Fast rotating massive stars at low metallicity: WR stars?

Dorottya Szécsi

Collaborators:
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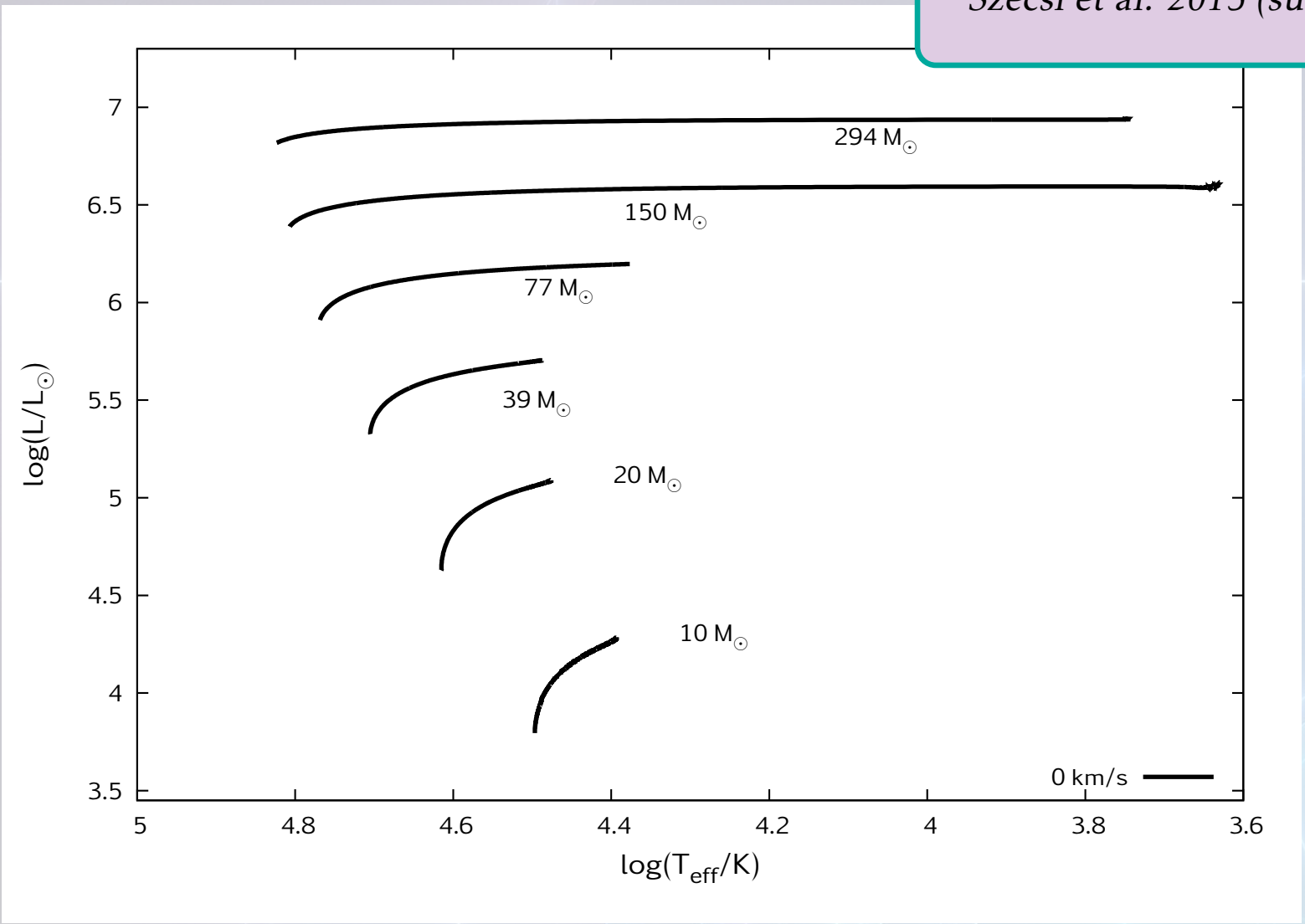
Argelander-Institut für Astronomie

Wolf-Rayet Workshop

3rd June 2015, Potsdam

Stellar evolution at low-Z

$Z=1/50\ Z_\odot$ models from
Szécsi et al. 2015 (subm.)



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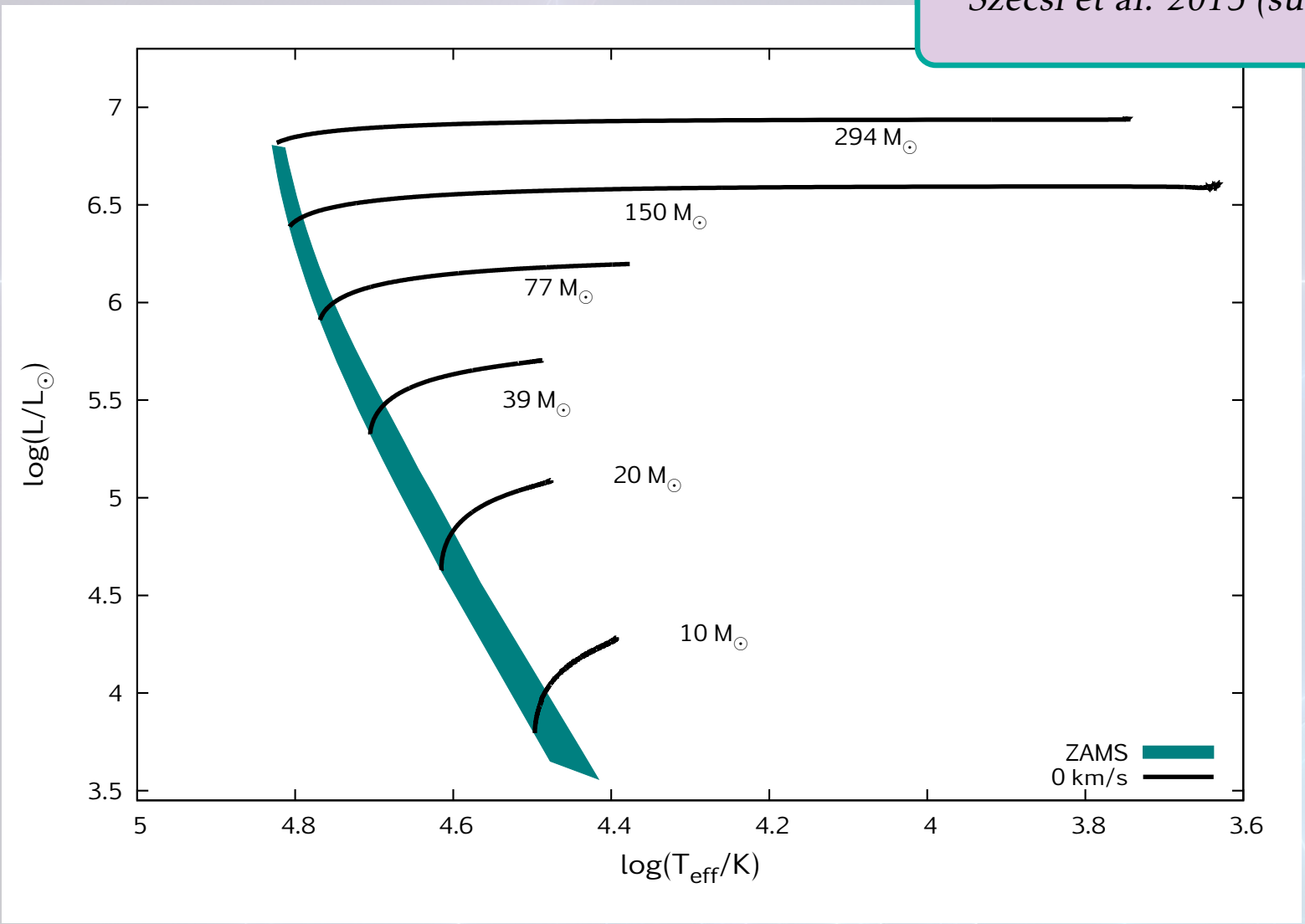

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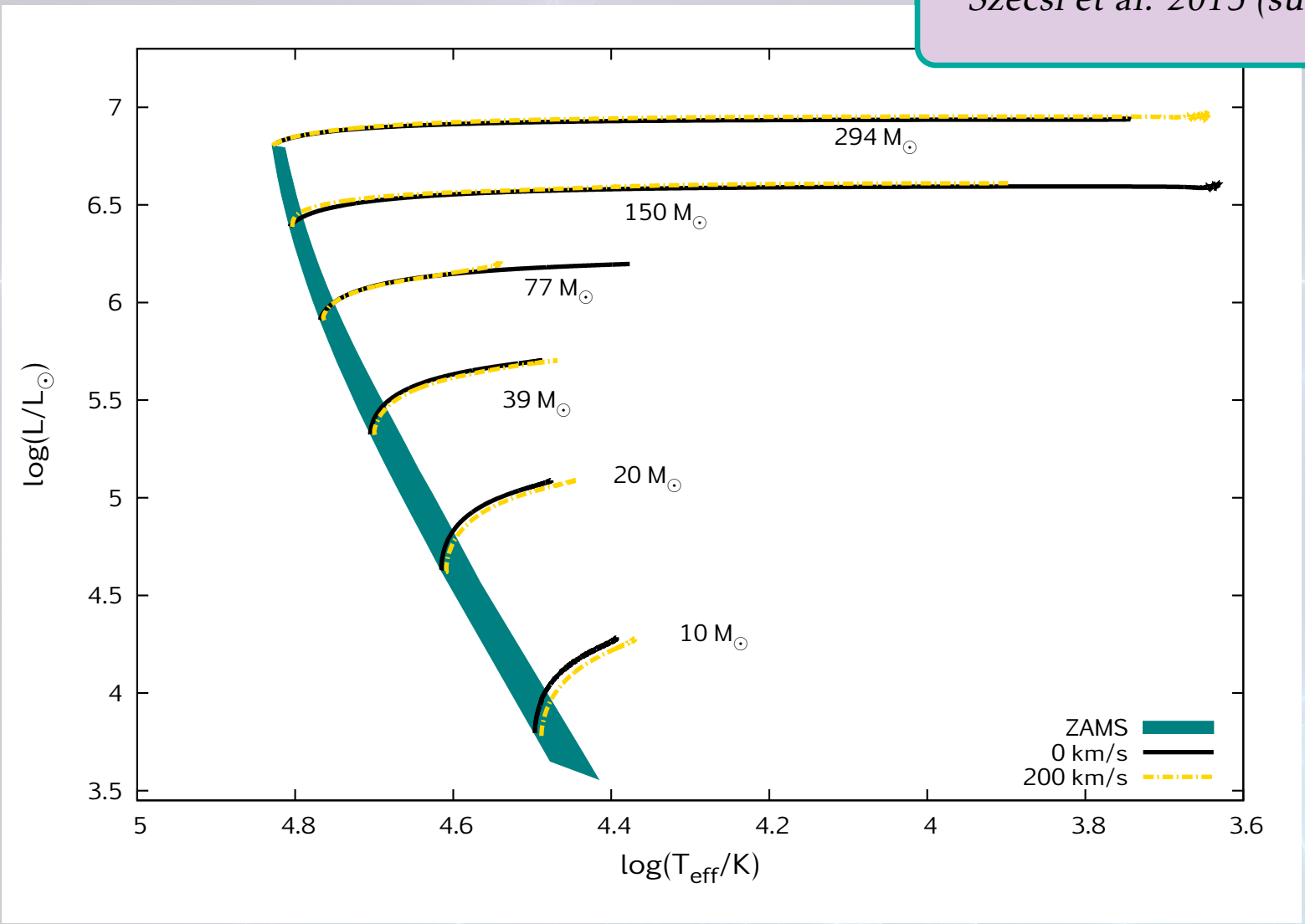

