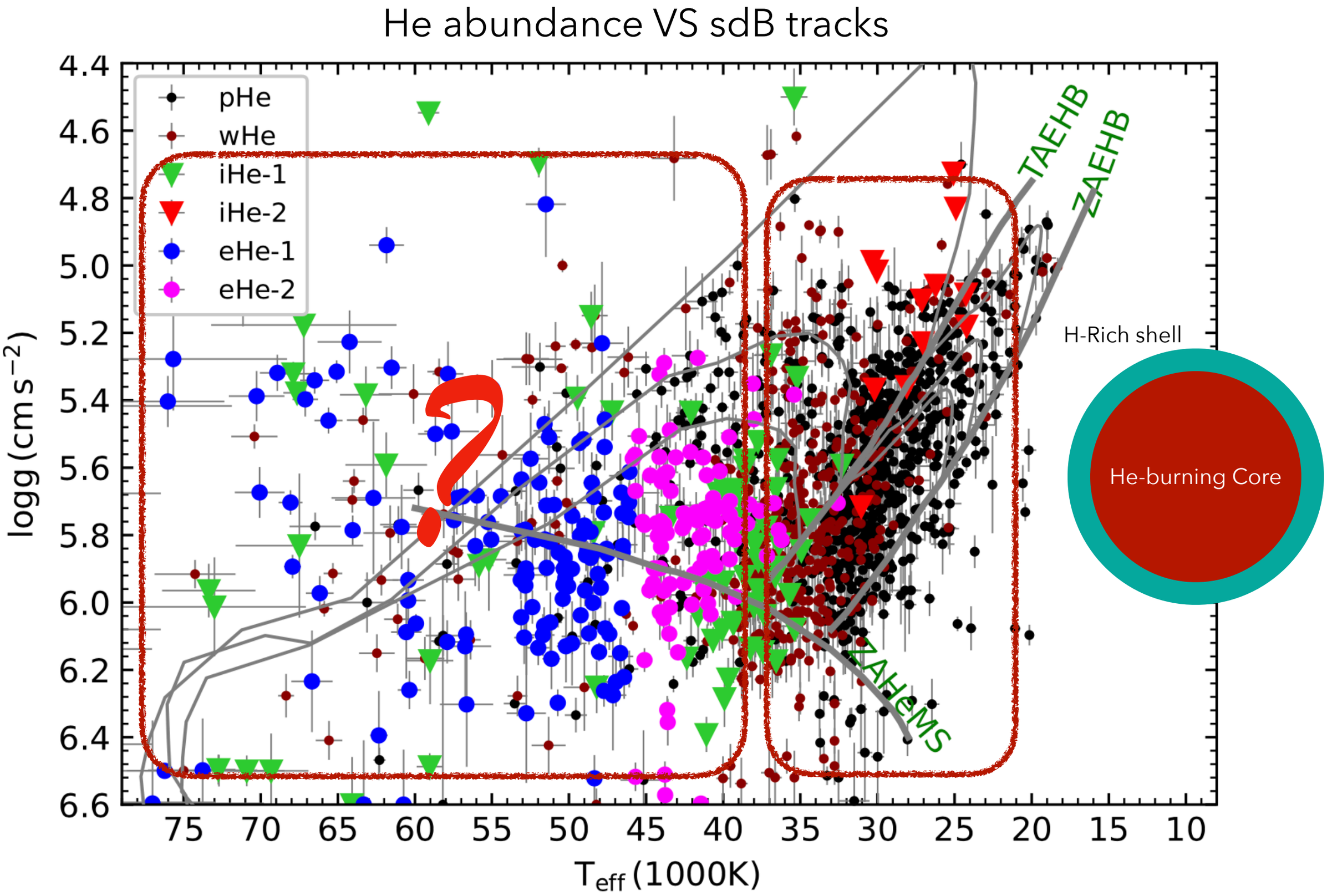


Luo,Y et al. 2021

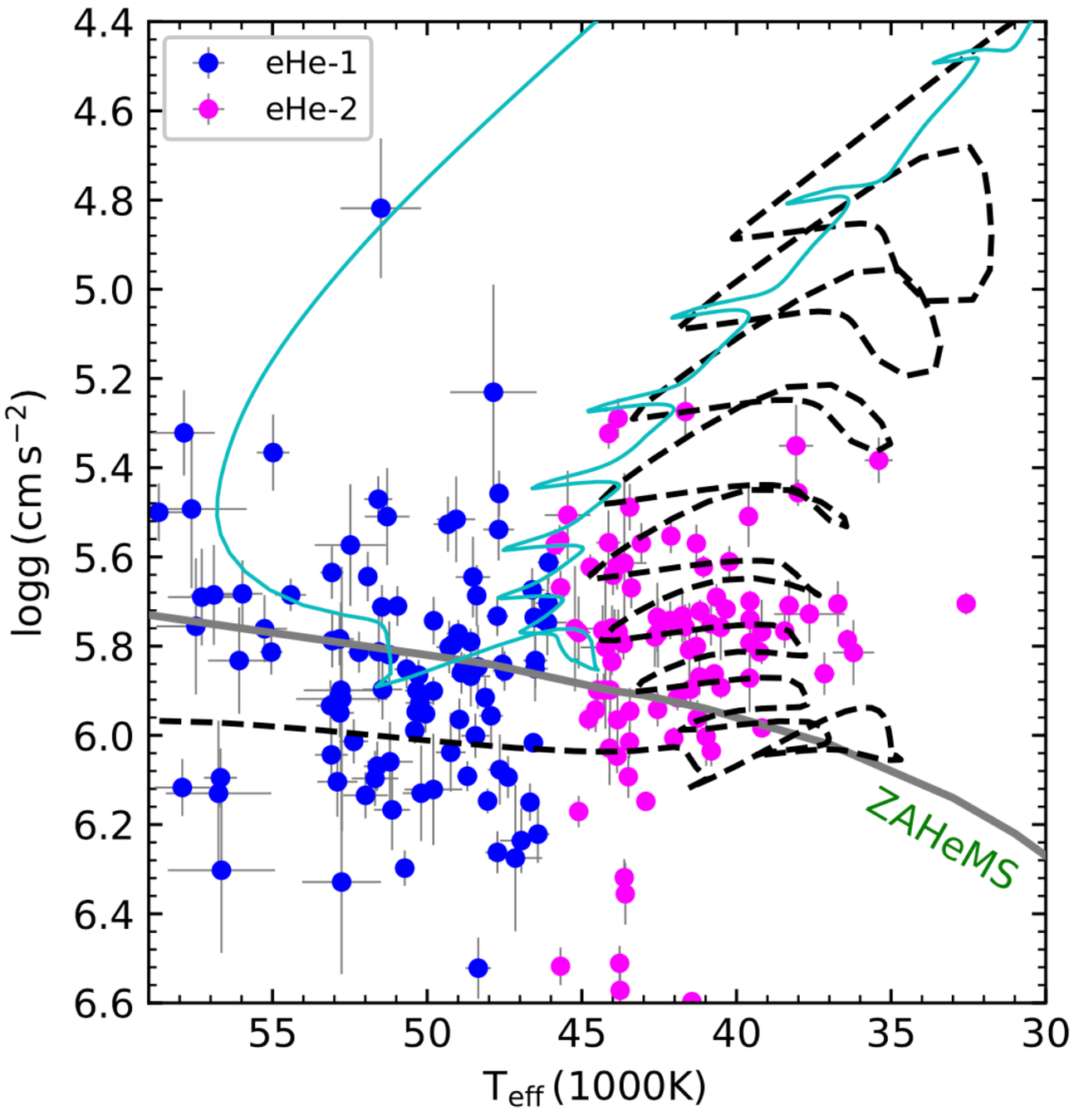
I. Background – hot subdwarfs

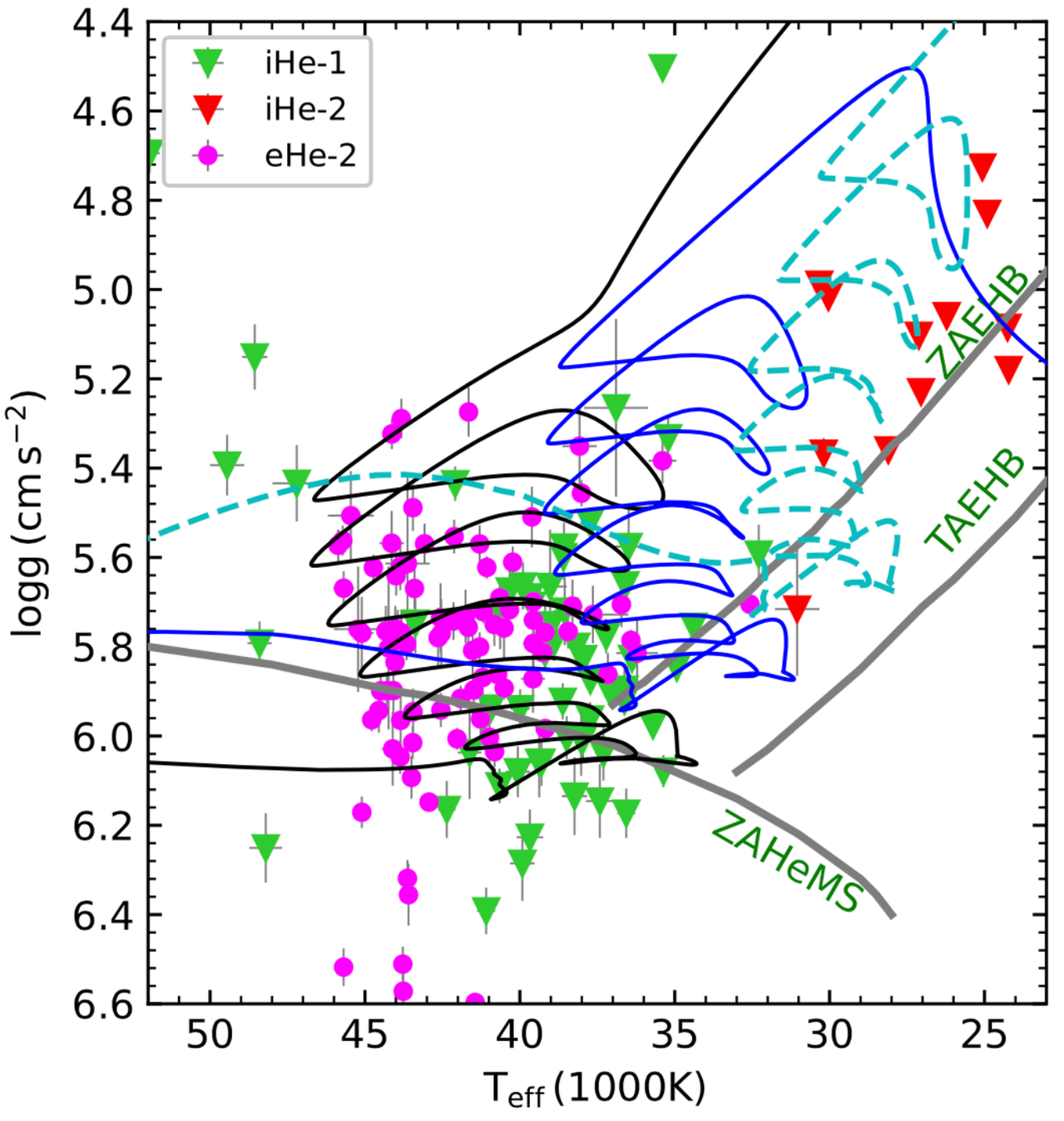


Luo,Y et al. 2021

I. Background – hot subdwarfs

sdO/B tracks from merger channel





