Modeling the Progenitors of Low-Mass Post-Accretion Binaries

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Image: NightCafe

The S-Process as a Tracer through Cosmic Time

[Fe/H] (proxy for age)

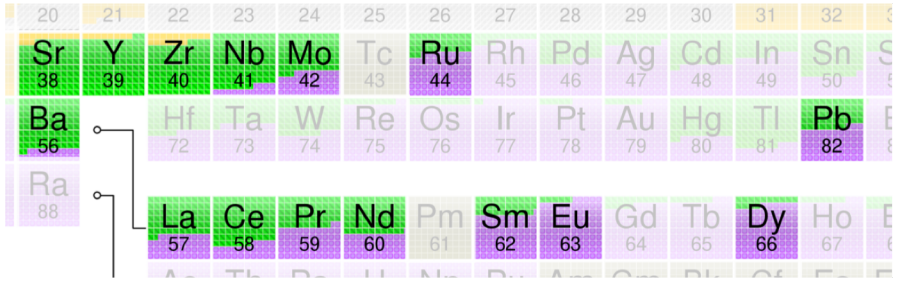
-2.00 -1.00 0.00

CEMP-s
low [Fe/H] < -1.00
low mass ≤ 1.0 $M_\odot$

CH
[Fe/H] ~ -1.00
low-mod. mass

Barium (Ba)
high [Fe/H] > -1.00
mod. mass ~2.5 $M_\odot$

- Heavy element enrichment
- High binary fraction
- Giants / SGB / dwarfs



Based on data from Jennifer Johnson

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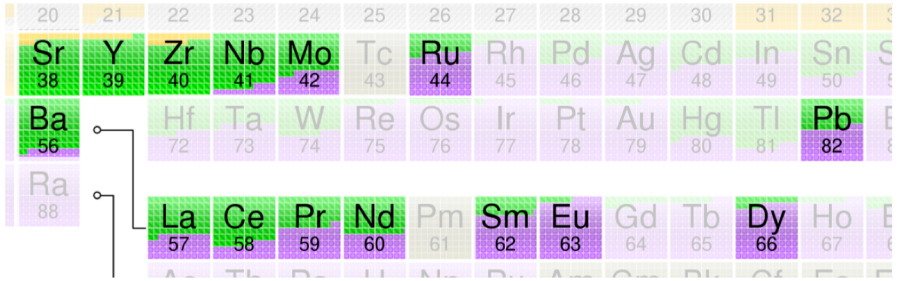

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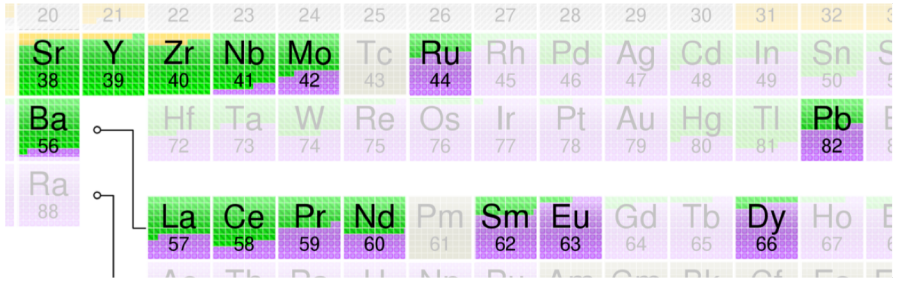

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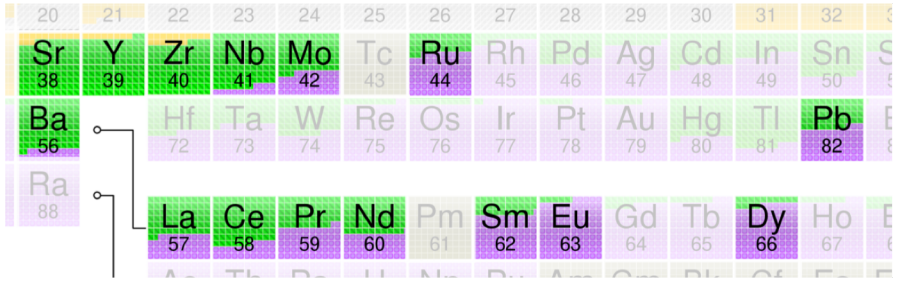
- Probes of:
  - AGB nucleosynthesis
  - Binary interaction processes
  - Stellar mixing processes



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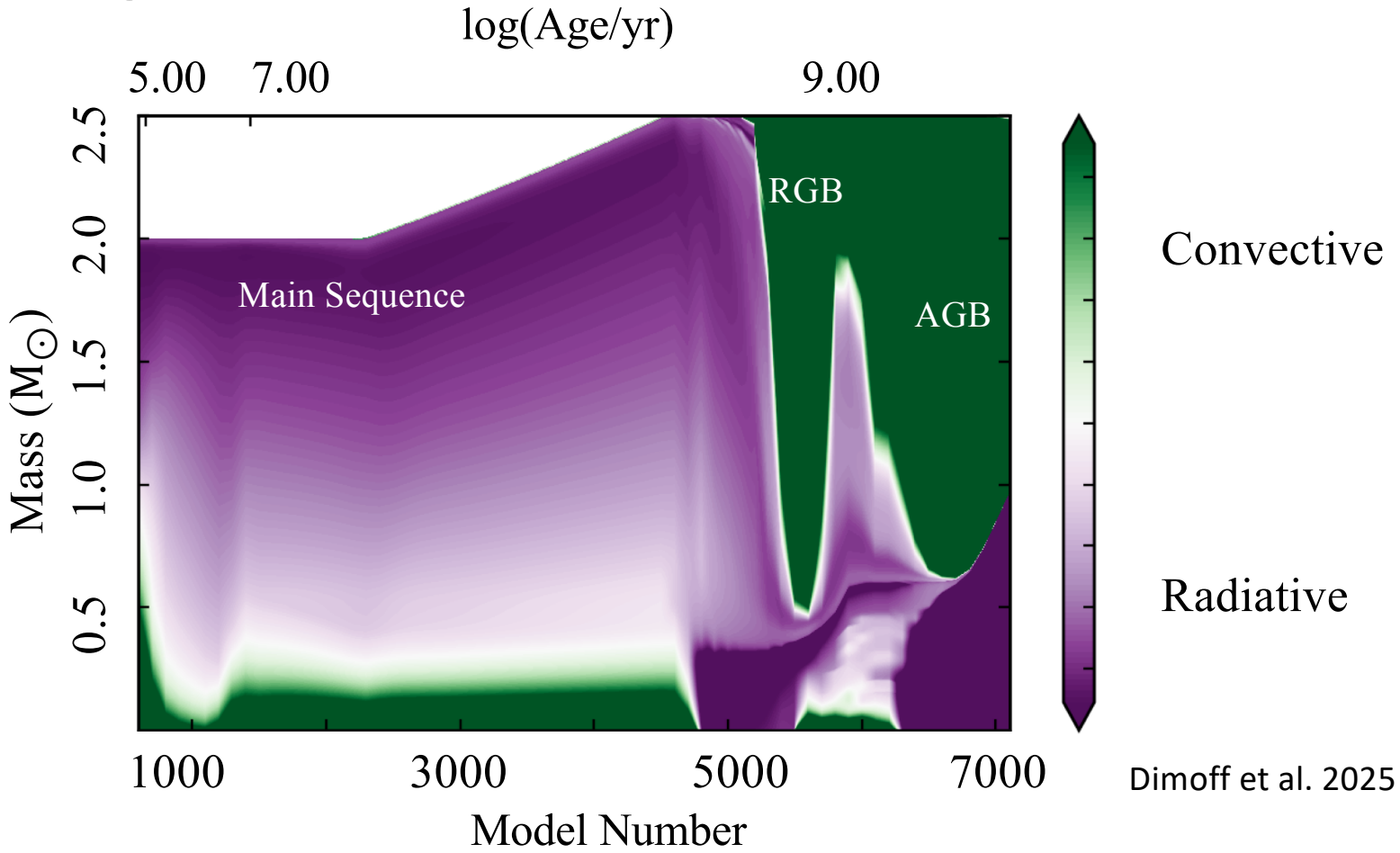
Modeling the Effect of Accretion on Evolution