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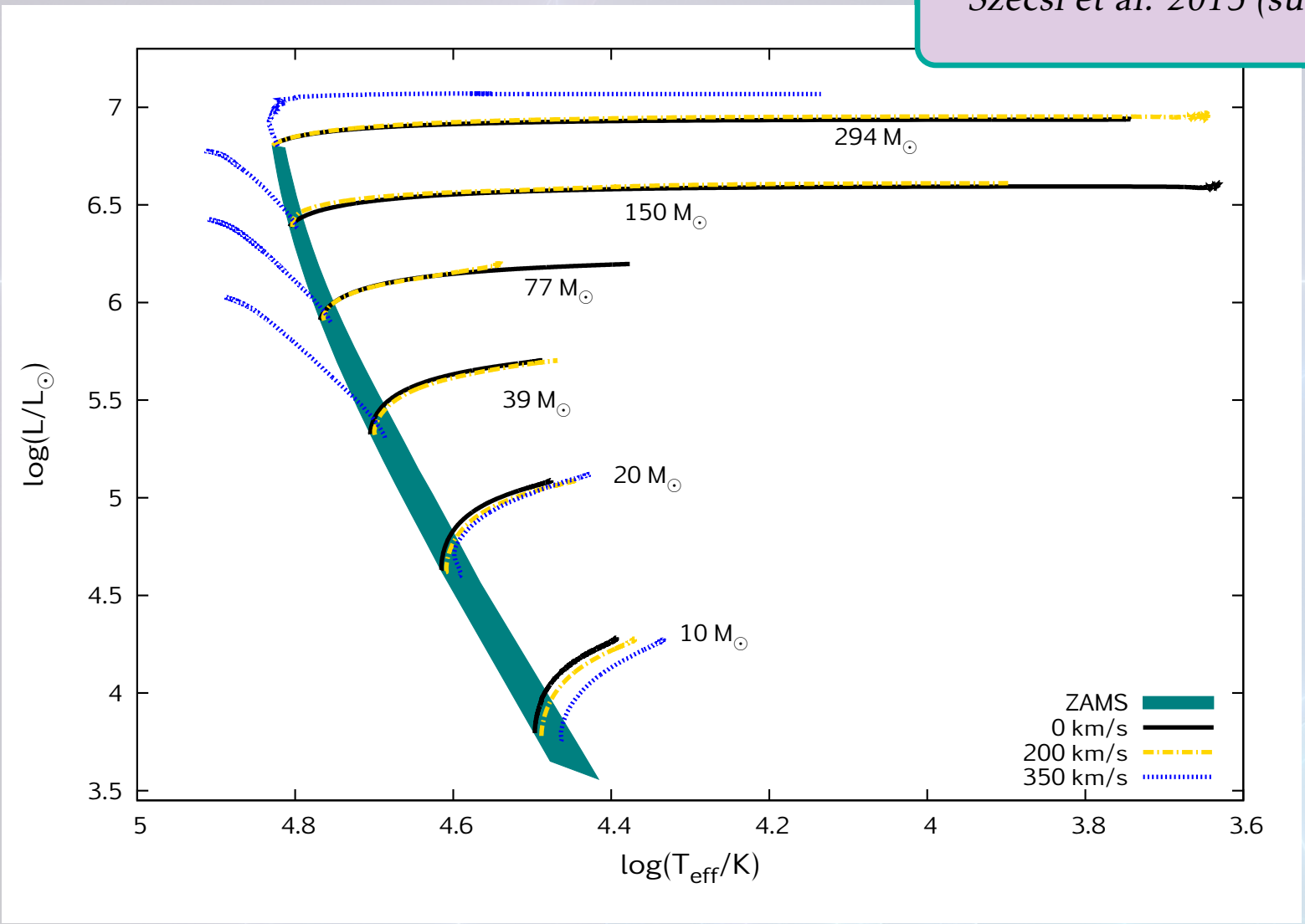

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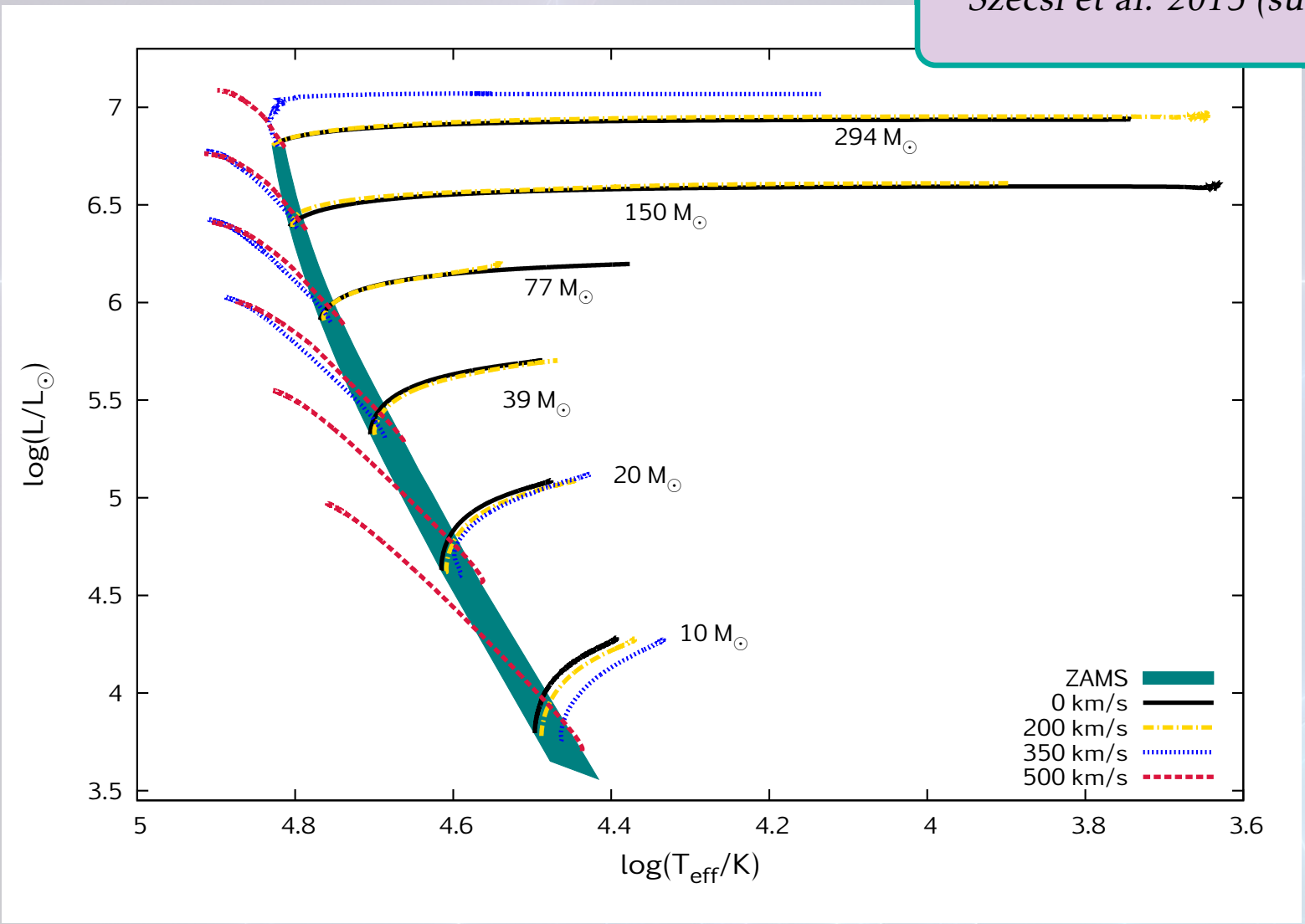