Tracks are taken from Zhang & Jeffery (2012)

Luo,Y et al. 2021

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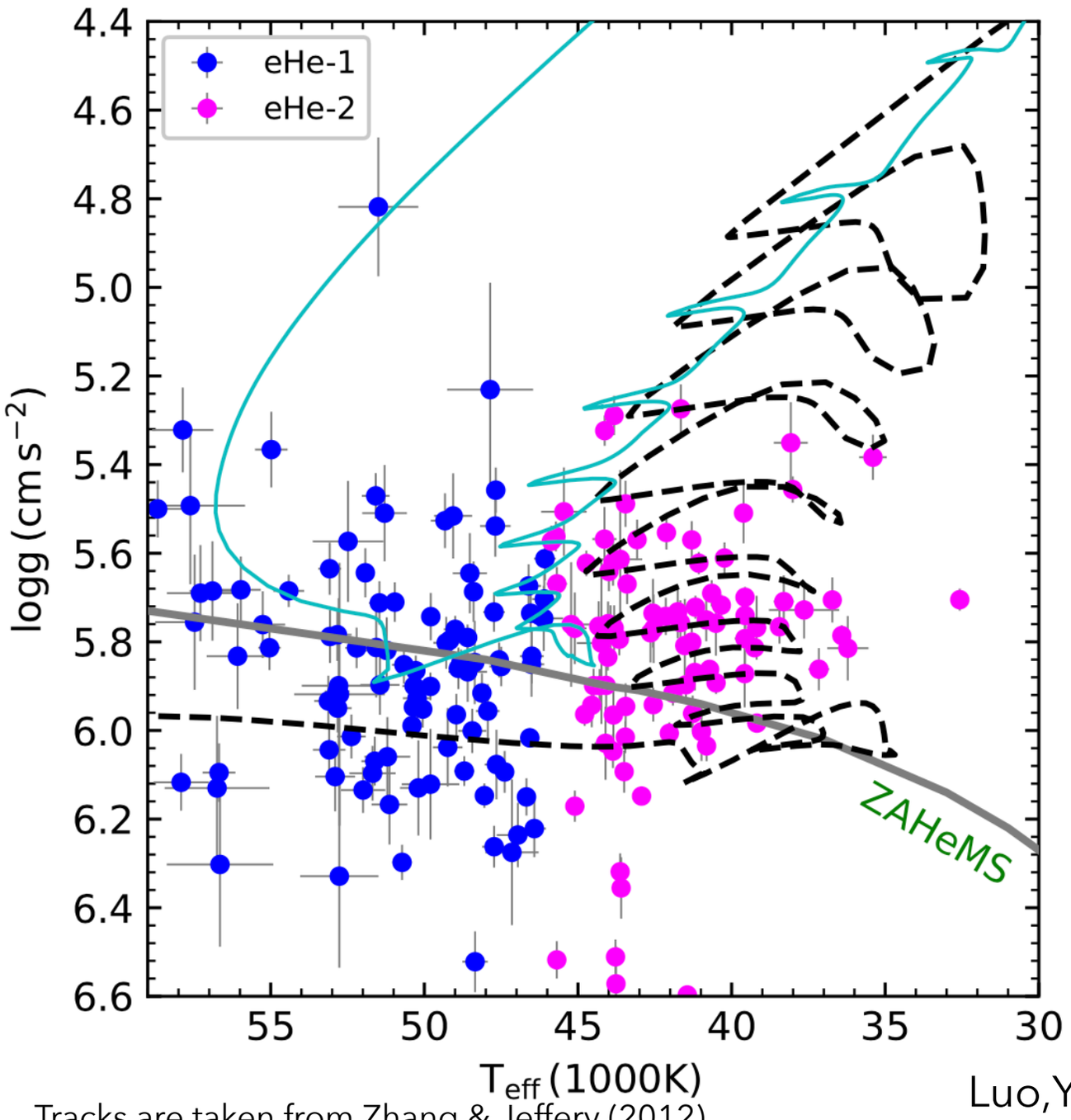
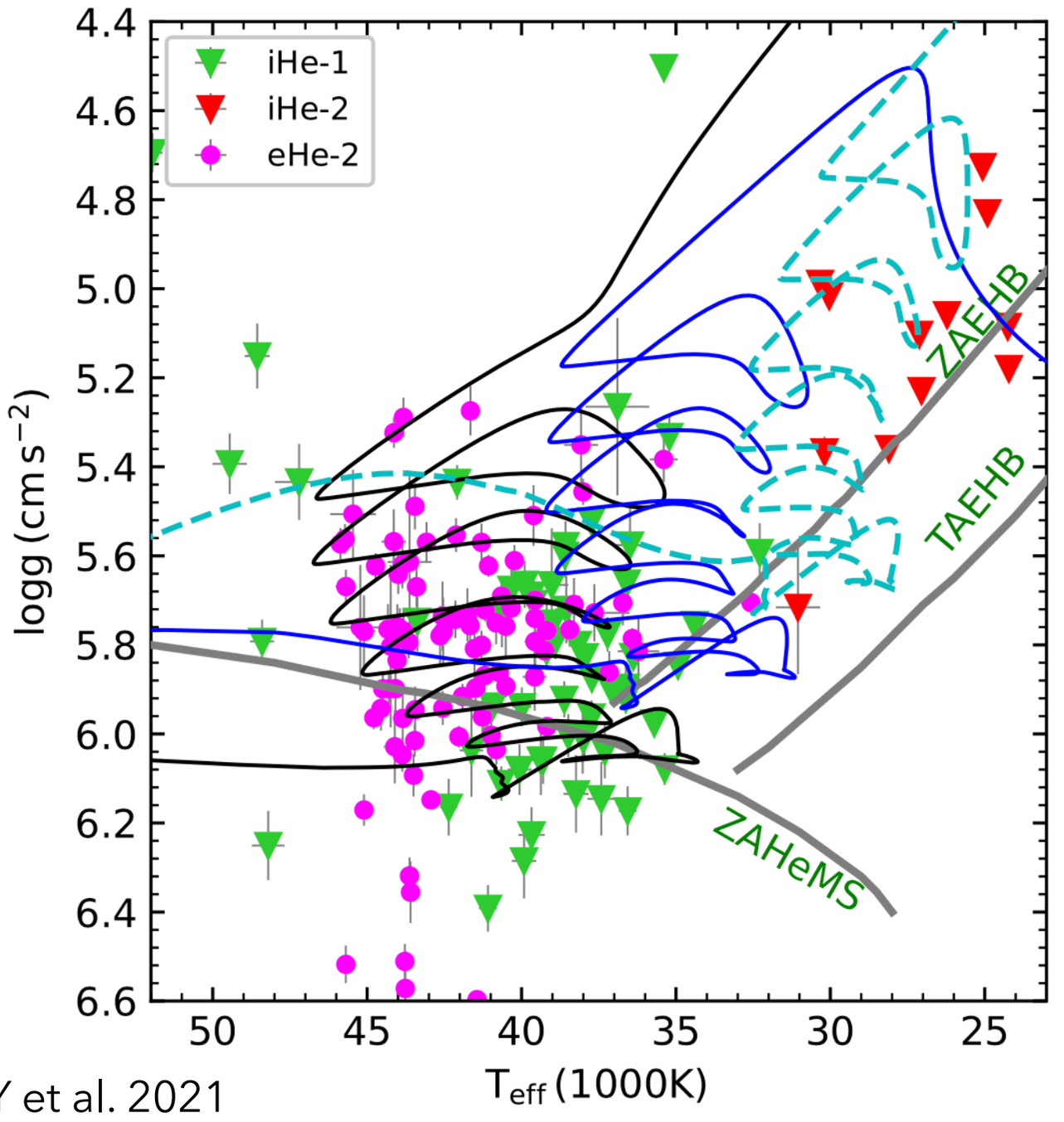
sdO/B tracks from merger channel