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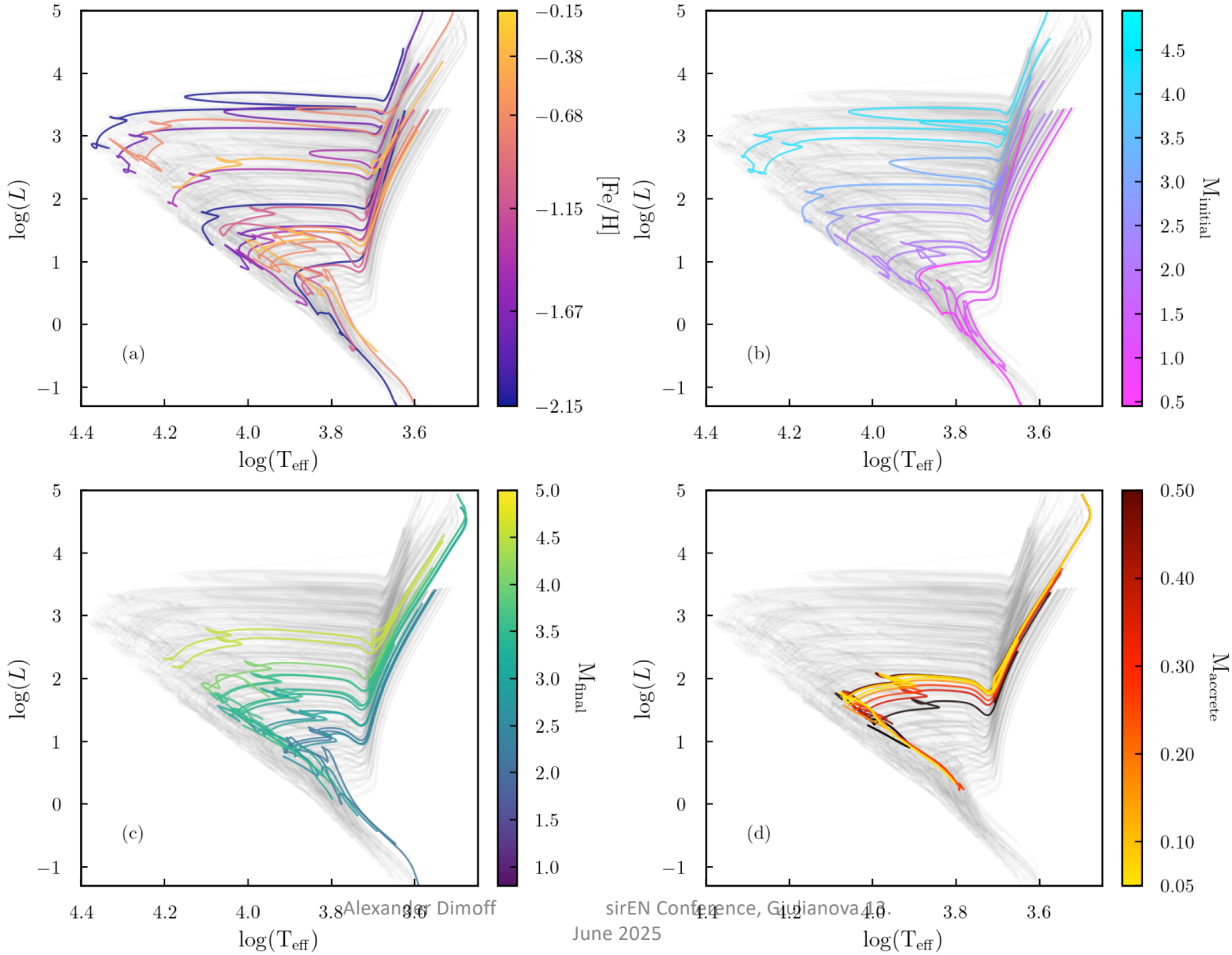
log(L)
log(T_eff)
(a)
[Fe/H]
−0.15
−0.38
−0.68
−1.15
−1.67
−2.15
(b)
M_initial
(c)
M_final
(d)
M_accrete

Modeling the Effect of Accretion on Evolution

M_f =2.5 $M_\odot$, M_{AGB} =2.5 $M_\odot$, [Fe/H] = -0.15

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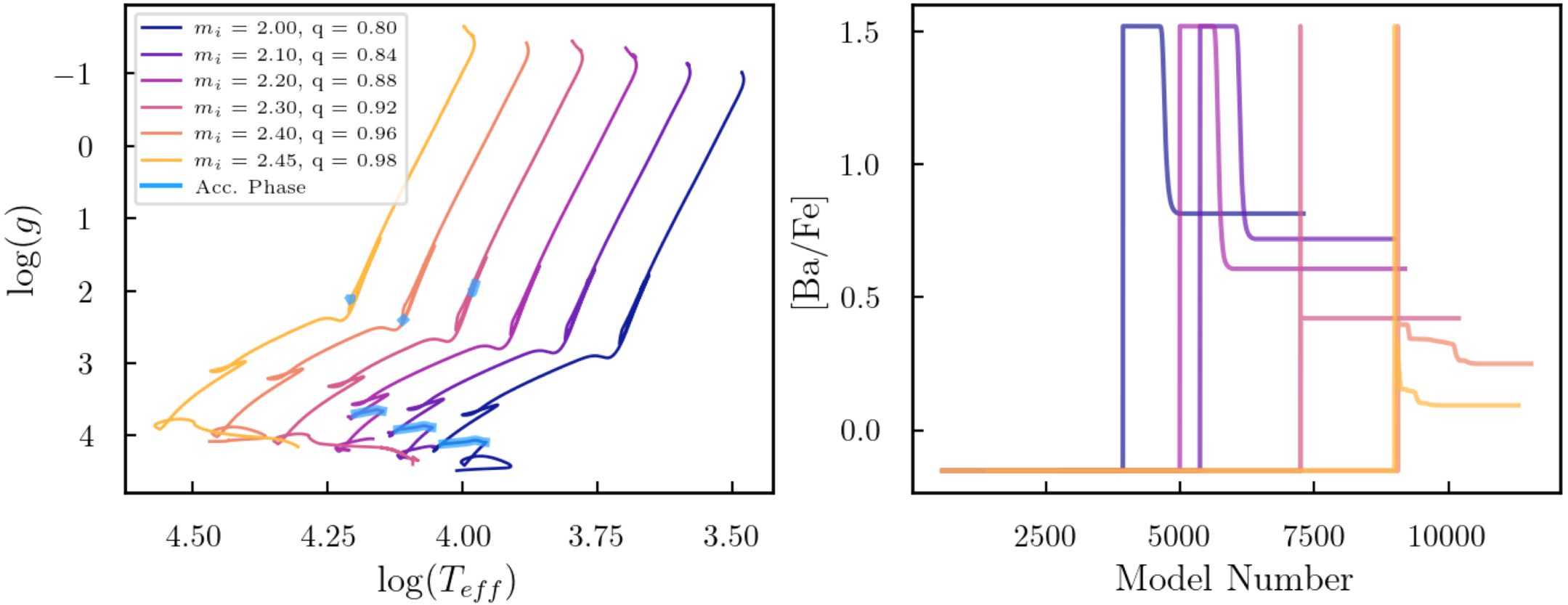
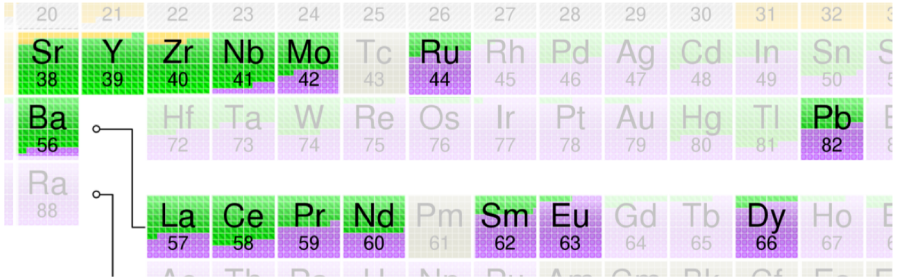