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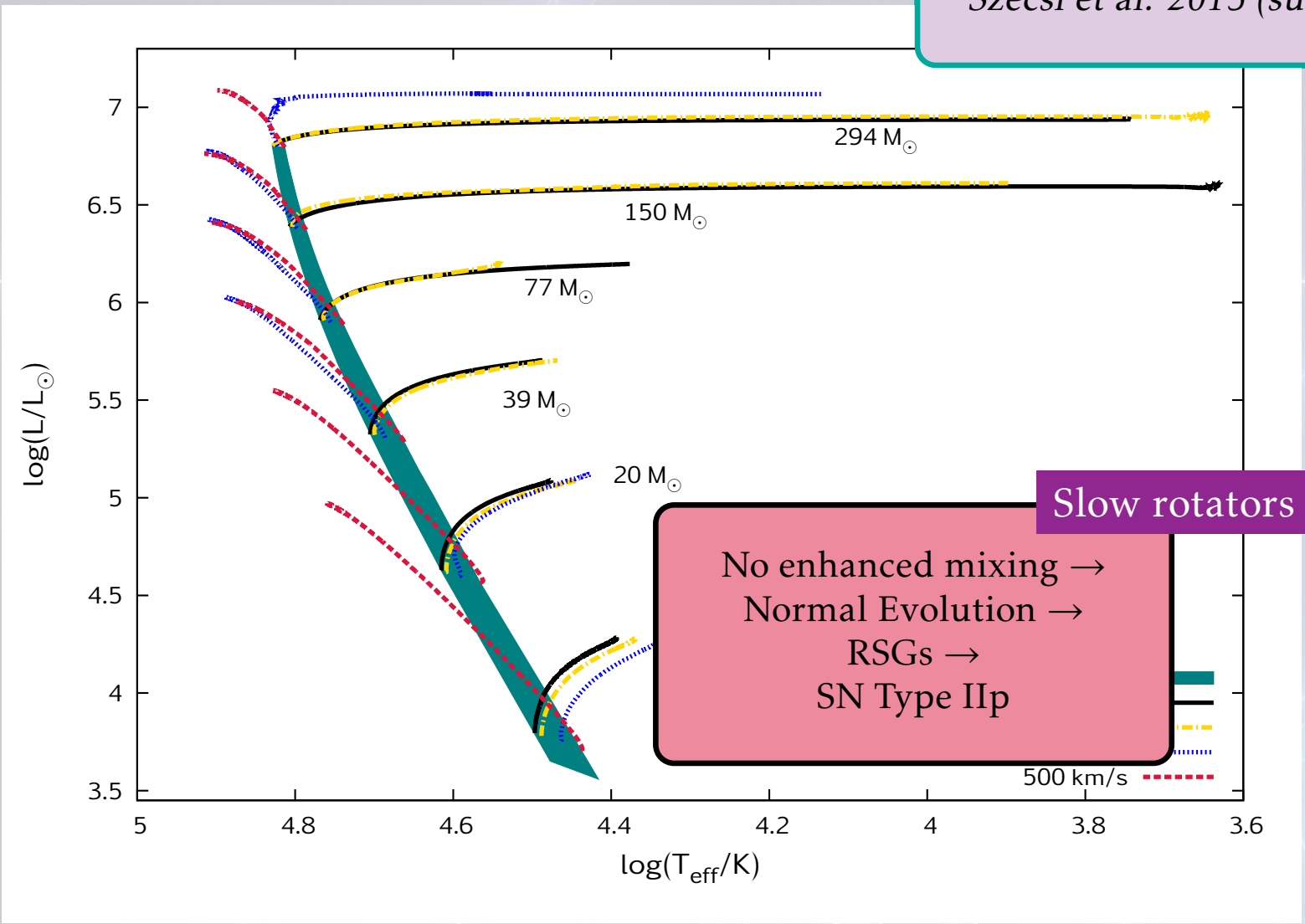

Slow rotators

No enhanced mixing →
Normal Evolution →
RSGs →
SN Type IIp

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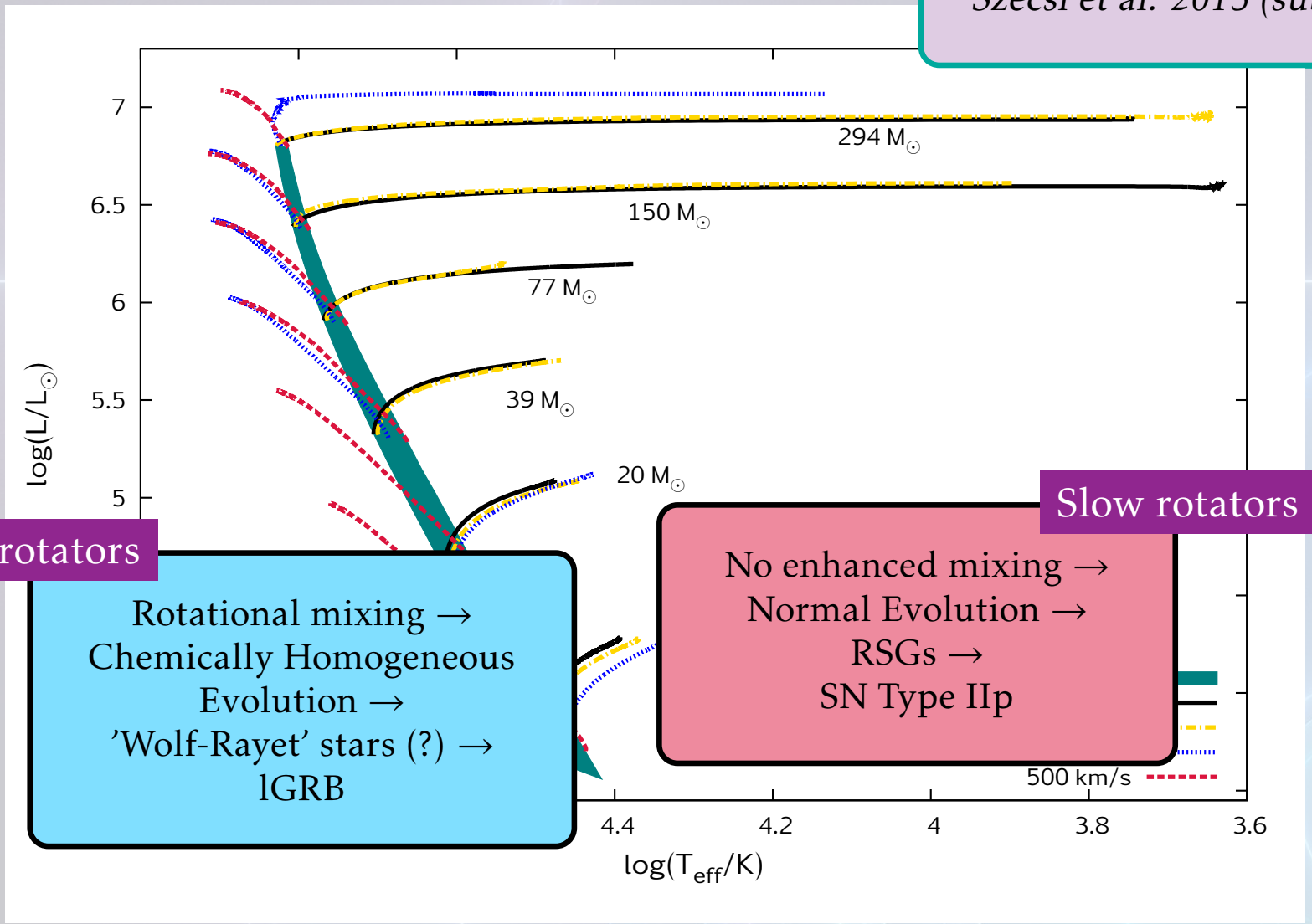

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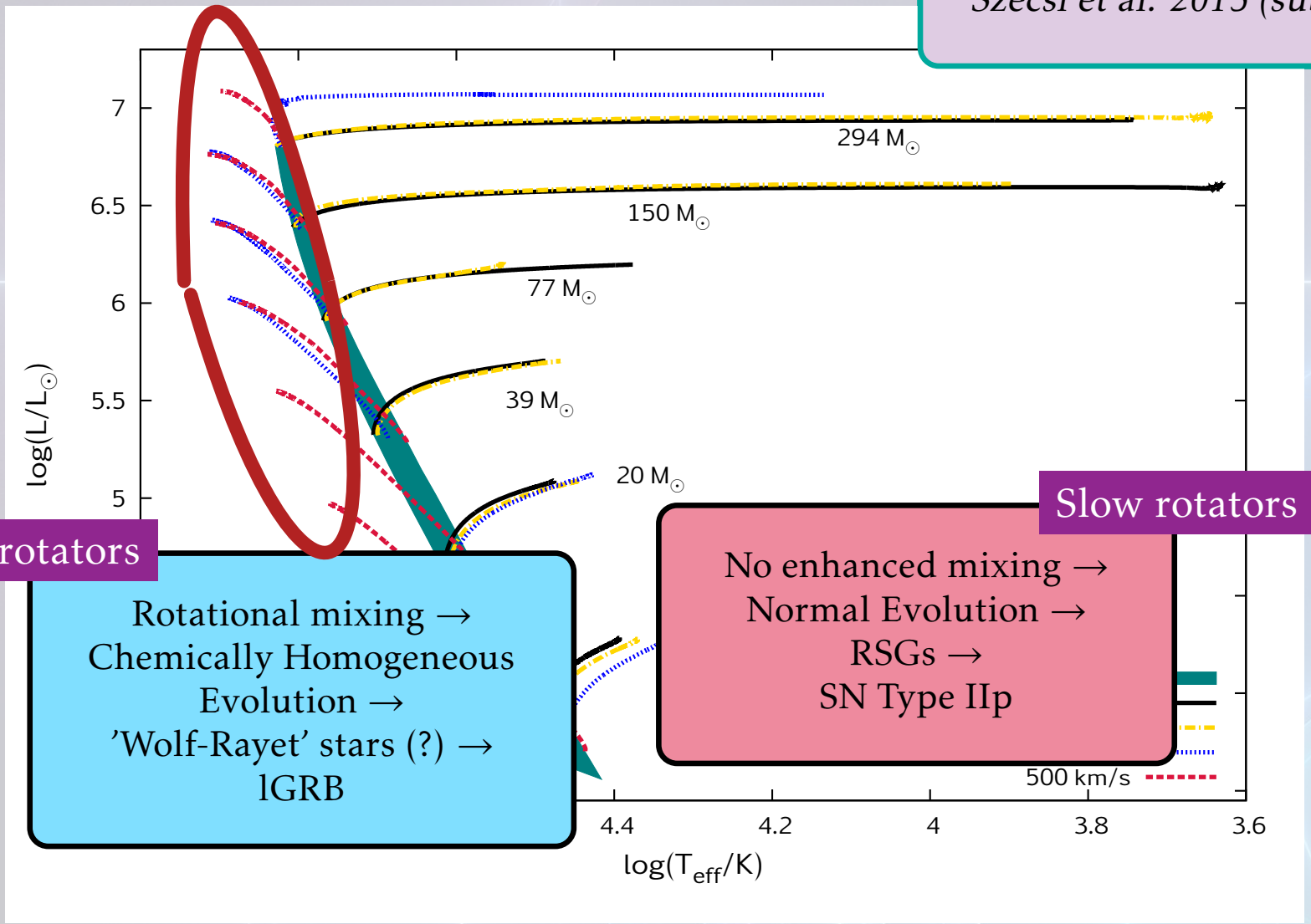