Tracks are taken from Zhang & Jeffery (2012)

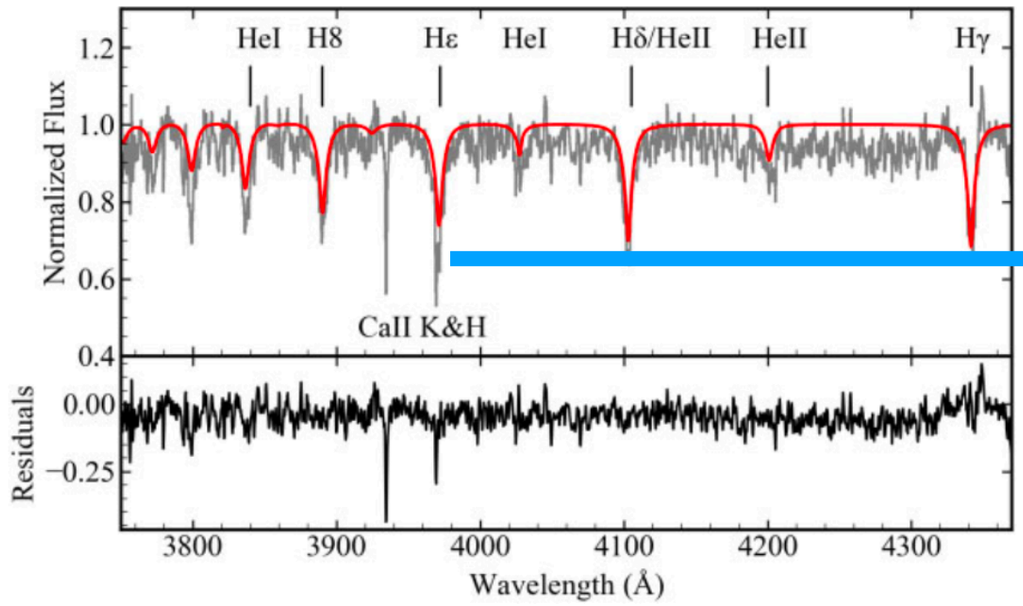
Luo,Y et al. 2021

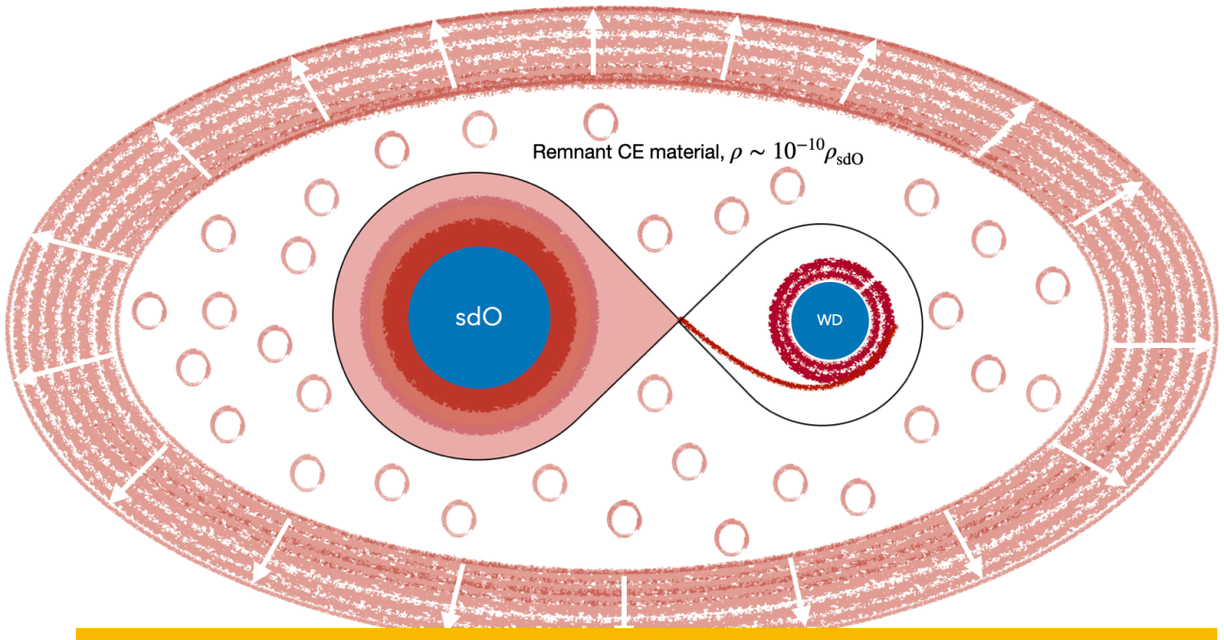
Merger channel can not explain the formation of sdO/B binaries