Observational Samples

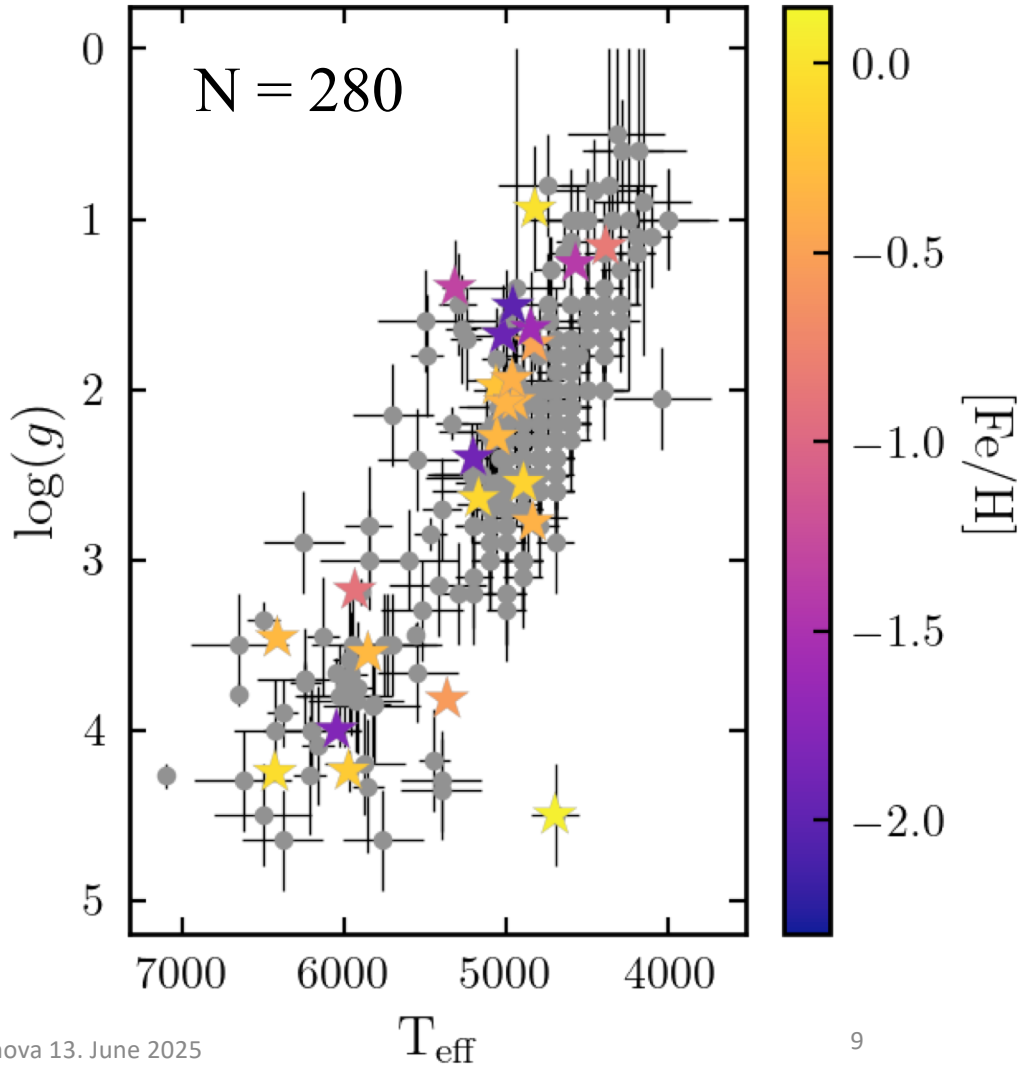
- Literature: T_{eff} , log(g), [Fe/H], [X/Fe]



Based on data from Jennifer Johnson

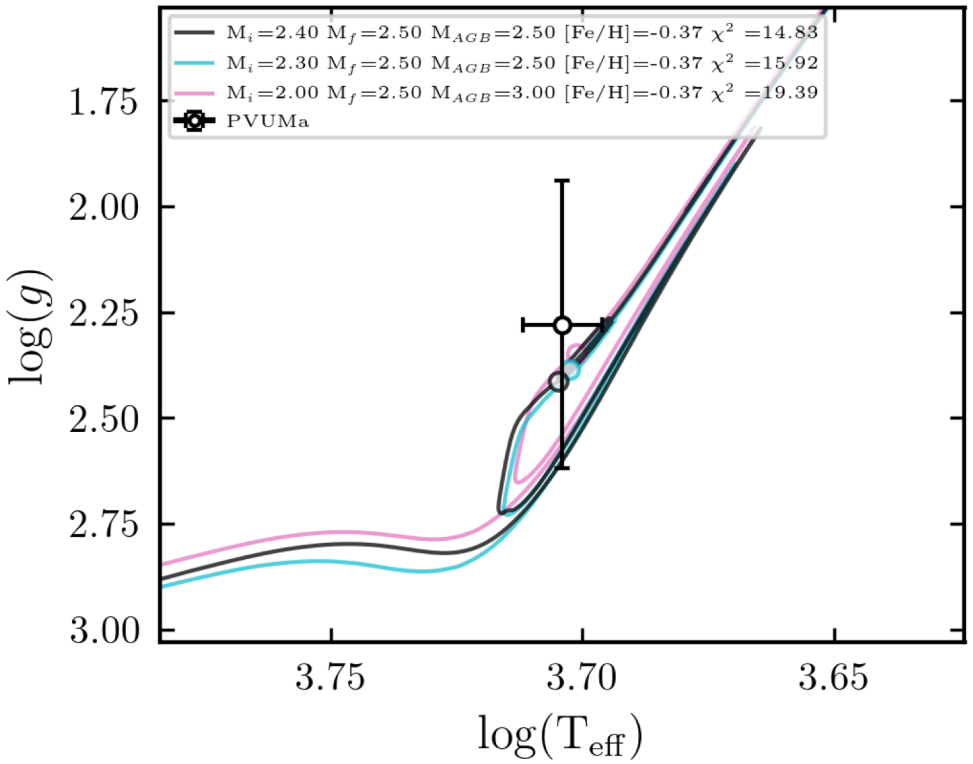
- Goswami et al. 2014, 2015, 2021
- DeCastro et al. 2016 + Roriz 2021
- Cristallo et al. 2016
- Dimoff et al. 2024