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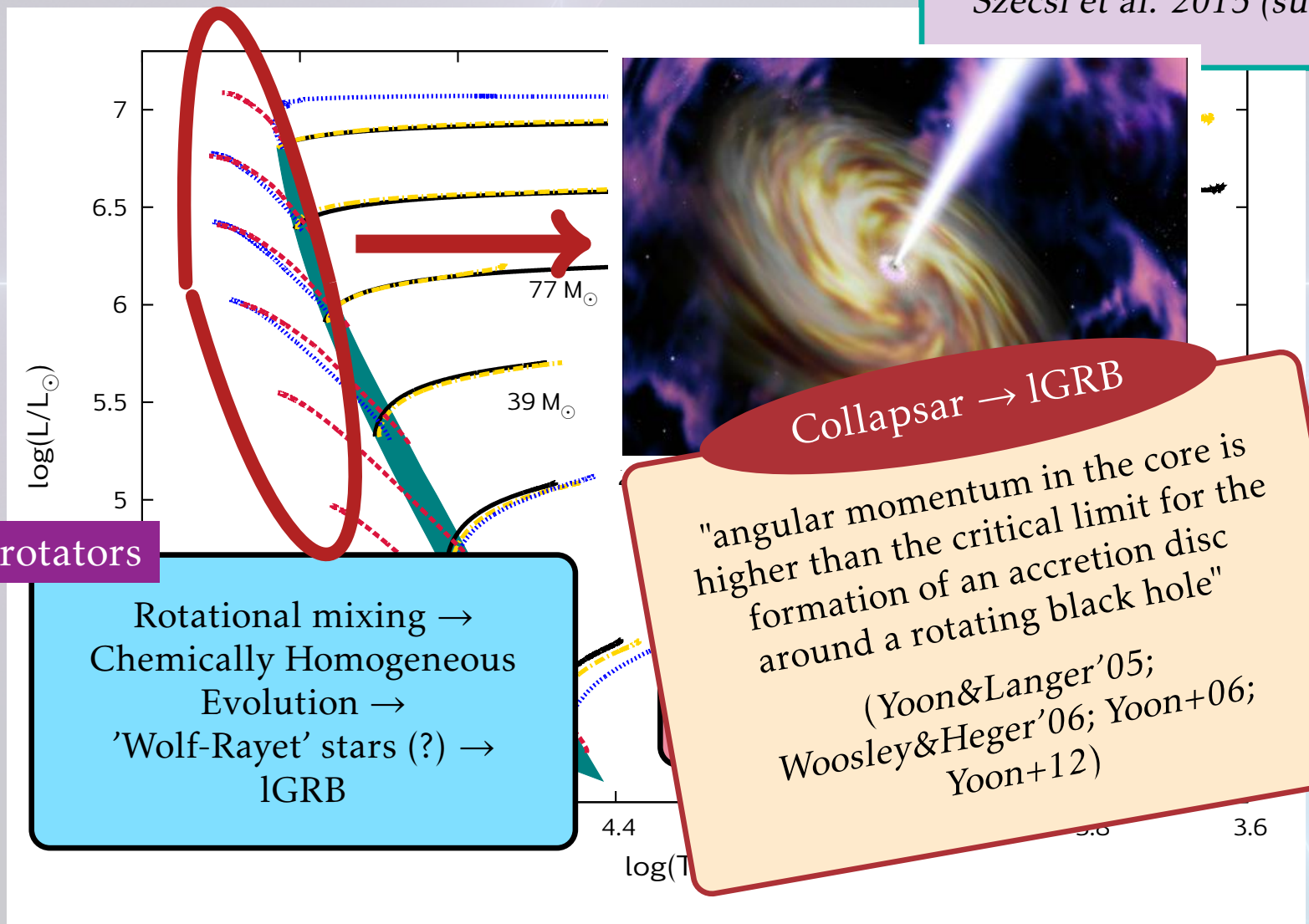

Fast rotators

Rotational mixing → Chemically Homogeneous Evolution → 'Wolf-Rayet' stars (?) → lGRB

Collapsar → lGRB

"angular momentum in the core is higher than the critical limit for the formation of an accretion disc around a rotating black hole"

(Yoon&Langer'05; Woosley&Heger'06; Yoon+06; Yoon+12)

WR stars?

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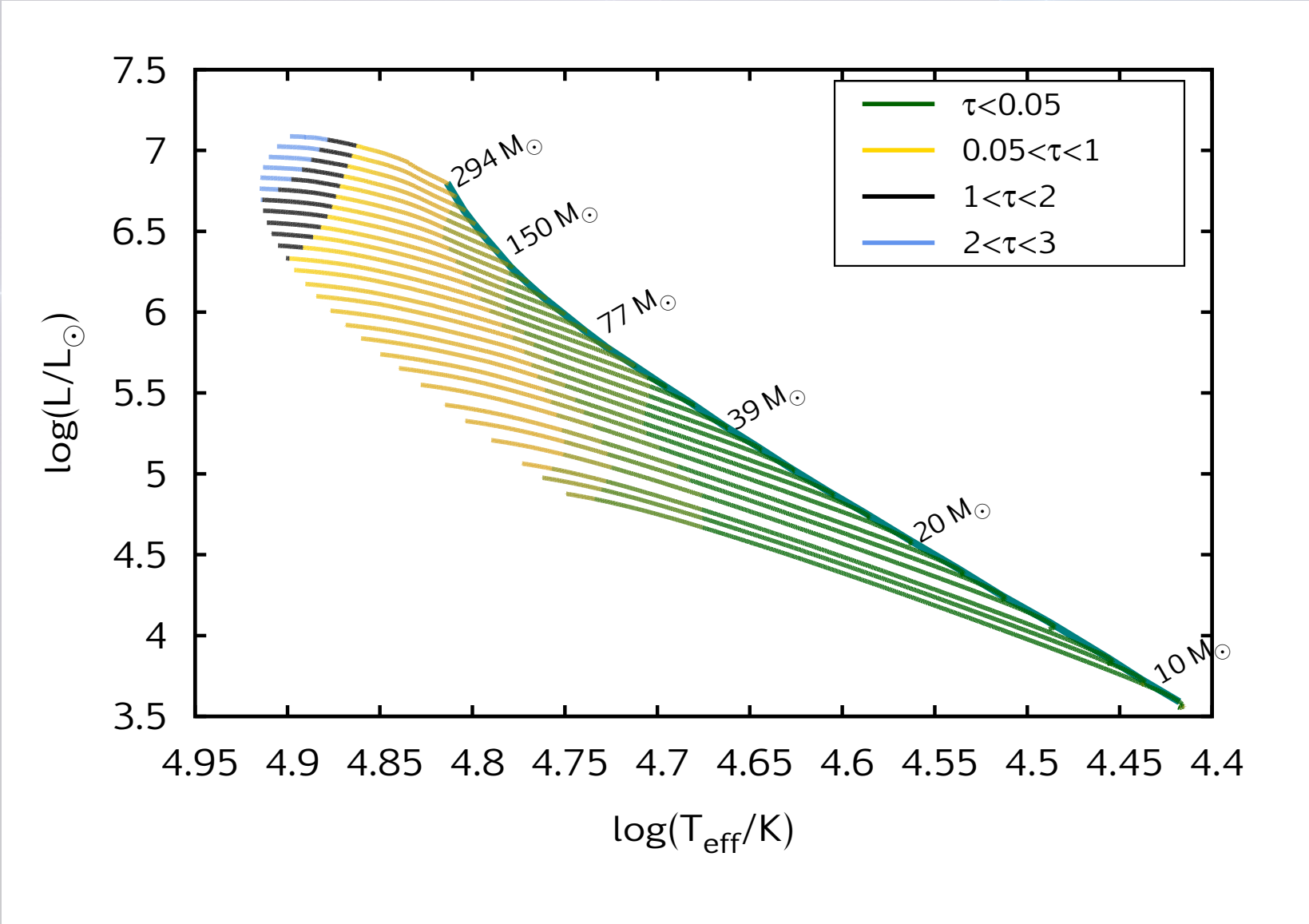
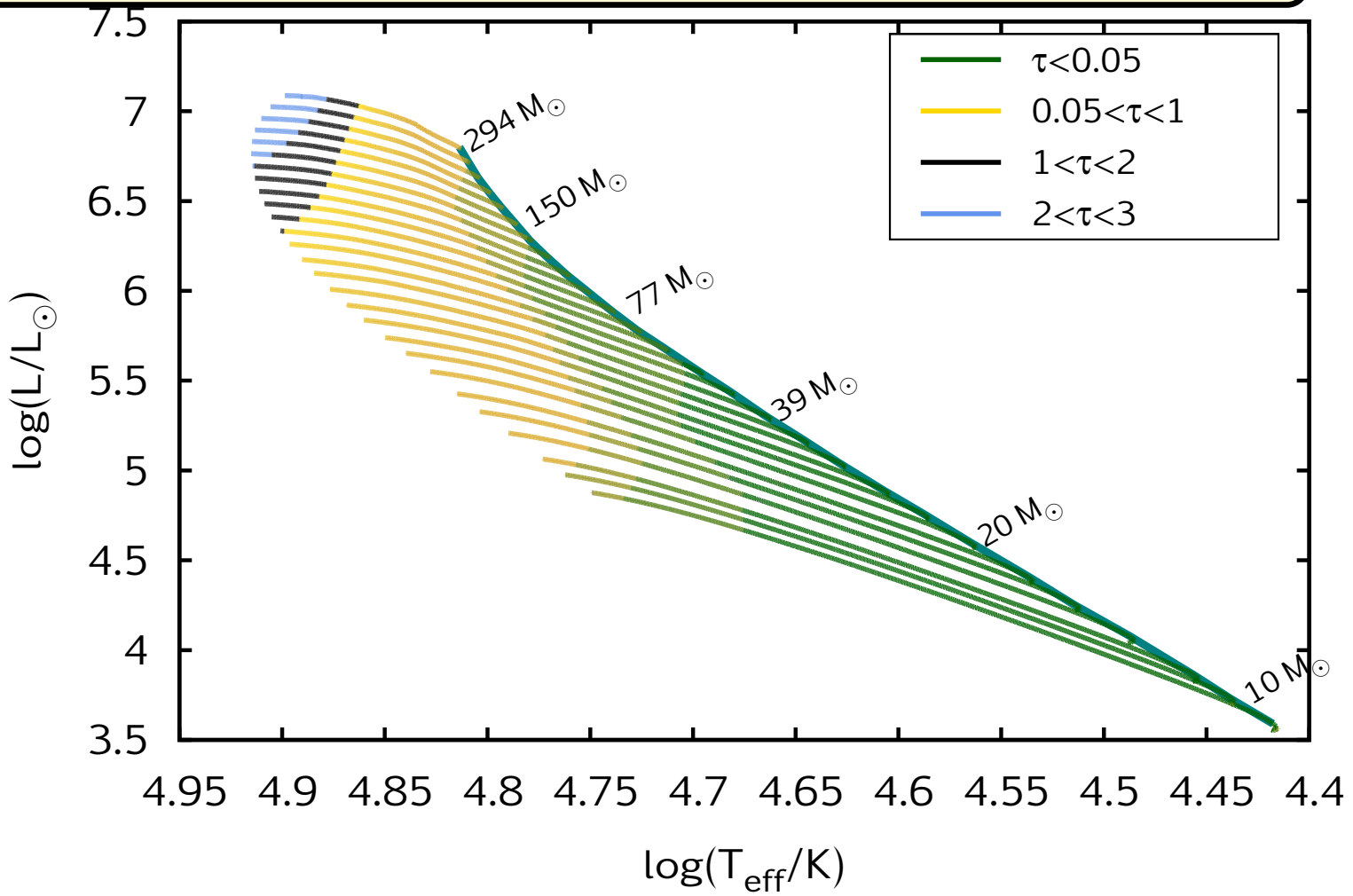