II. Motivation – SMSS J1920

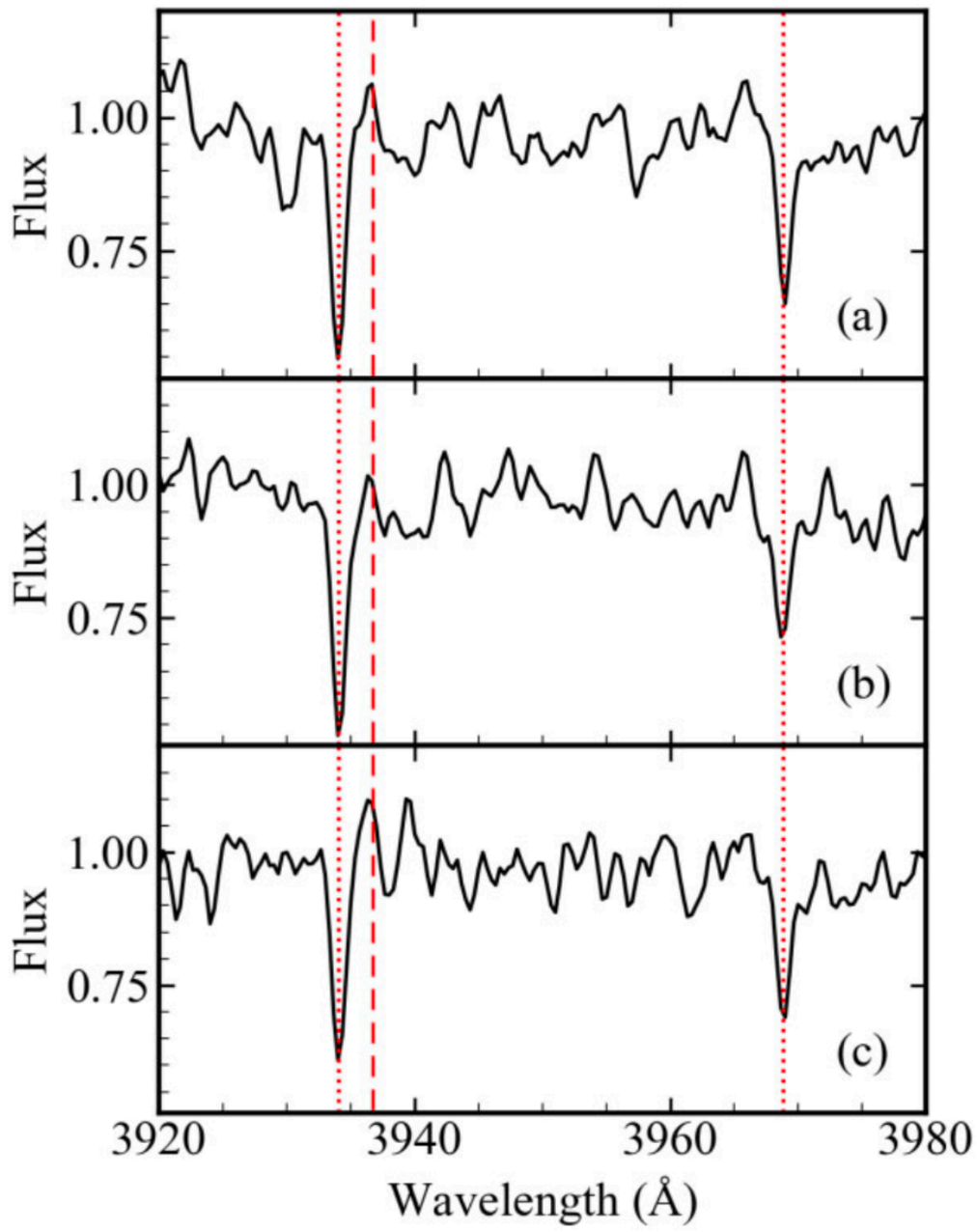
Binary parameters:

Orbital period	P_{orb} [h]	3.4946
sdO mass	M_{sdO} [$M_\odot$]	0.55
WD mass	M_{WD} [$M_\odot$]	0.41