Dimoff et al. 2025

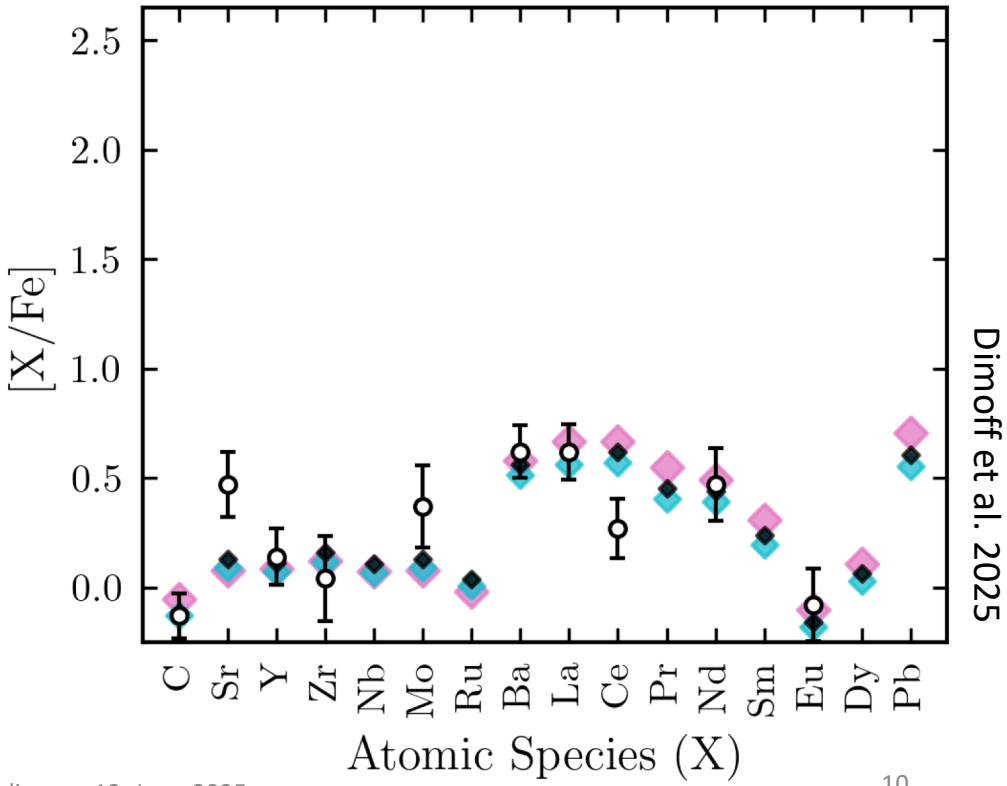


Modeling the Evolution of Ba (weak) Stars

Kiel diagram constrains mass / surface params



Abundances constrain:
AGB mass, accreted mass, mixing processes



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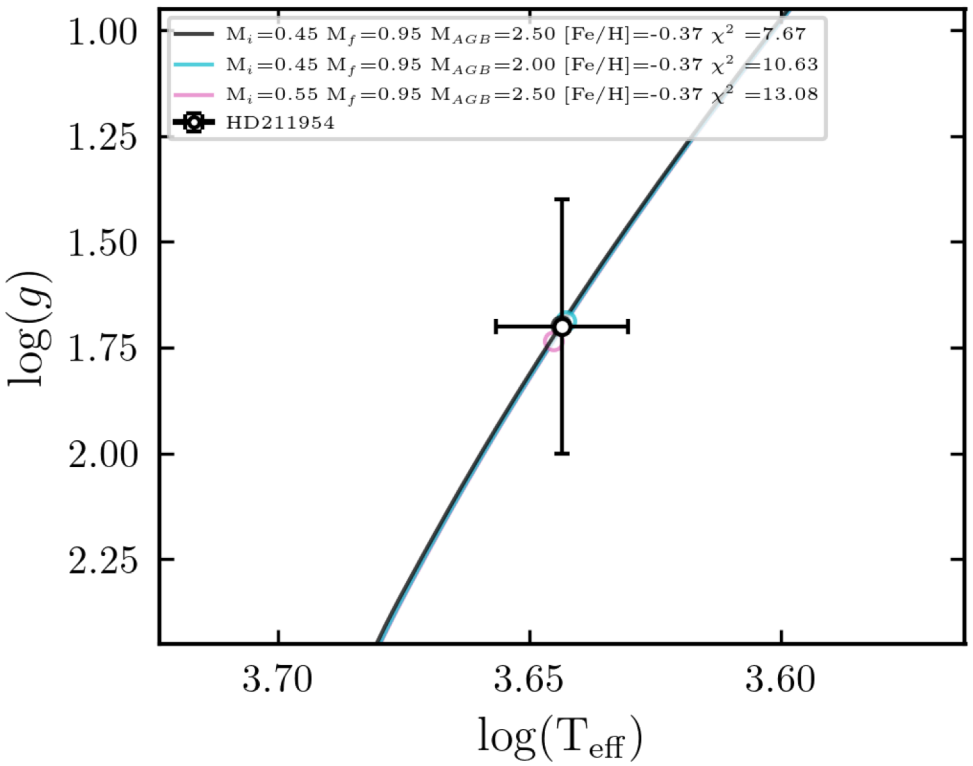
Modeling the Evolution of Ba (strong) Stars

Kiel diagram constrains mass / surface params



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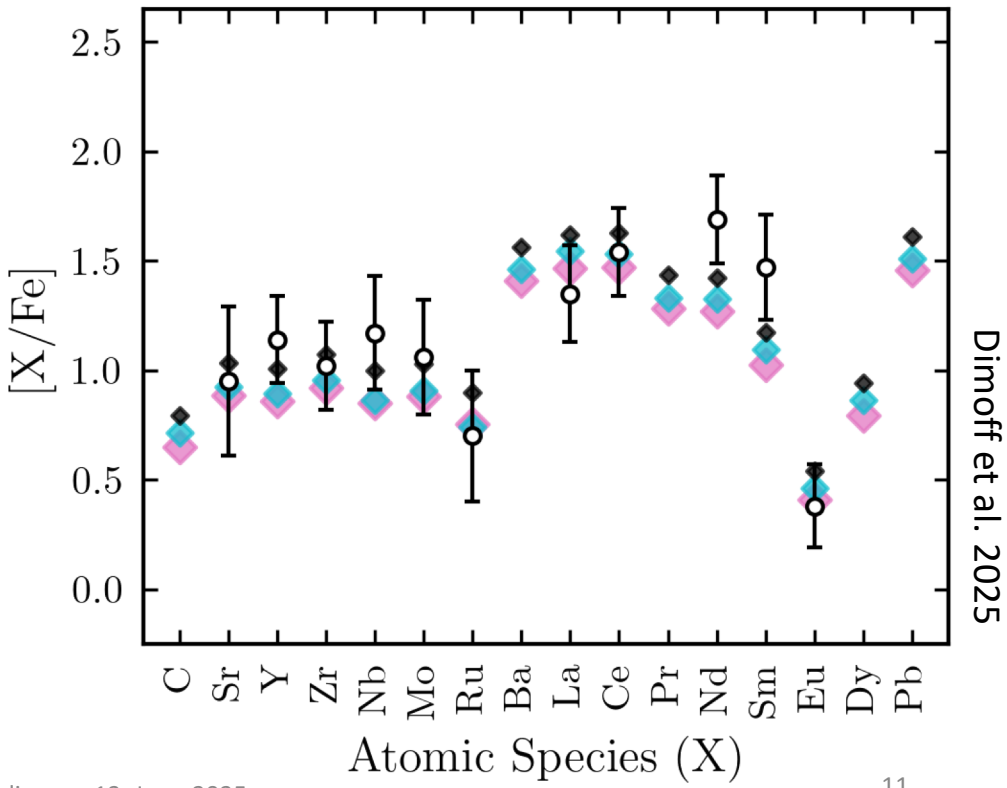

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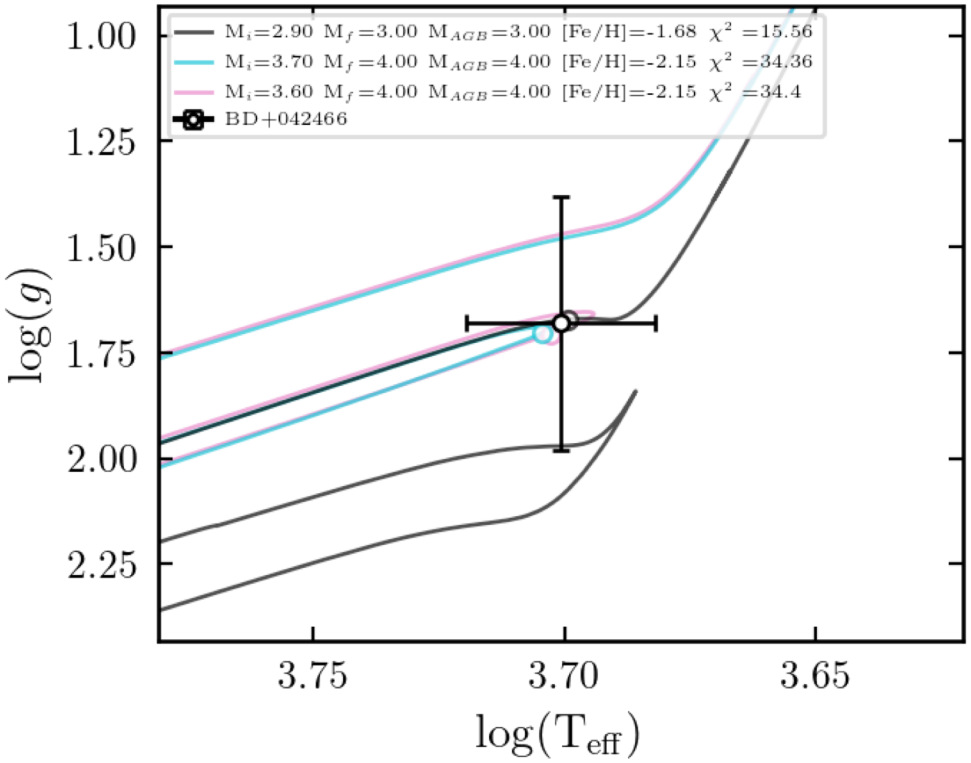
Modeling the Evolution of CH Stars

Kiel diagram constrains mass / surface params



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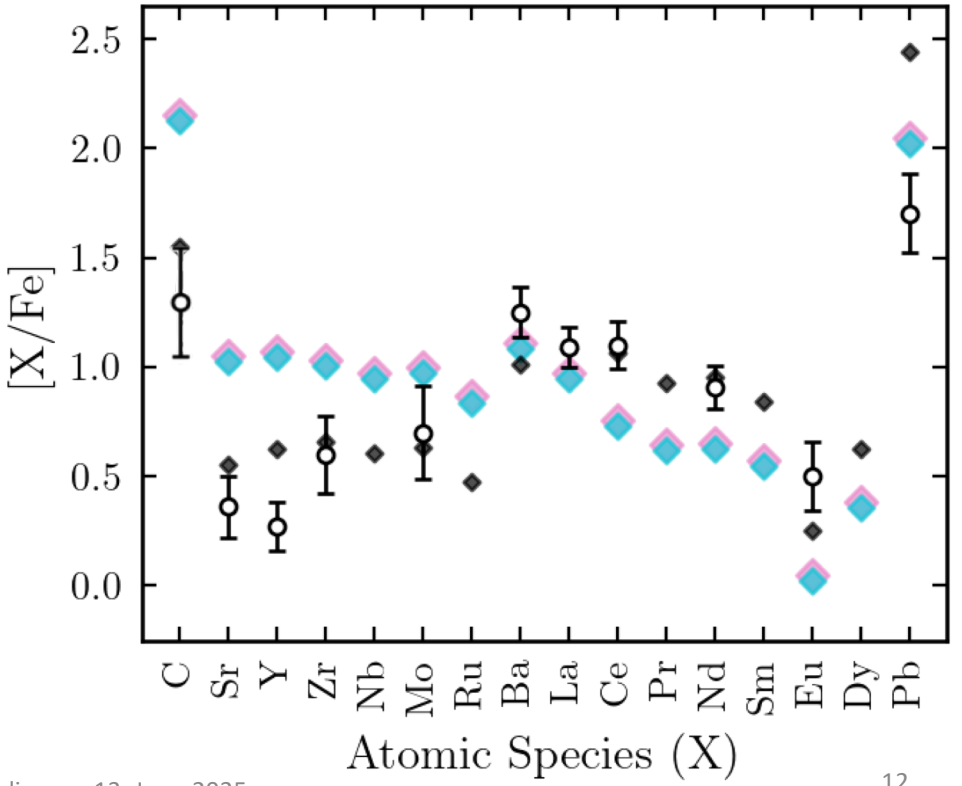