7.5
7
6.5
6
5.5
5
4.5
4
3.5
log(L/L⊙)
4.95
4.9
4.85
4.8
4.75
4.7
4.65
4.6
4.55
4.5
4.45
4.4
log(T_eff/K)
τ<0.05
0.05<τ<1
1<τ<2
2<τ<3
294 M⊙
150 M⊙
77 M⊙
39 M⊙
20 M⊙
10 M⊙

WR stars?

Main sequence lifetime: wind optical depth is $\tau \lesssim 1$



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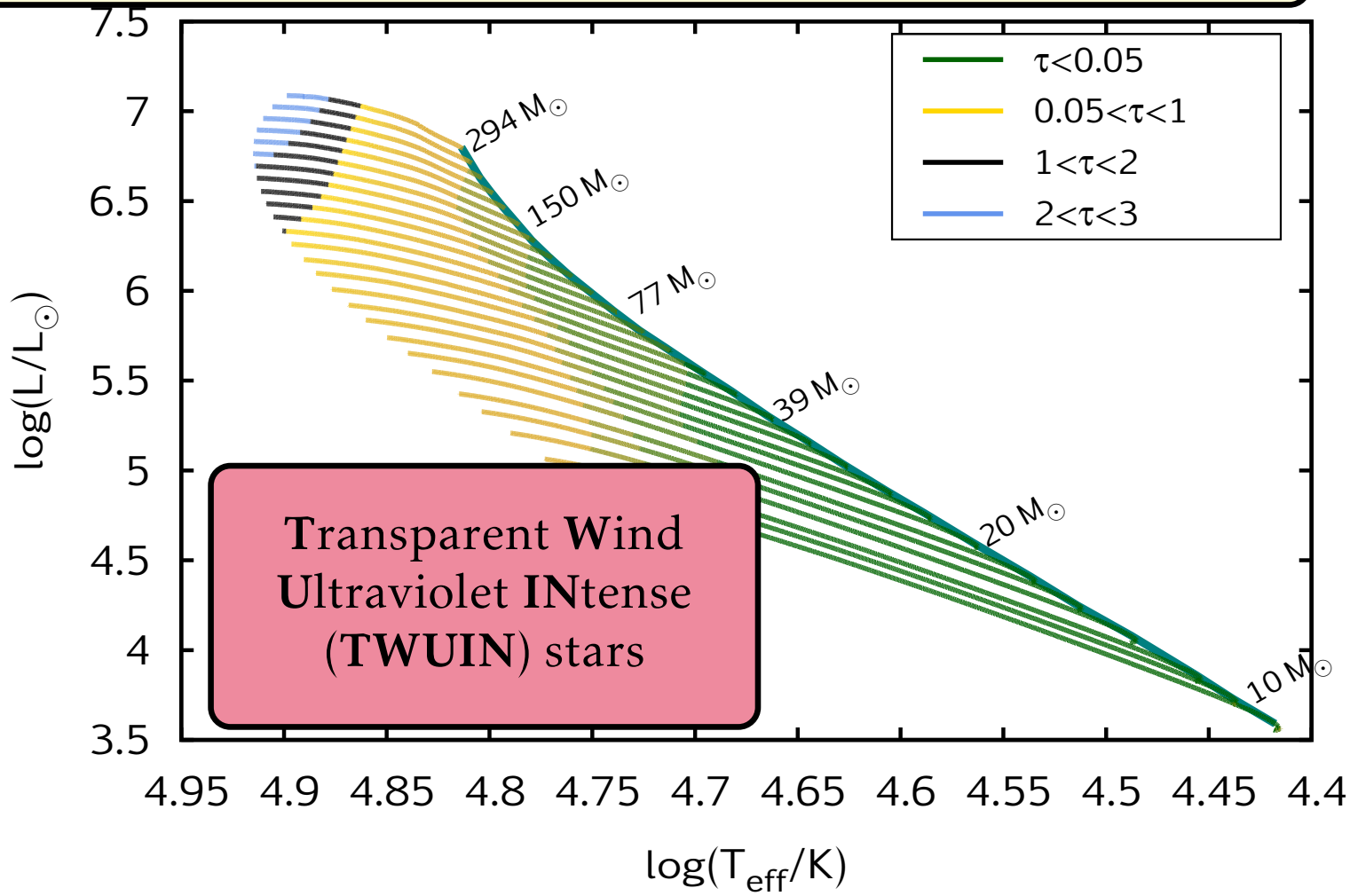

Transparent Wind UV INtense (TWUIN) stars

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- photoionization!

Do TWUIN stars exist?

I Zwicky 18

- Blue Compact Dwarf Galaxy
- 18 Mpc → local
- SFR: 0.1-1 $M_\odot$/yr
- ionized gas
- low metallicity:
  12+log(O/H)=7.17
  ↓
  $Z=1/50\ Z_\odot \approx 0.0002$

Legrand+07, Aloisi+09, Annibali+13, Kehrig+13, Lebouteiller+13

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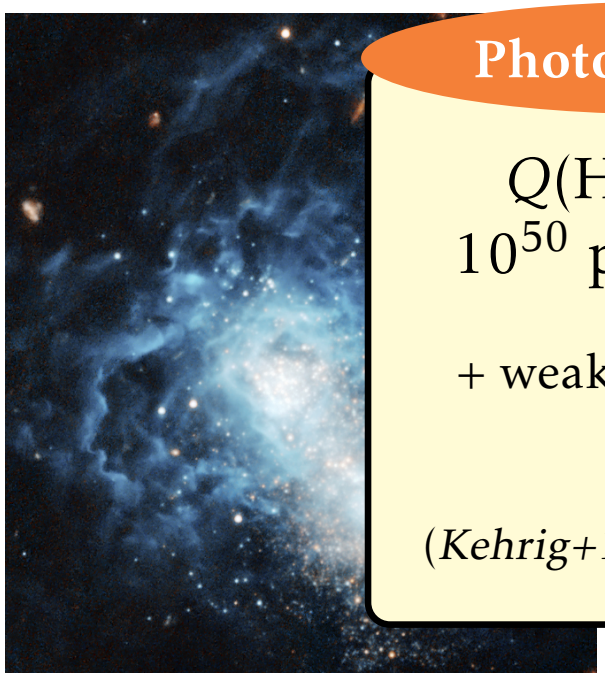

Photoionization

$Q(\mathrm{He\ II})^{obs} = 10^{50}$ photons s^{-1}

+ weak WR features

(*Kehrig+15,Crowther+06*)

Legrand+07, Aloisi+09, Annibali+13, Kehrig+13, Lebouteiller+13

Photoionization in I Zw 18

Observed

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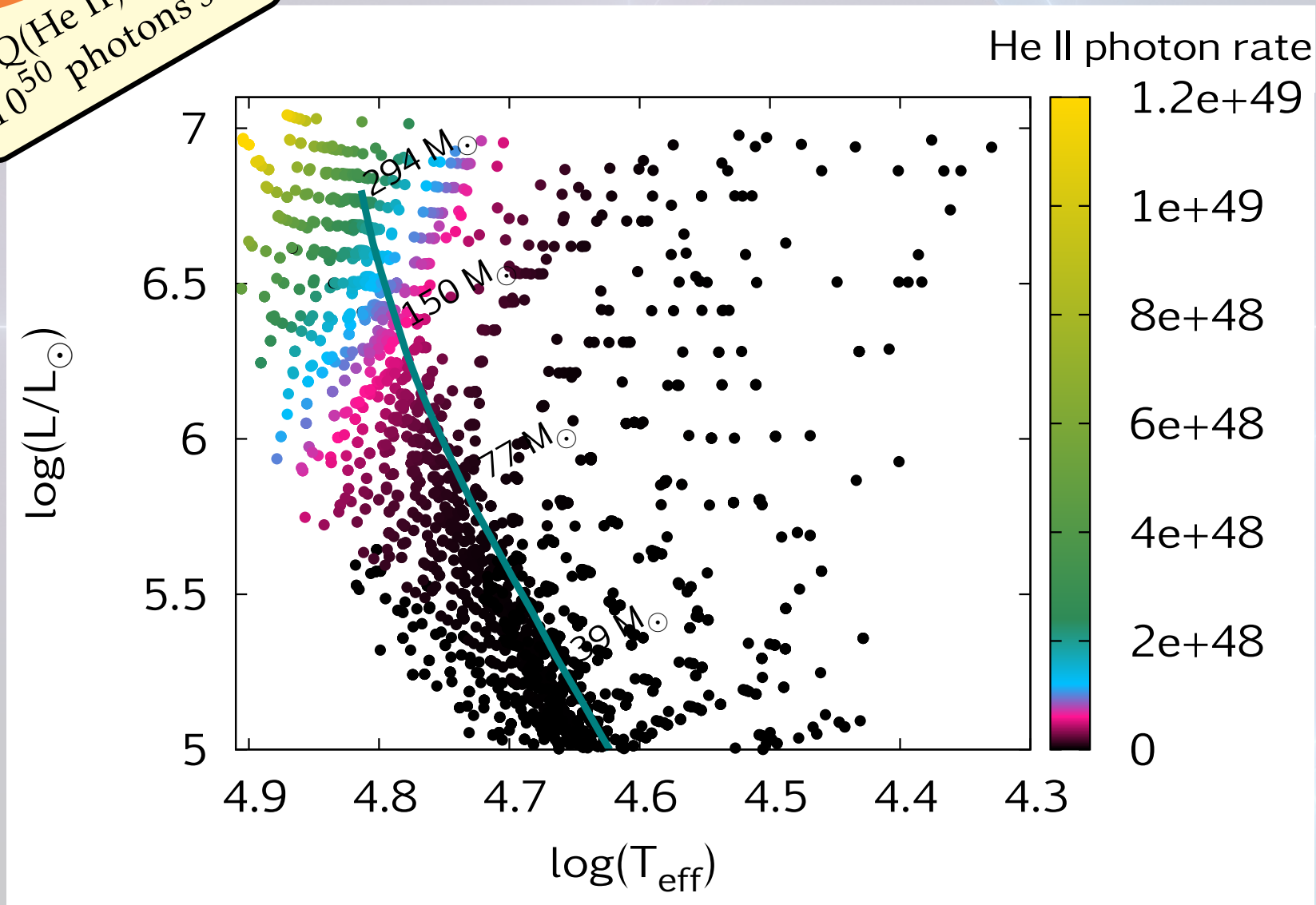