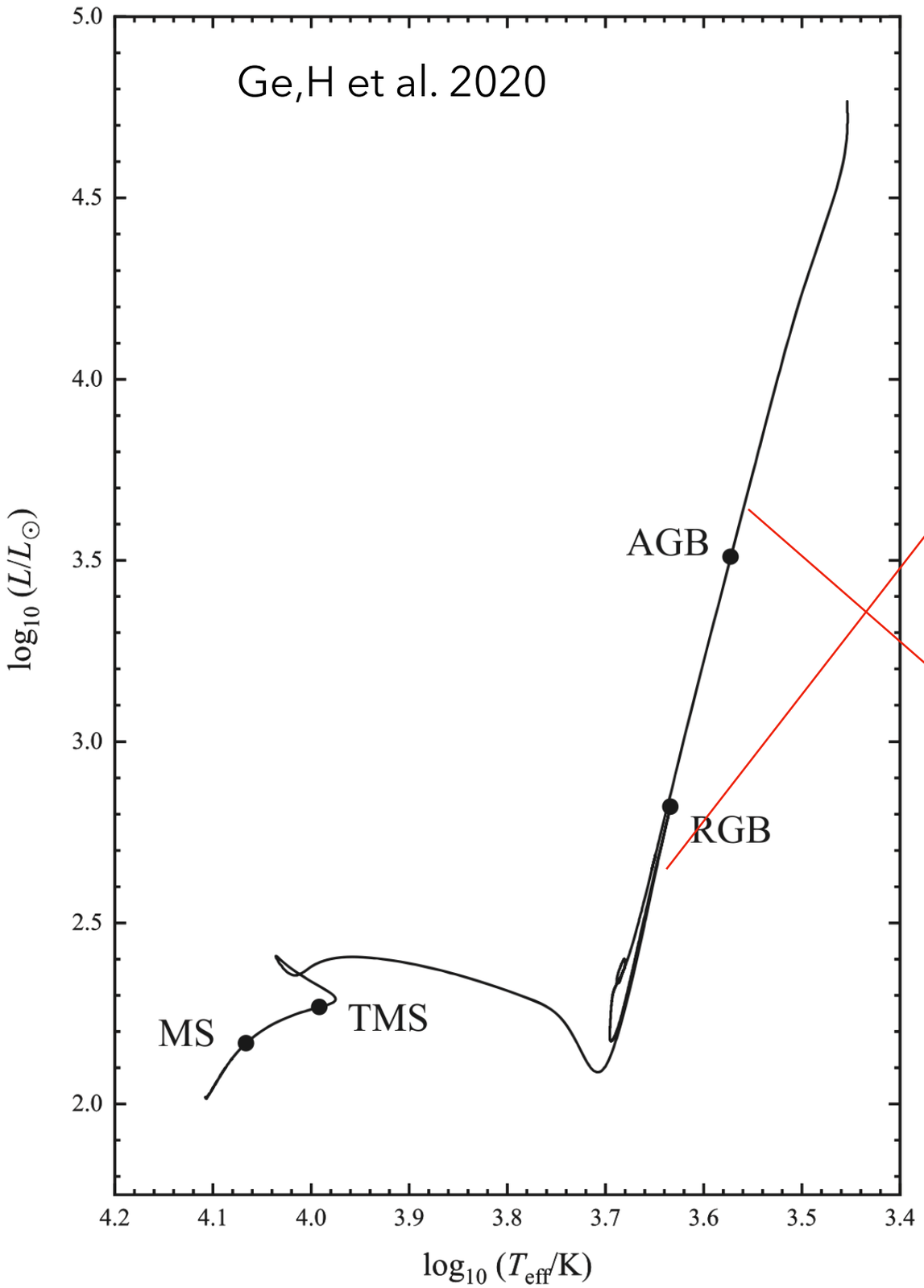
CaII K&H line

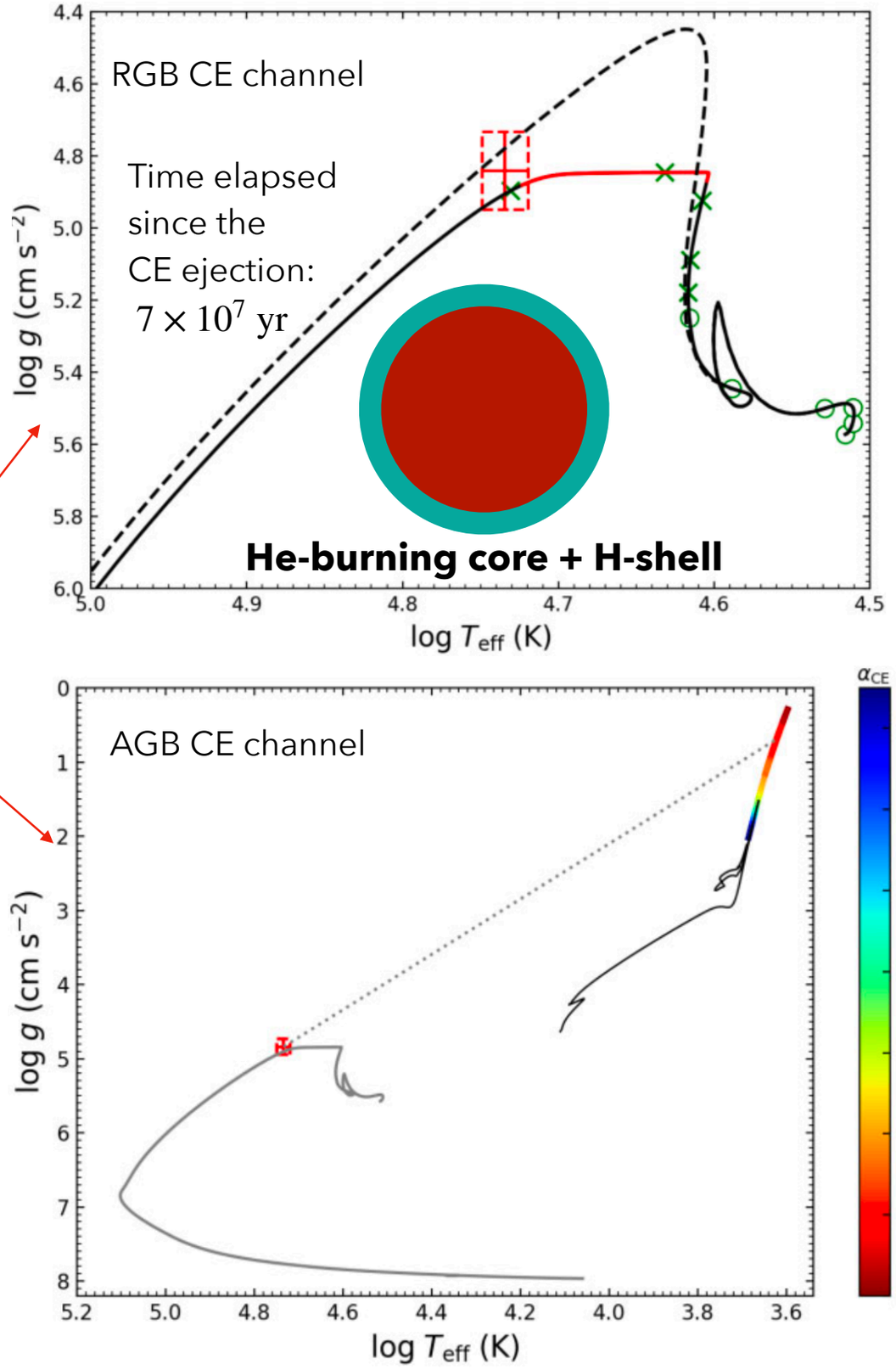


A recent common envelope ejection event ?

Li,J et al. 2022, MNRAS

II. Motivation – SMSS J1920