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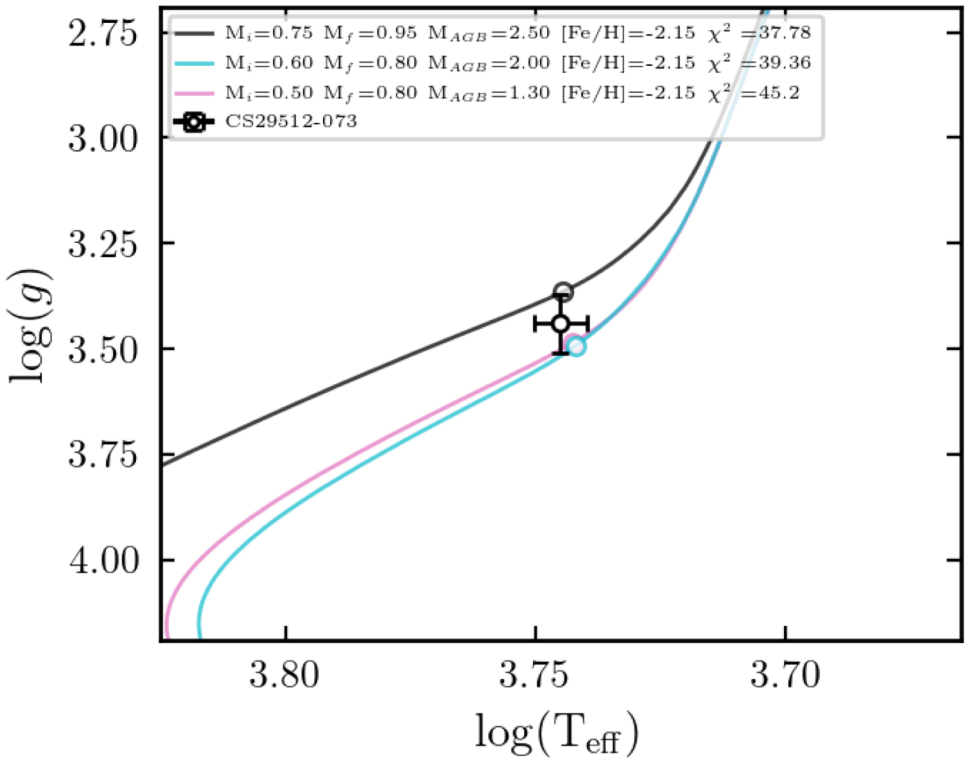
Modeling the Evolution of CEMP-s Stars

Kiel diagram constrains mass / surface params



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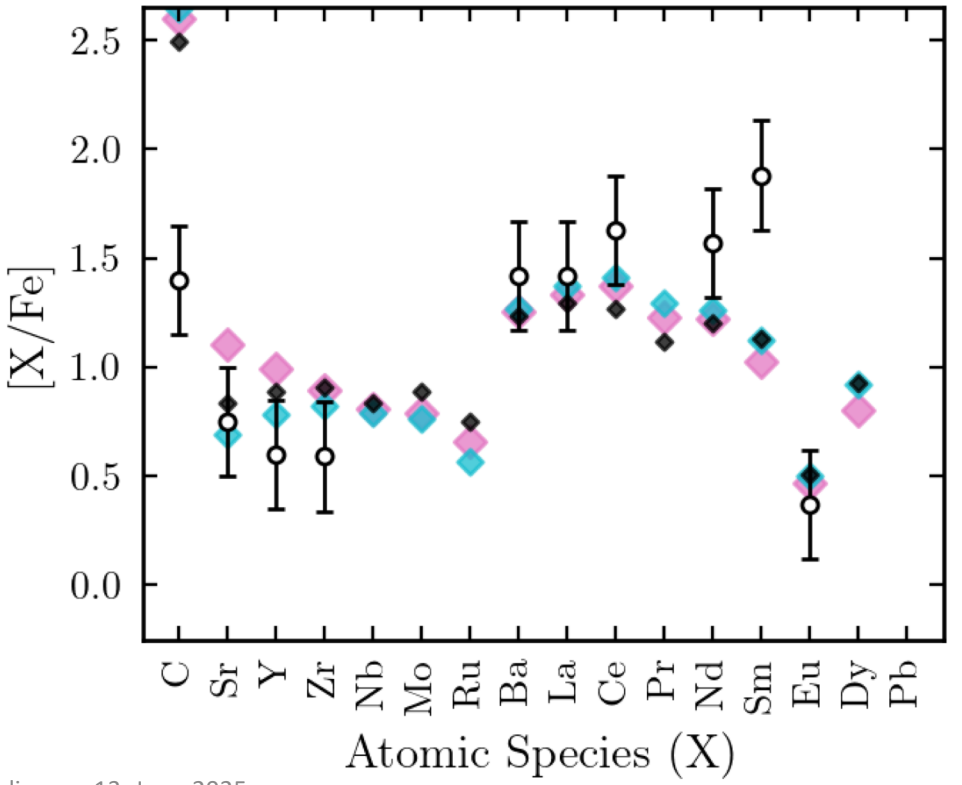

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Populations at Different Metallicity

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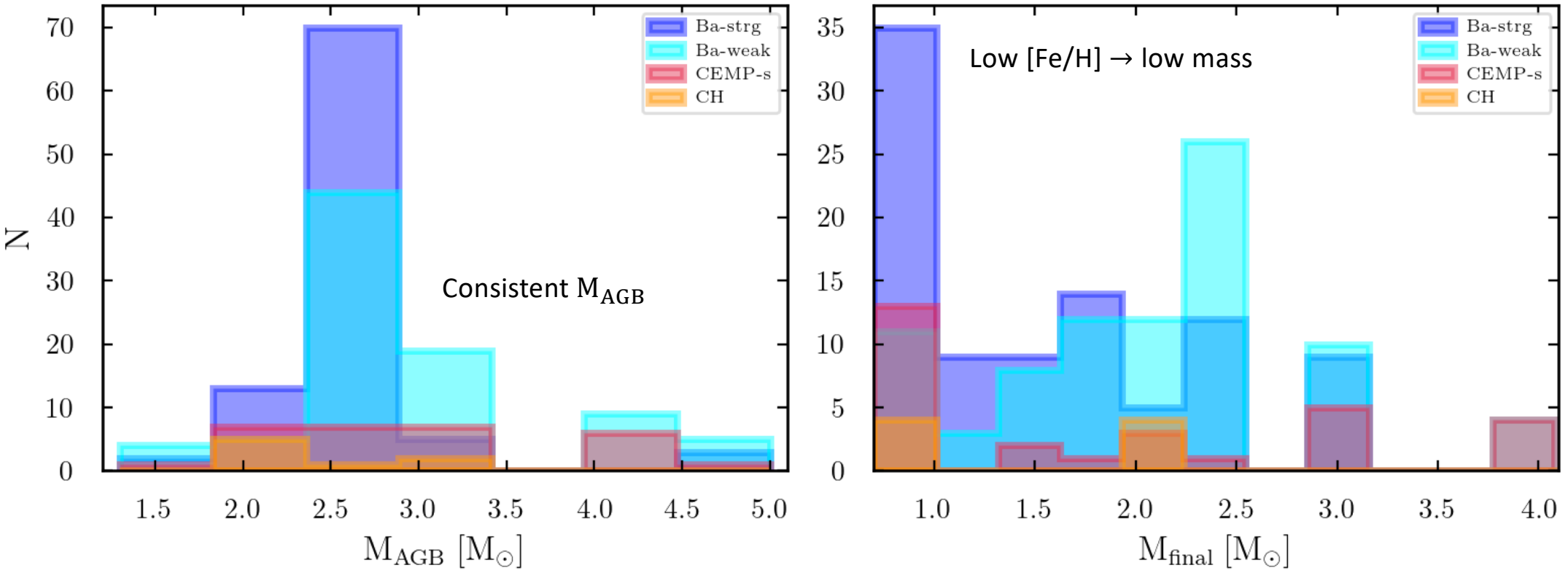