Shirazi+12, Kehrig+15, Heap+15

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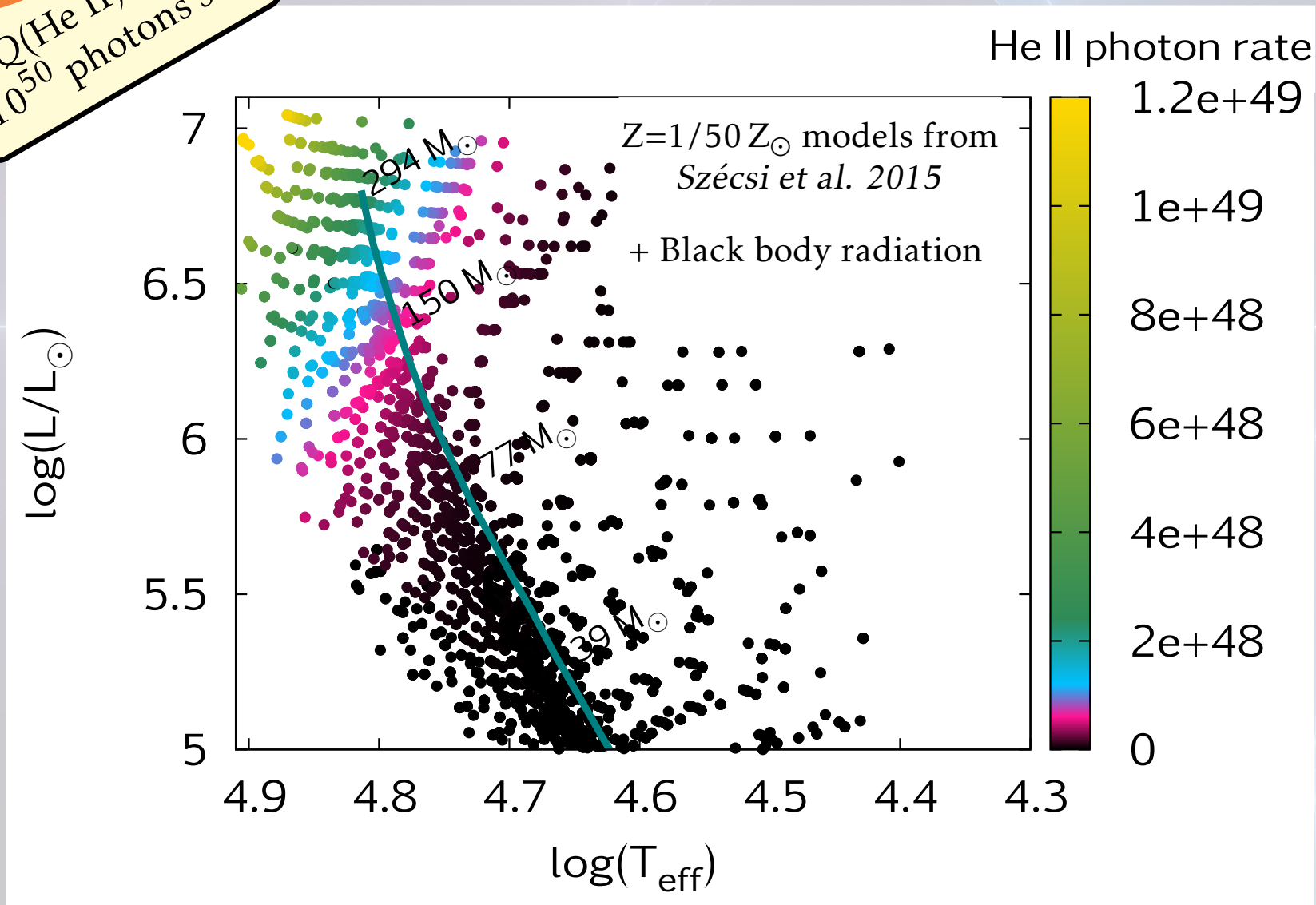

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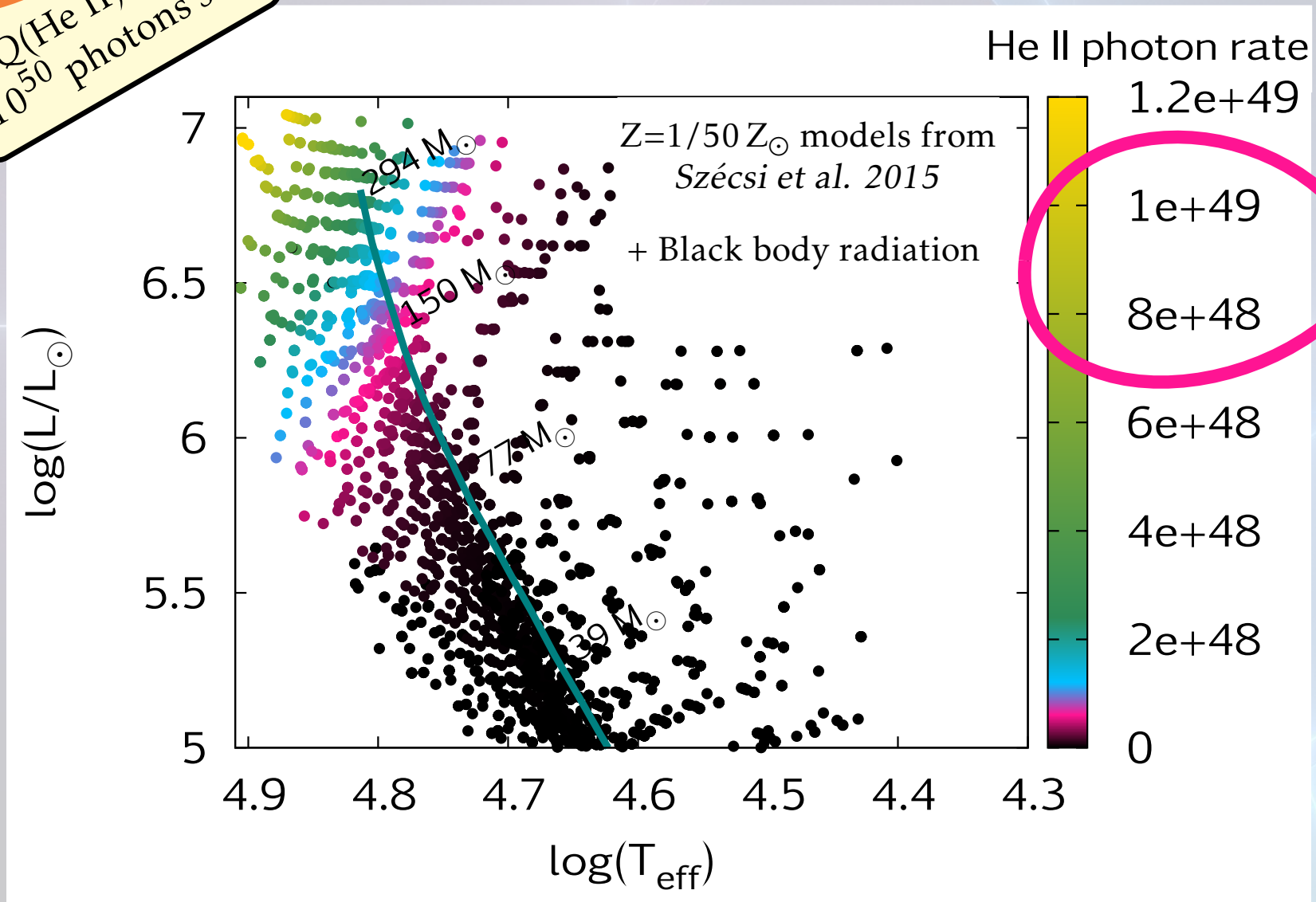