Li,J et al. 2022, MNRAS

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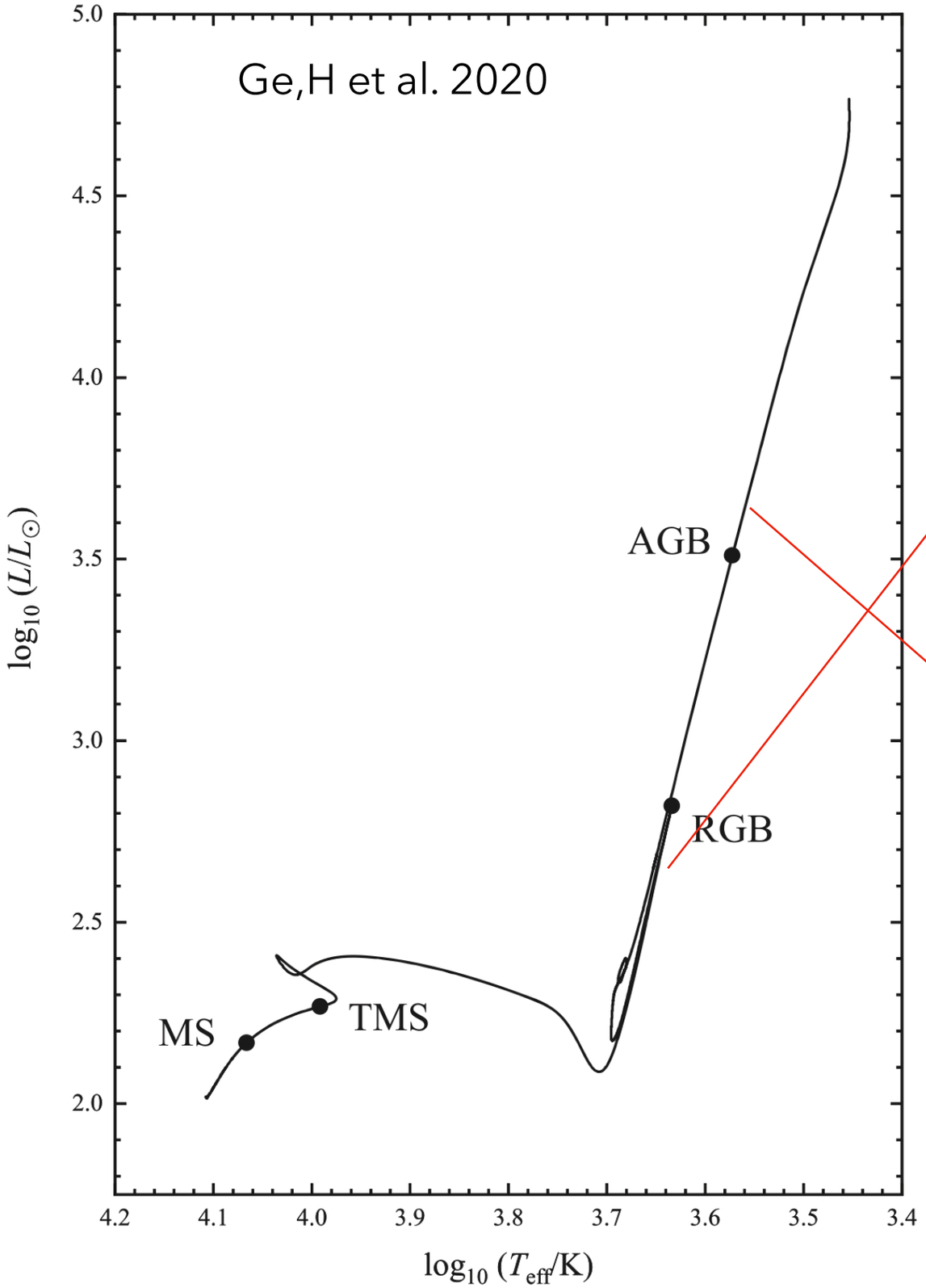
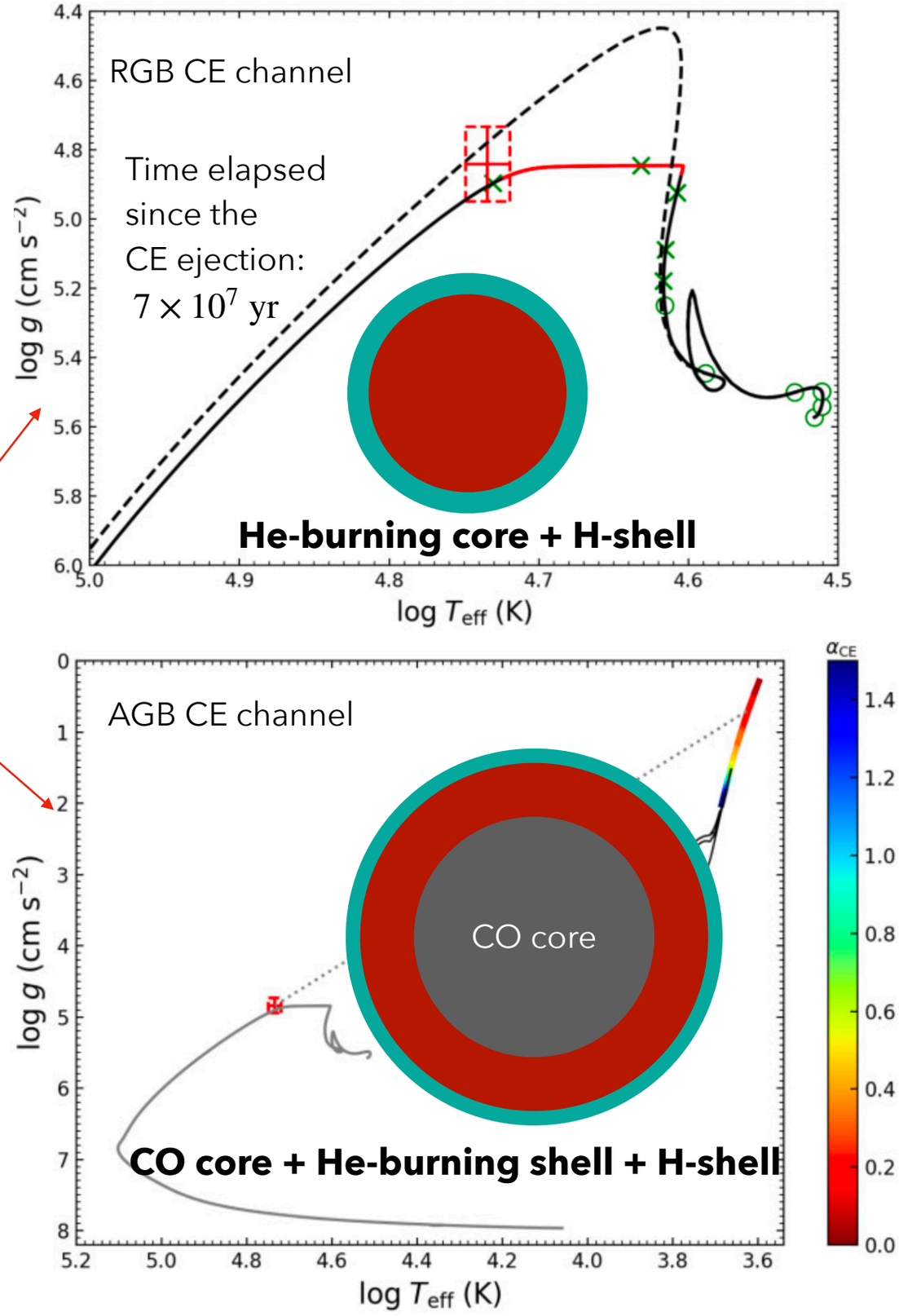
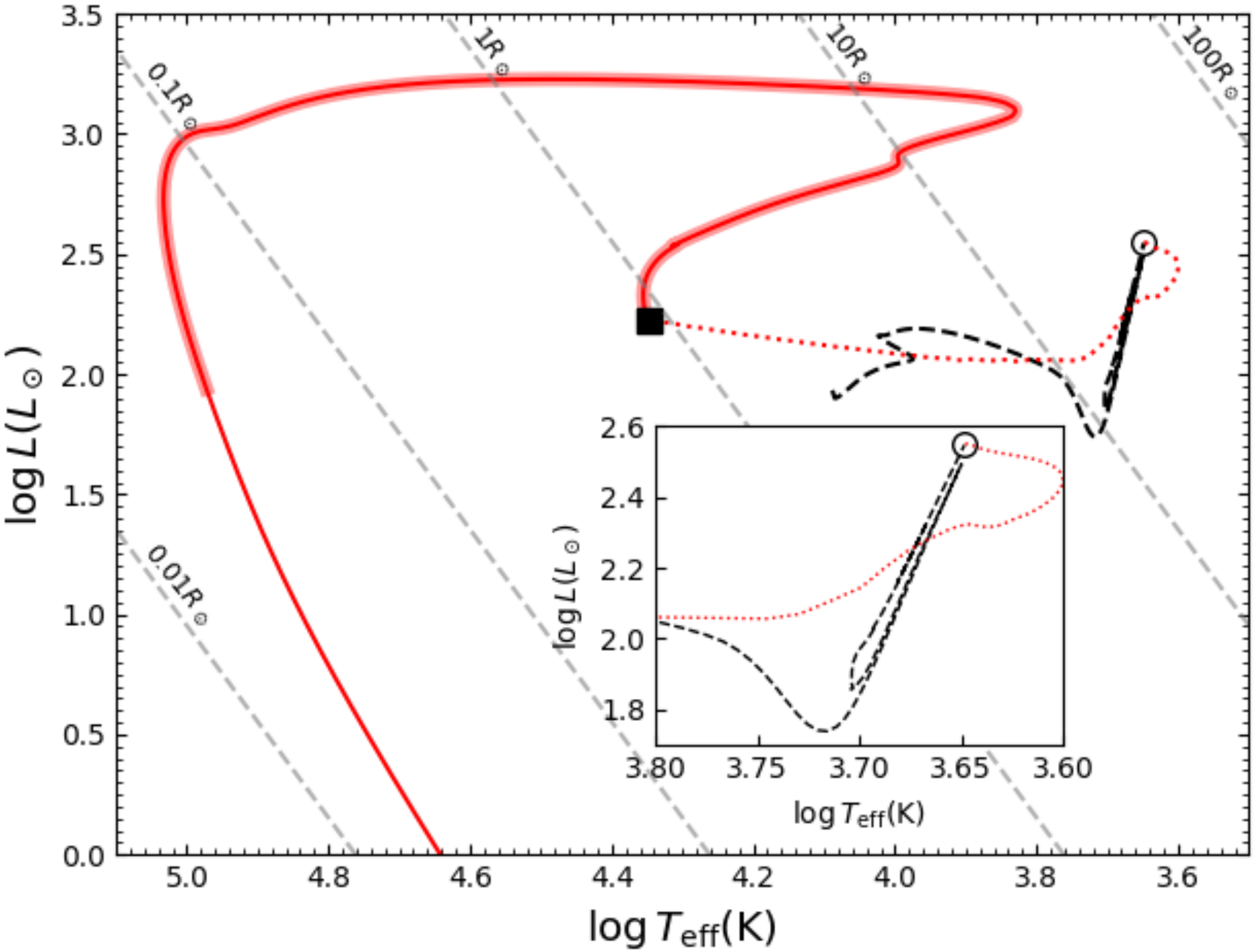