Populations at different [Fe/H]

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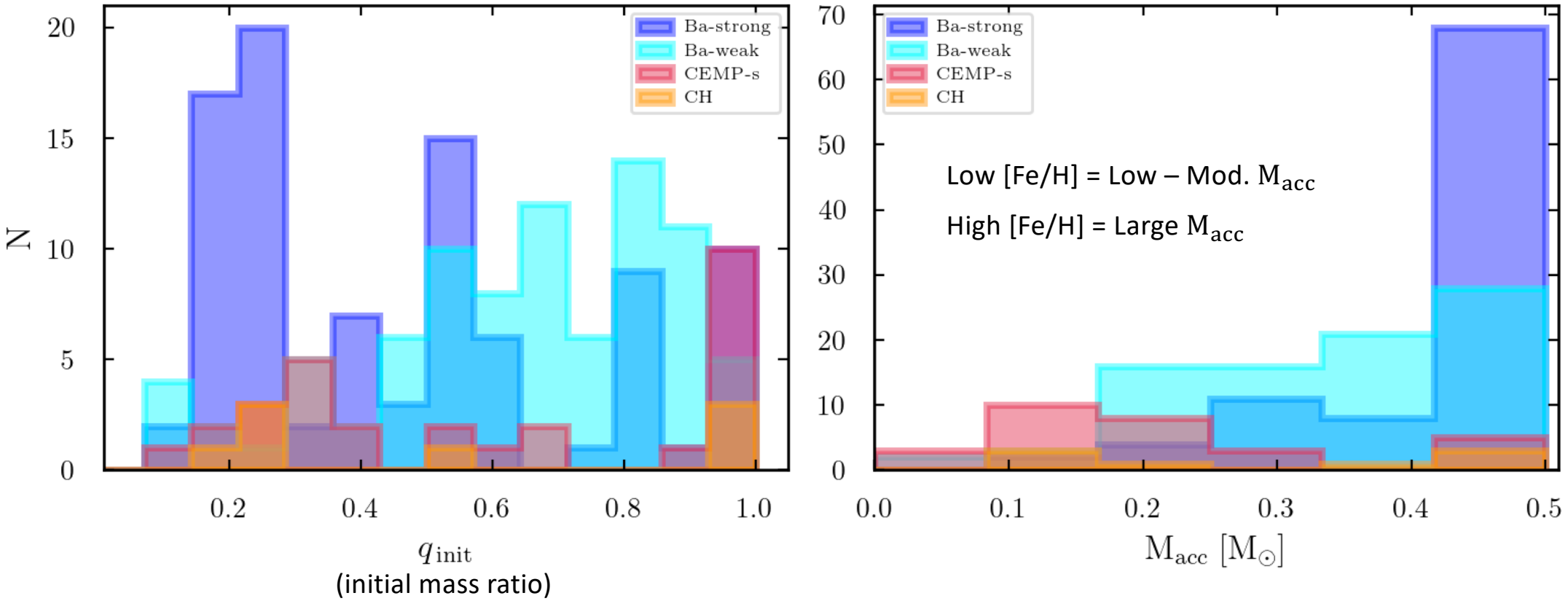

The $q - \eta$ plane: Ba stars don't fit the pure wind regime

- Efficiencies η in Ba stars higher than BHL wind accreiton
  - Inefficient, η < 12% (Liu+ 2017)
  - Wide orbits, small accretion masses
- Alternative mechanisms:
  - Accretion disc formation
  - Tidally-enhanced mass loss
  - RLOF in close orbits (P < 3000 d)
  - Wind-RLOF (Mohamed & Podsiadlowski 2007, Krynski+ 2025)

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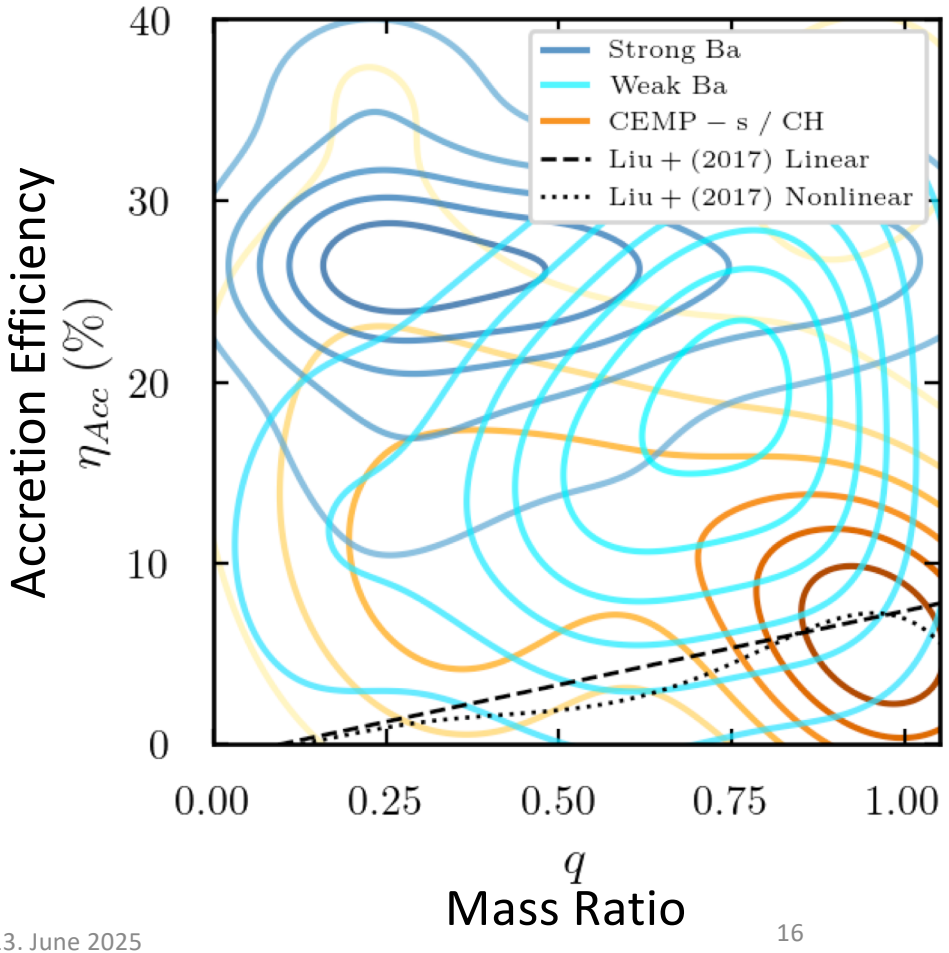
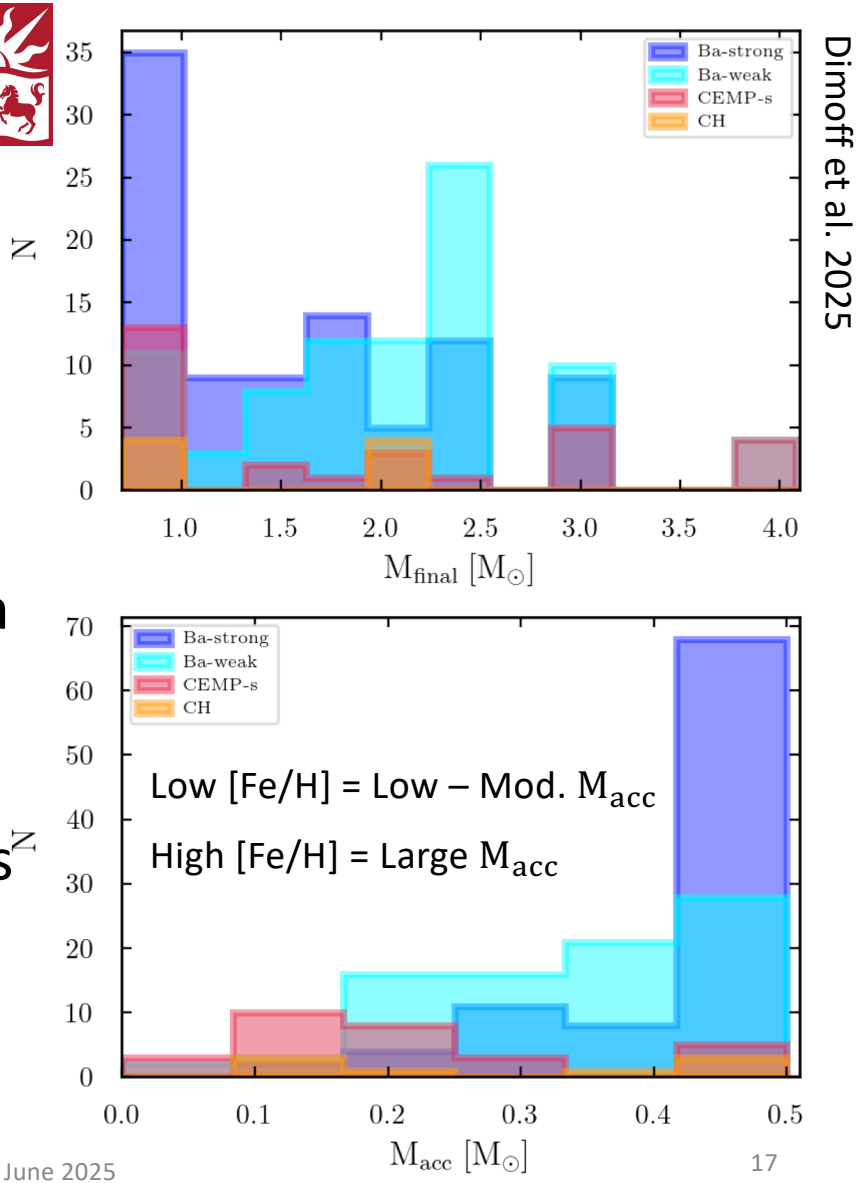