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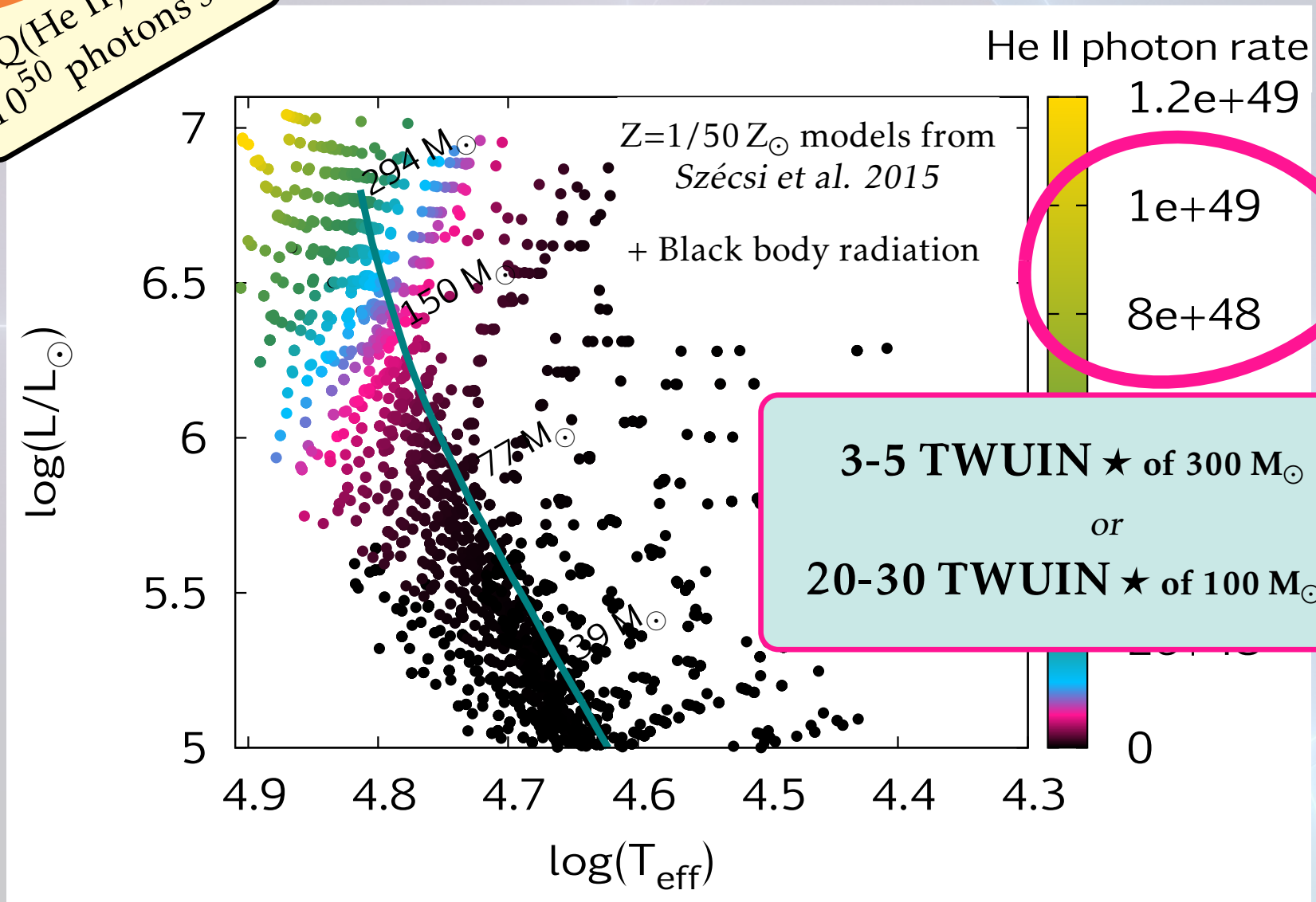

3-5 TWUIN ★ of 300 $M_\odot$ (?)

or

20-30 TWUIN ★ of 100 $M_\odot$ (✓)

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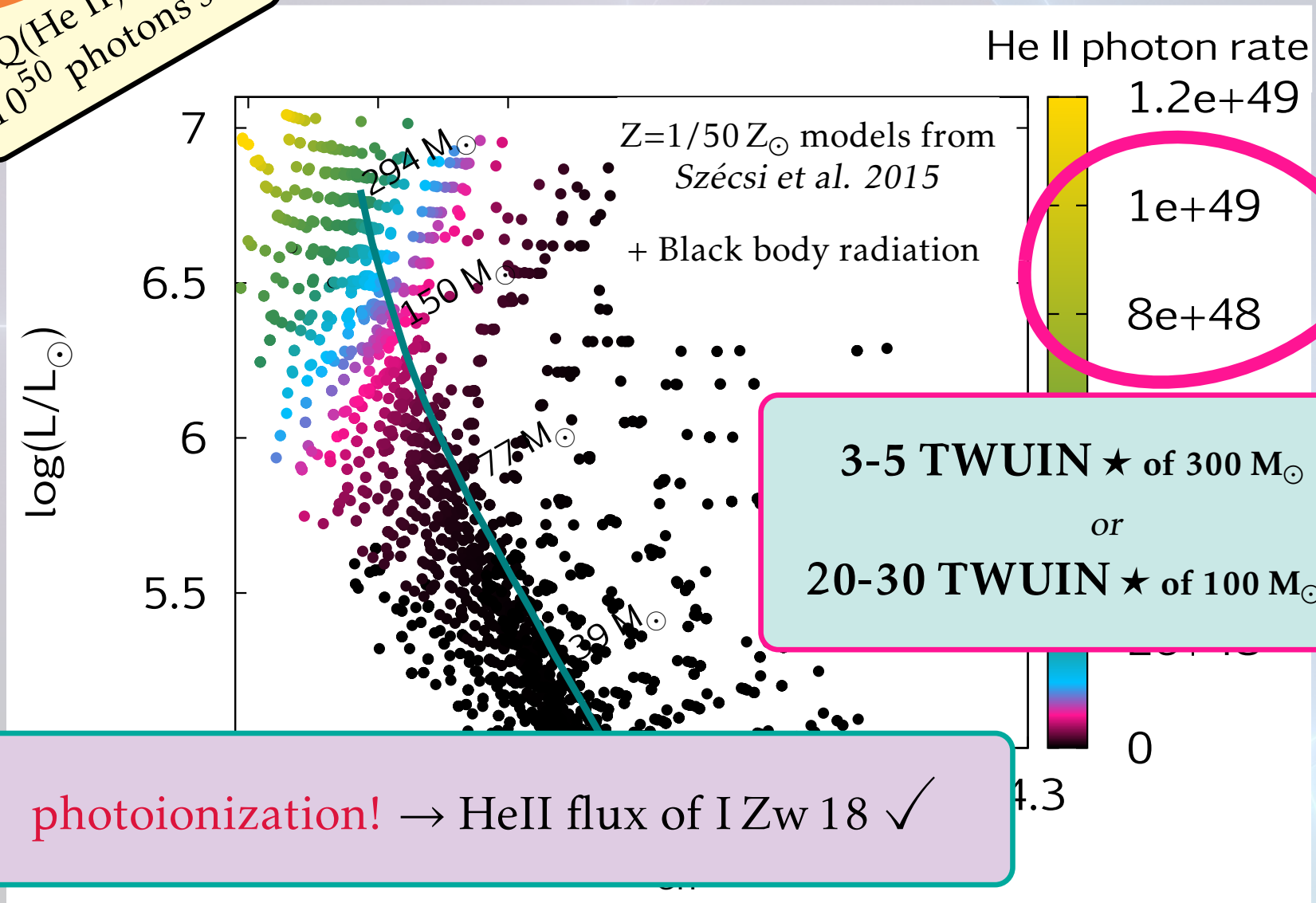

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photoionization! → HeII flux of I Zw 18 ✓

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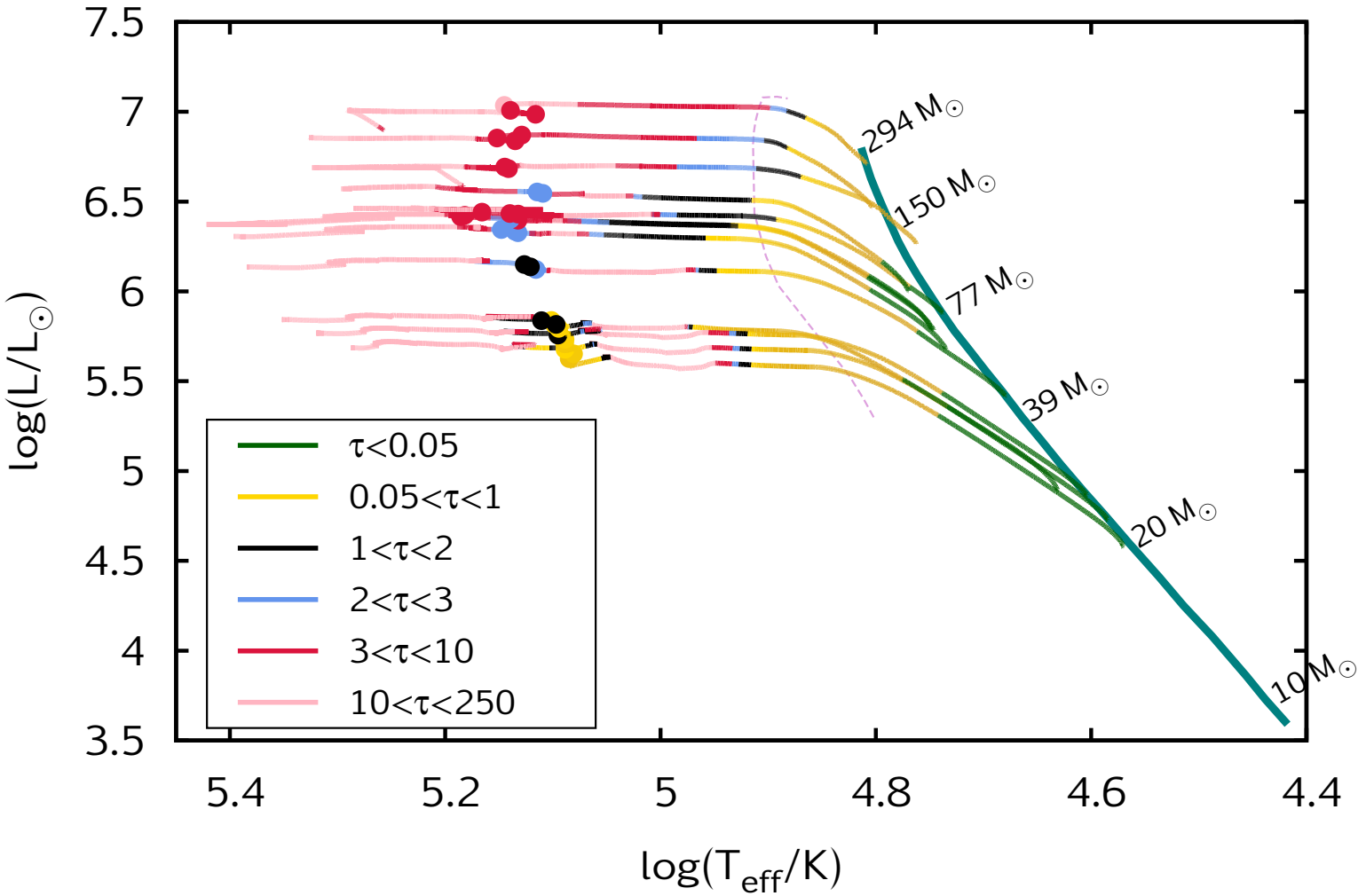
Post-MS phase of TWUIN stars