Li,J et al. 2022, MNRAS

III. A new route to sdOs —— AGB CE channel

Stellar Evolution Code: MESA



Donor mass: $3.0M_{\odot}$

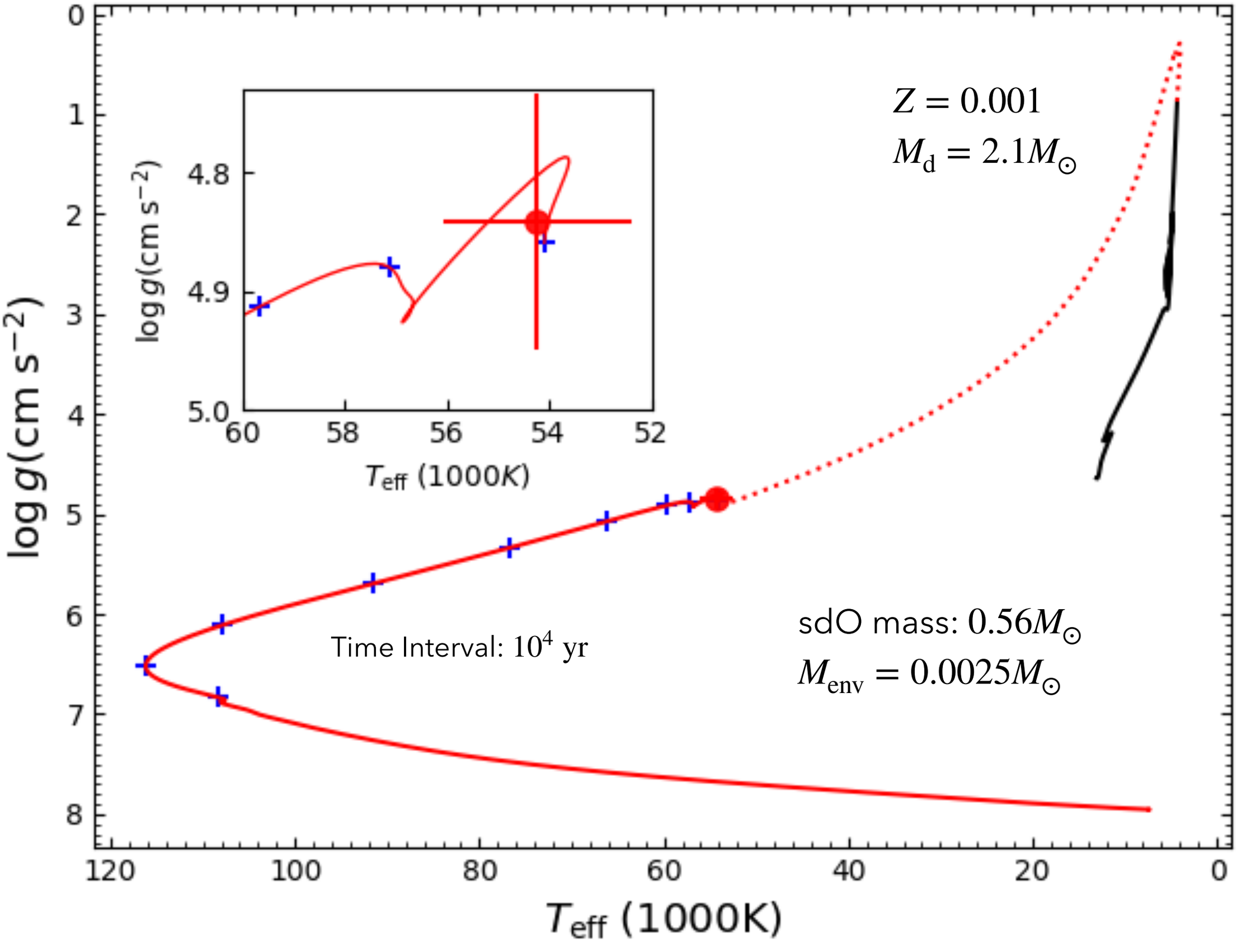
Z = 0.02

sdO mass: $0.55M_{\odot}$

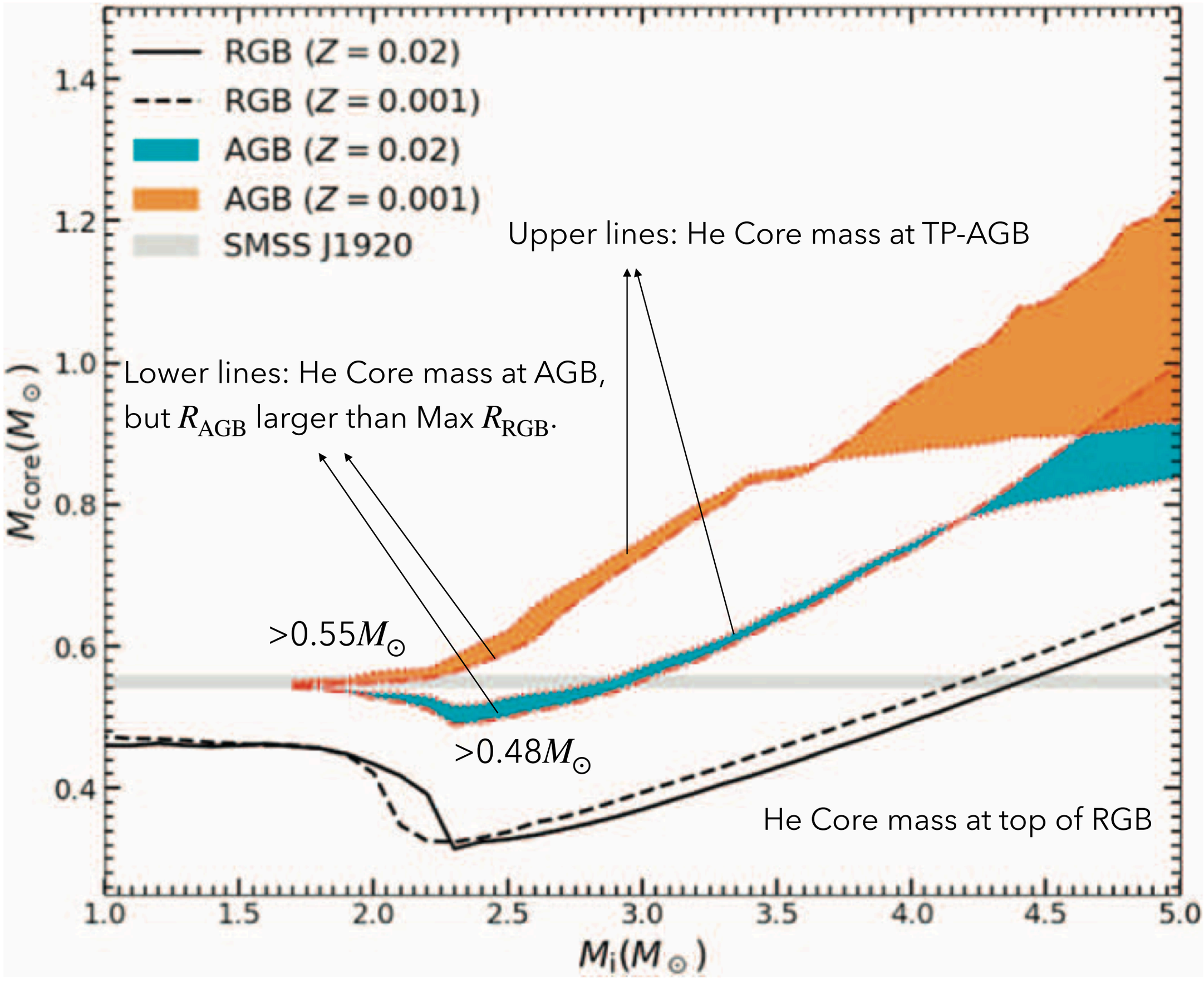
$M_{\rm env} = 0.01M_{\odot}$

Li,Z et al. ApJ, 2024

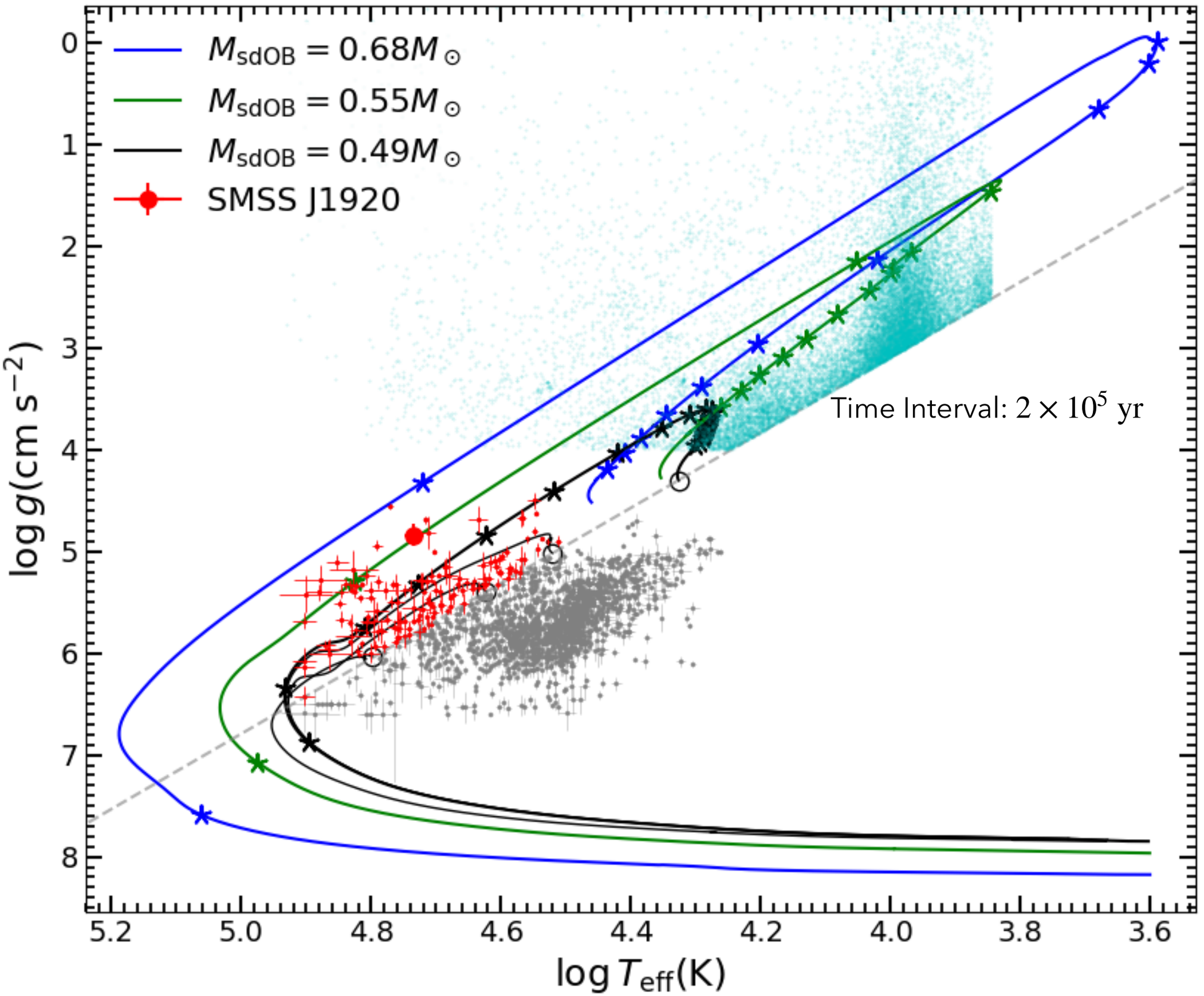
III. AGB CE channel —– SMSS J1920



III. AGB CE channel —— parameter space



III. AGB CE channel —— Comparison with observations



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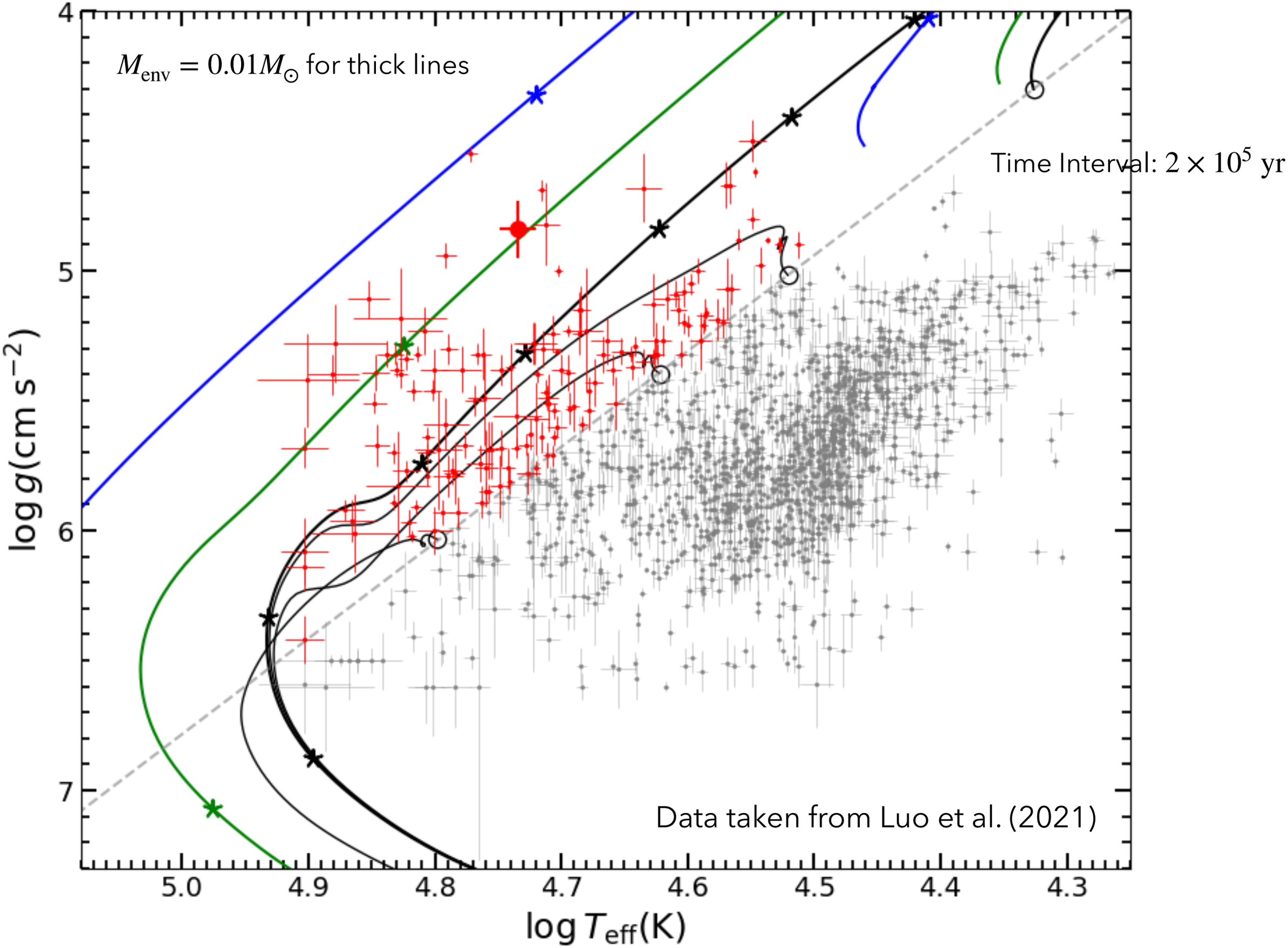
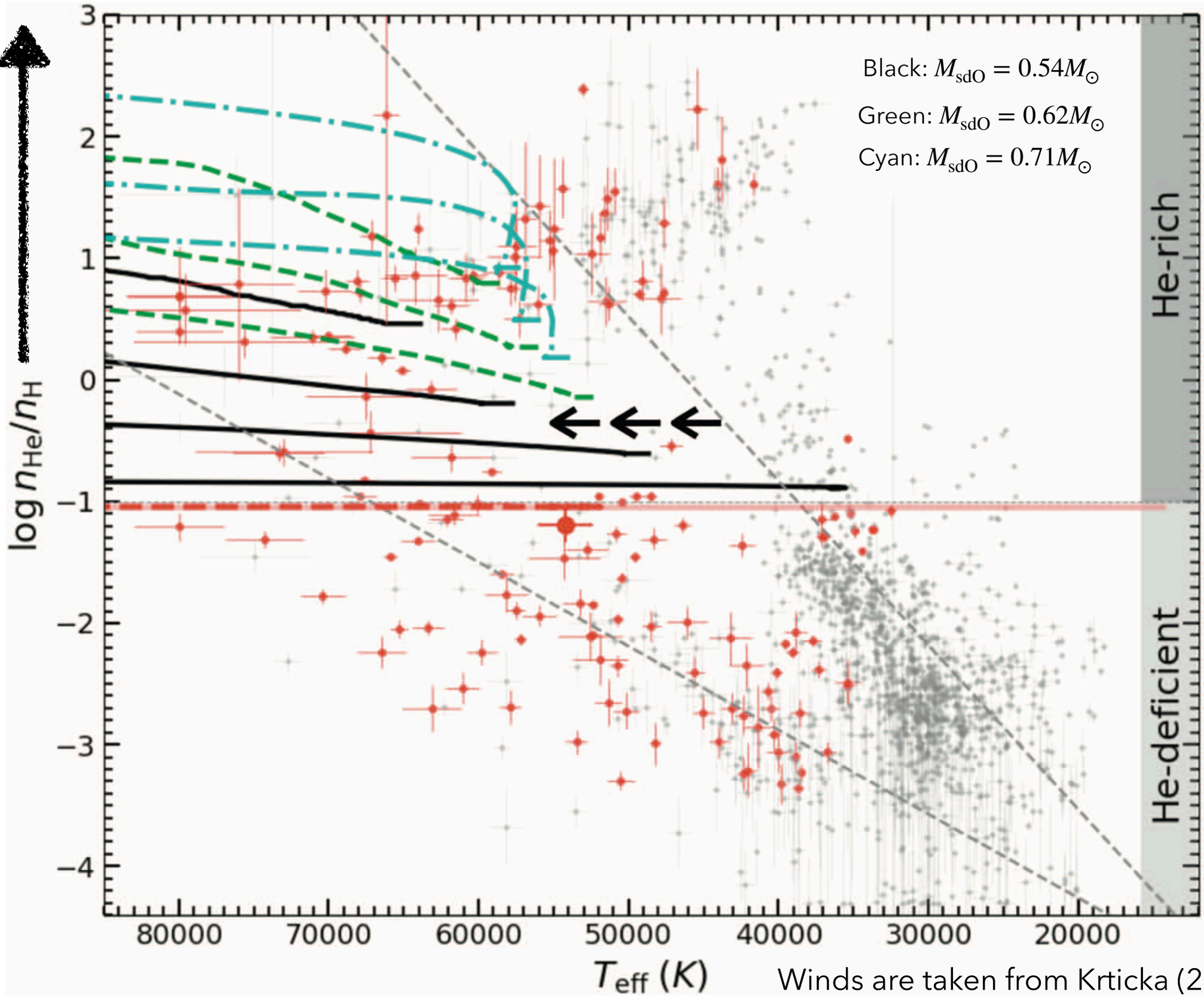


III. AGB CE channel —— Comparison with observations

The red dots are for sdO/B samples that can be covered with the evolutionary tracks in log Teff – log g diagram.

Envelope Mass Decrease



Winds are taken from Krticka (2016)

Summary

- AGB CE ejection channel —— The evolutionary model for SMSS J1920

sdOB Binary

+

sdOB mass $\gtrsim 0.48 M_{\odot}$

+

High-log T and low-log g

+

He-rich sdOB

The Astrophysical Journal, 964:22 (7pp), 2024 March 20 https://doi.org/10.3847/1538-4357/ad2206

A New Route to Massive Hot Subdwarfs: Common Envelope Ejection from Asymptotic Giant Branch Stars

Zhenwei Li[1,2,3], Yangyang Zhang[4], Hailiang Chen[1,2,3], Hongwei Ge[1,2,3], Dengkai Jiang[1,2,3], Jiangdan Li[1,2,3], Xuefei Chen[1,2,3], and Zhanwen Han[1,2,3,5]

YNAO Invites Global Talents for Excellent Young Scientists Fund (Overseas) of NSFC Talent programs from CAS and Yunnan Province

Funding and Supports (NSFC & CAS-BR)

- Senior position
- Research start-up fund (1-3 million RMB)
- Living subsidy (>1 million RMB pre-tax)
- Competitive salary and benefits
- A transitional apartment

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- Young Science and Technology Talents
- Special Research Assistants
- Postdoctoral Fellows (0.2-0.3 million RMB/yr pre-tax & a free apartment)

Contacts: Ms. Zhao, Email: zxj@ynao.ac.cn, Tel:(86)871-63920899


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Lijiang Gaomeigu


Fuxian Lake-NVST


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