Summary

1. CH, CEMP-s are generally low mass, low accretion mass systems (Stancliffe+ 2007, Abate+ 2015)
2. Ba-weak are show moderate accretion (Escorza+ 2017, Stancliffe 2021)
3. Ba-strong need to accrete ***at least*** 0.5 $M_{\odot}$ to explain surface abundances
4. Trends in M_{acc} with [Fe/H] hint at different mixing or acc. efficiencies



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Modeling the Evolution of CEMP-s Stars

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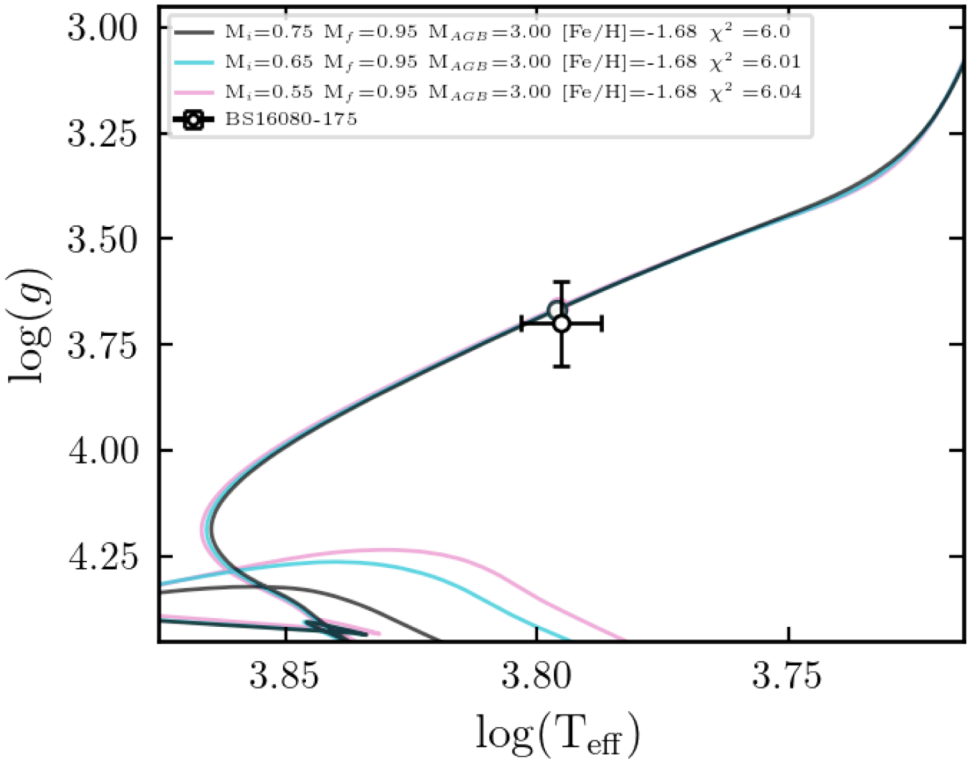

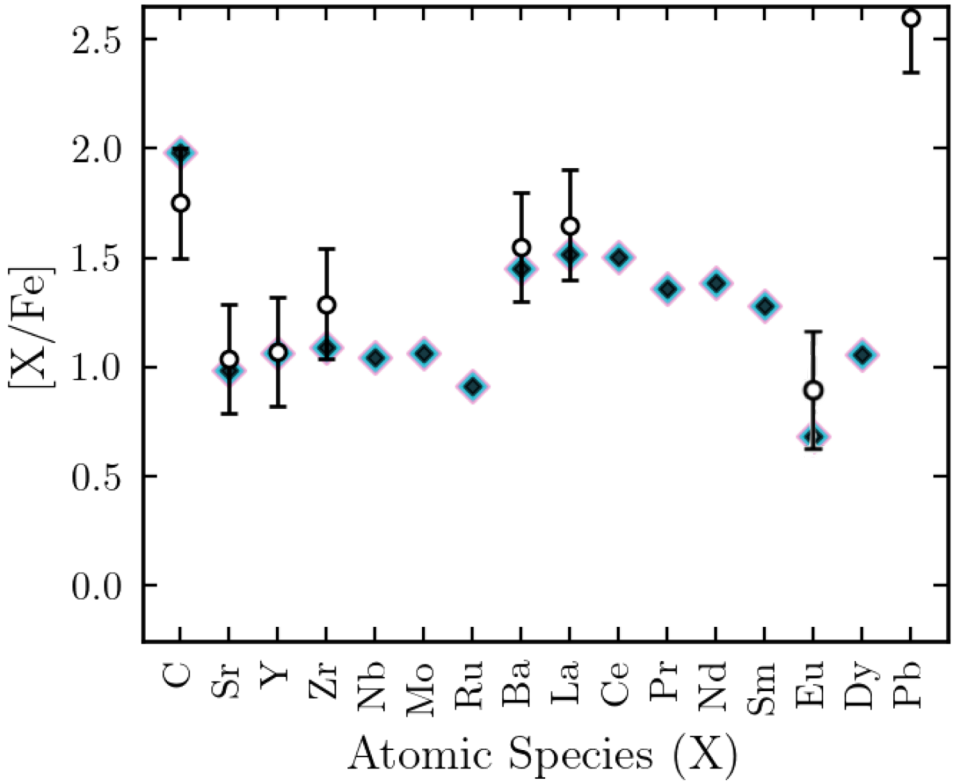

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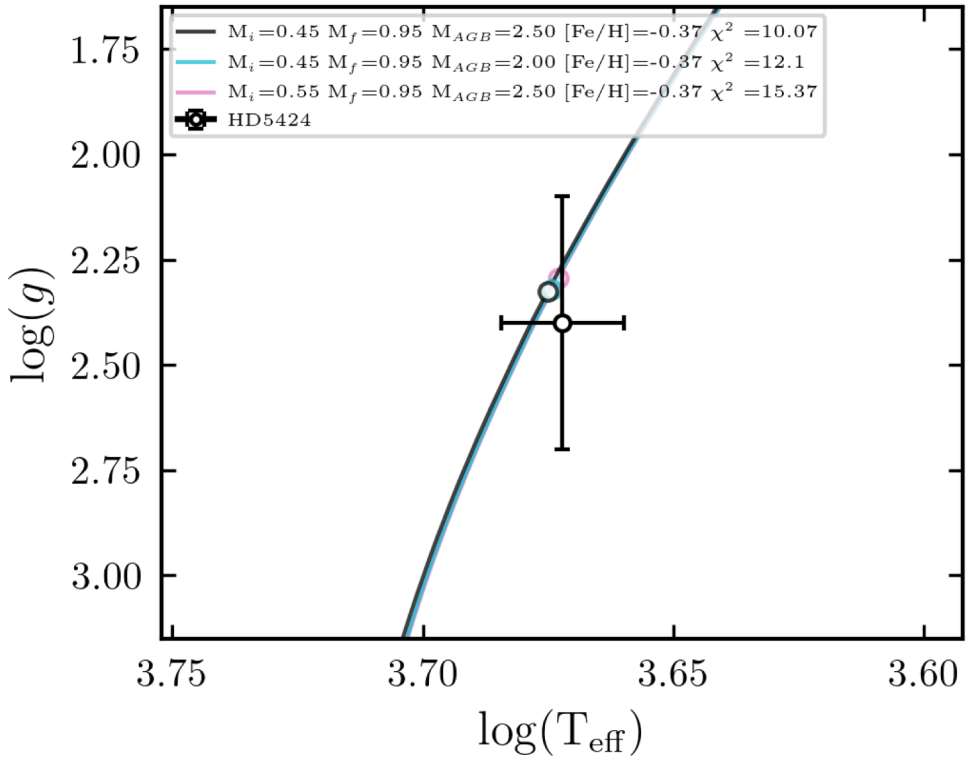

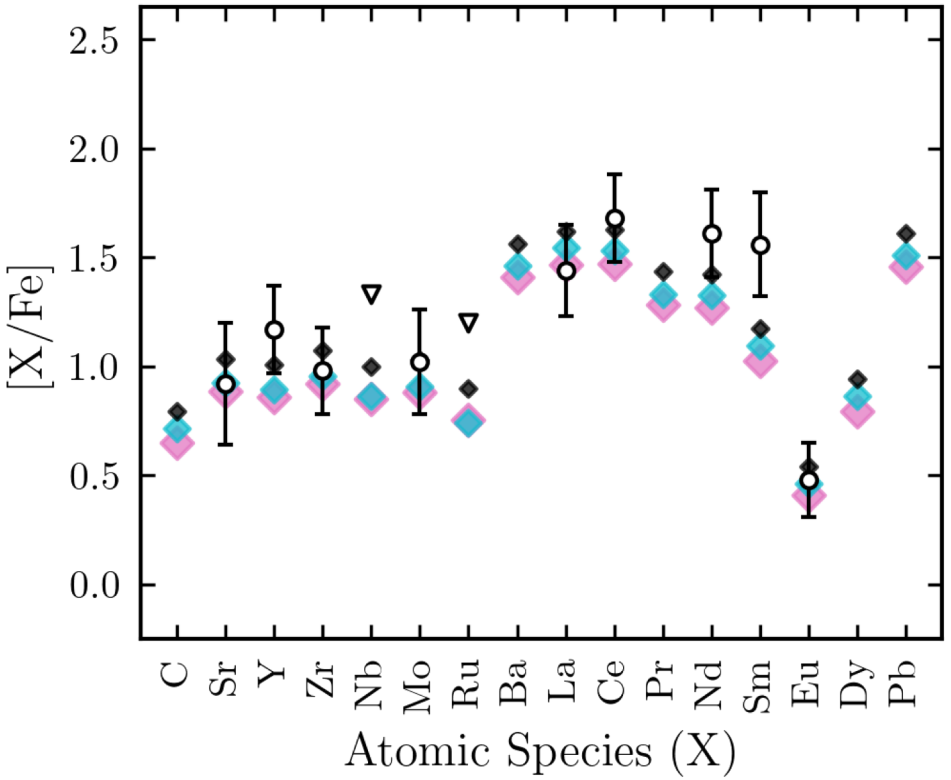

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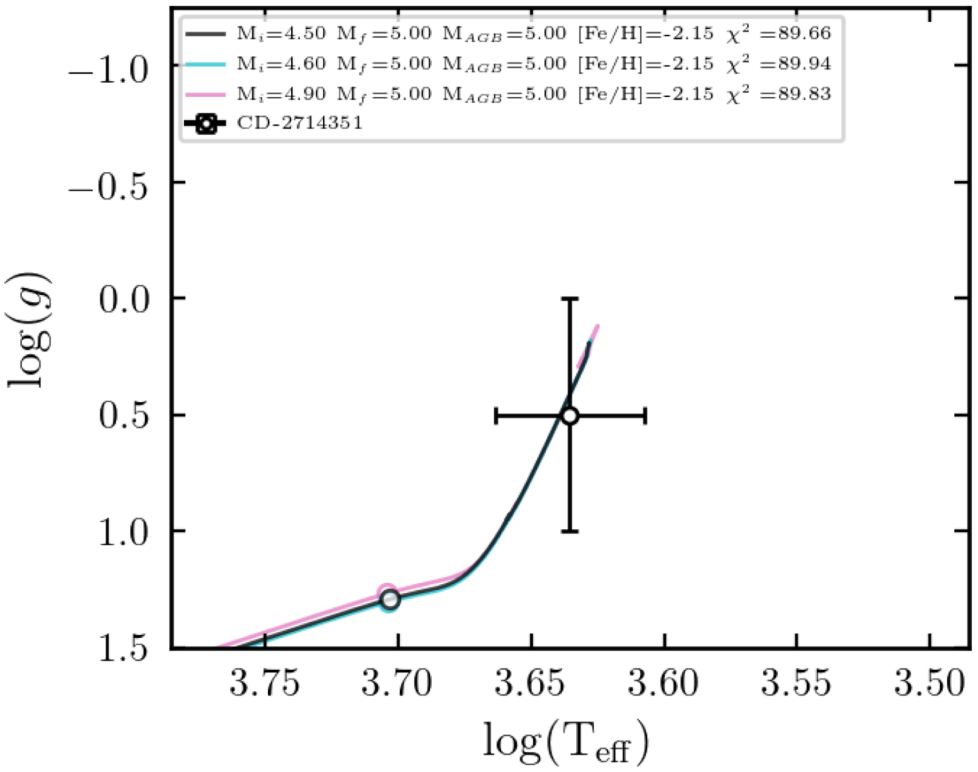

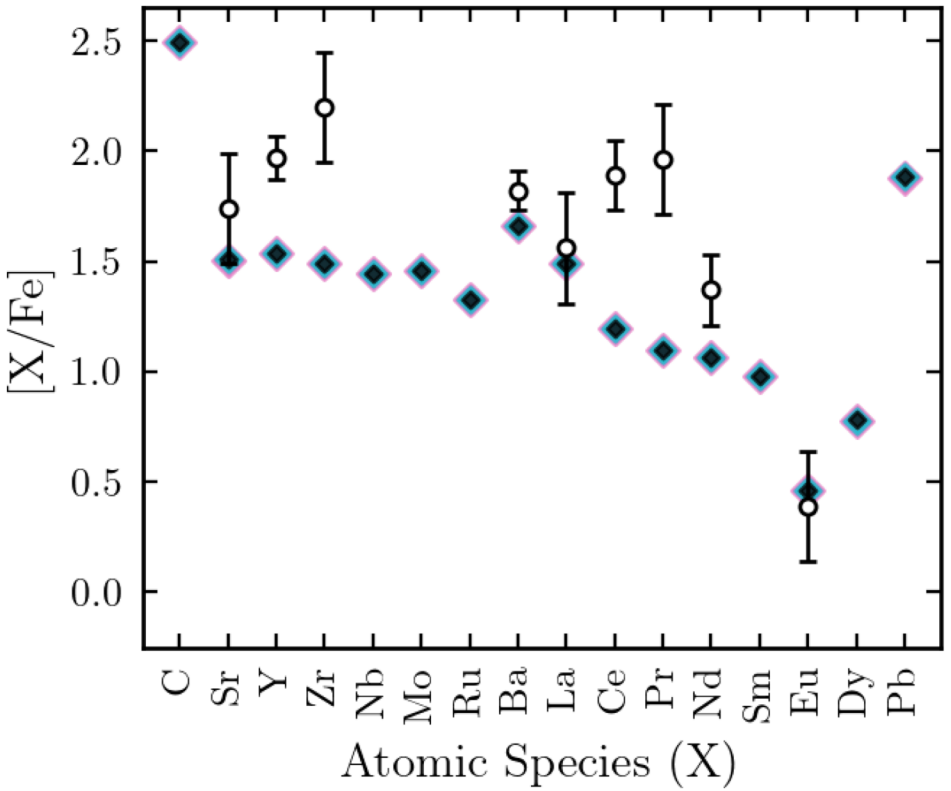

Scatter in the $e - P$ diagram

- Significant scatter in e vs. P
- Marinovic, Glebeek, Pols (2007) suggest tidally enhanced mass loss
- Dermine+ (2012) and Krinsky+ (2025) suggests circumbinary discs can high eccentricities

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