Takeaway message

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Observation

He II photons

(*Shirazi+12, Kehrig+15*)

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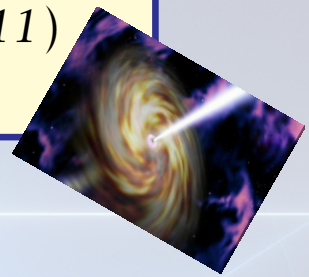
Observation

lGRBs

(*Fruchter+08, Niino'11*)



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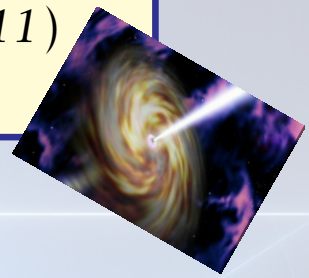

Explanation

Hot stars with weak winds

Takeaway message

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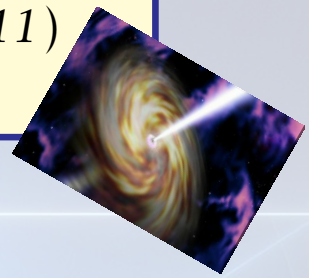

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Hot stars with weak winds

Theory

Chemically Homogeneous Evolution

Takeaway message

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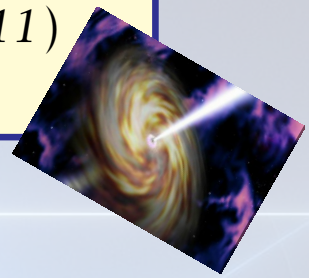

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Transparent Wind UV INtense (**TWUIN**) stars

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!

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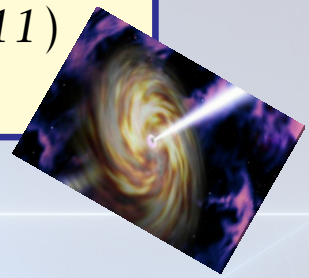

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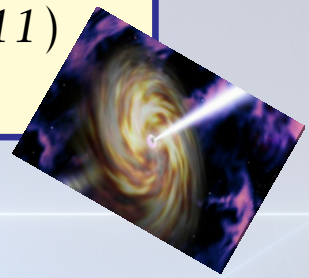

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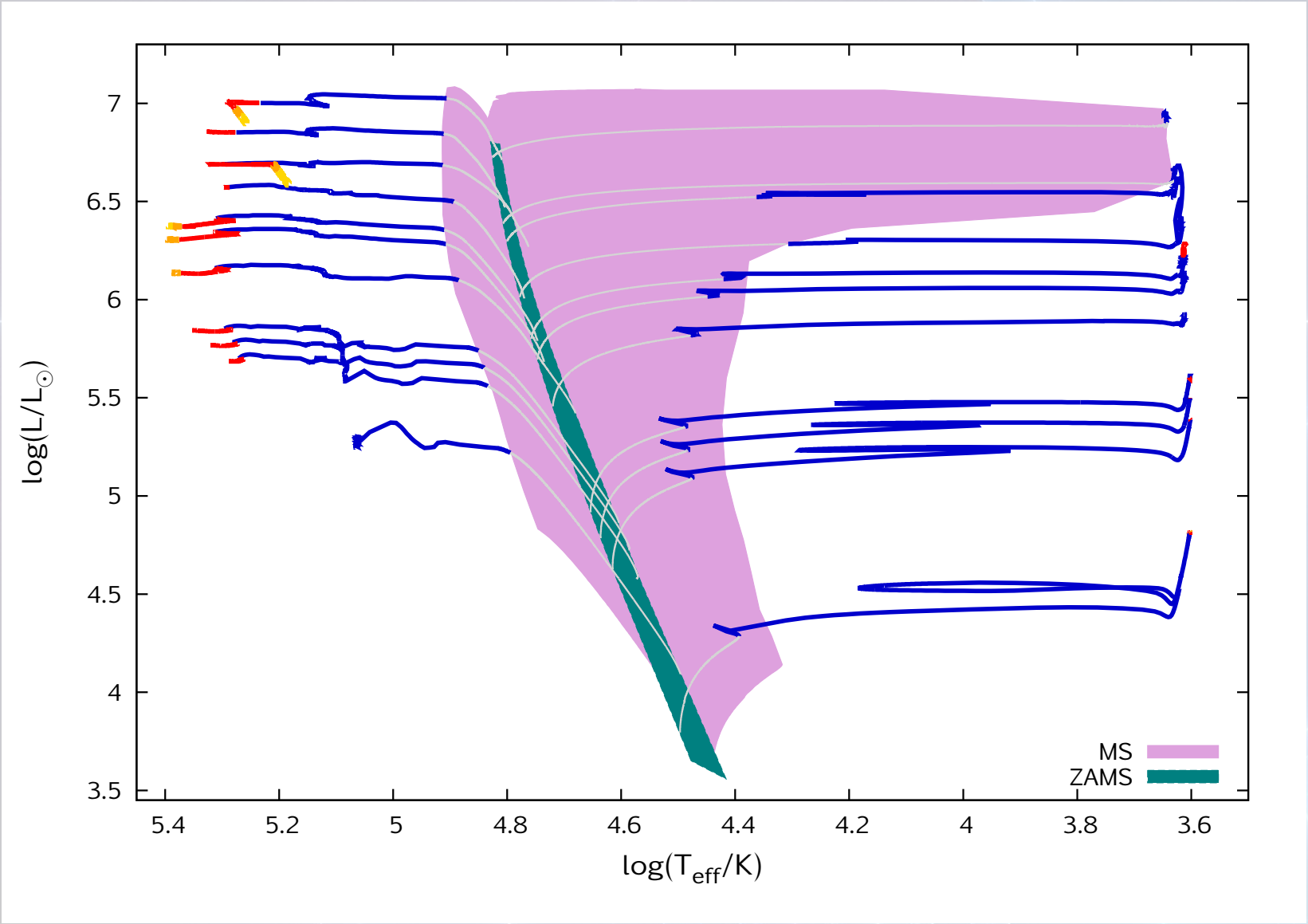
Thank you for your attention!

Appendix: The grid of low-Z stellar models



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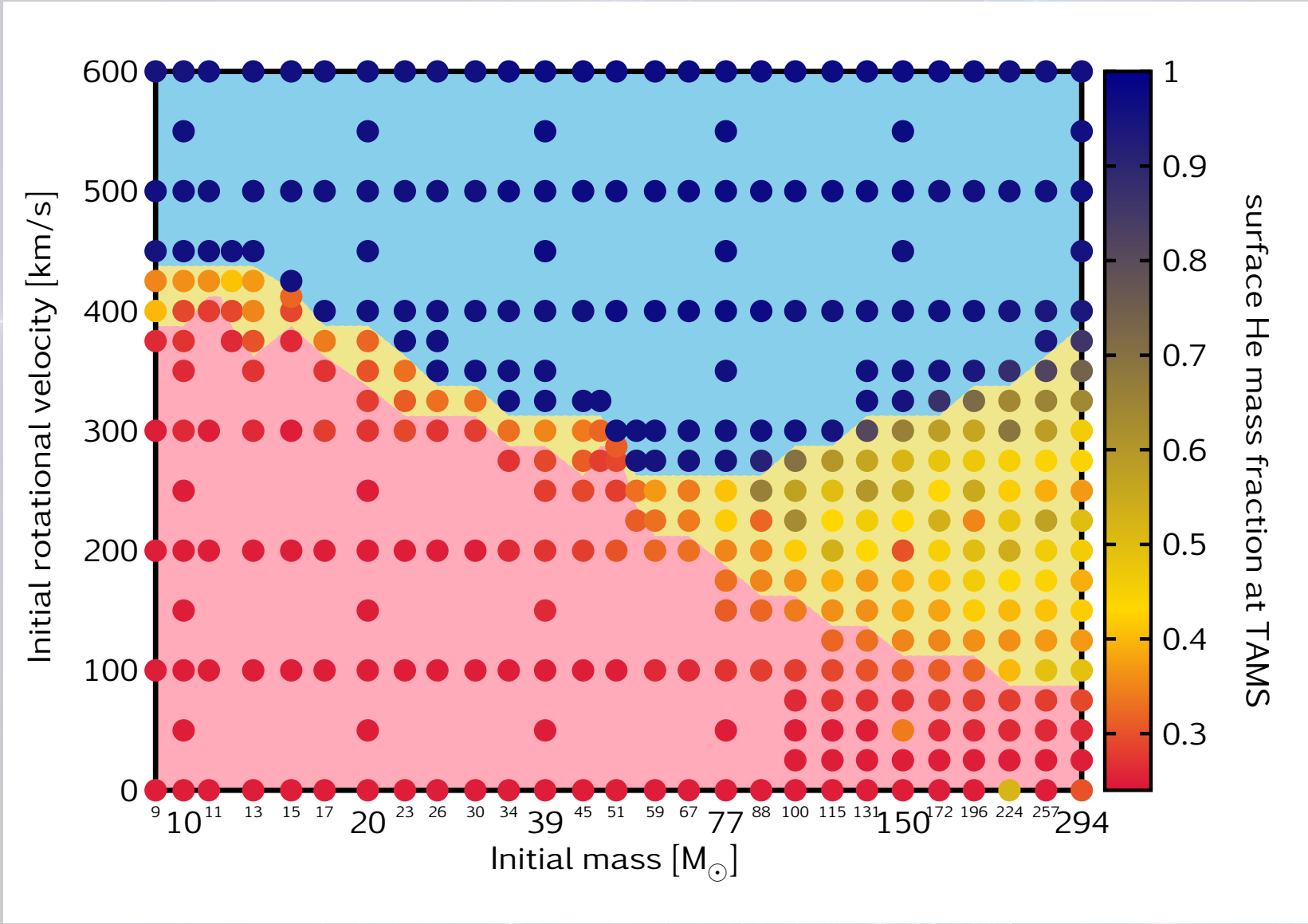
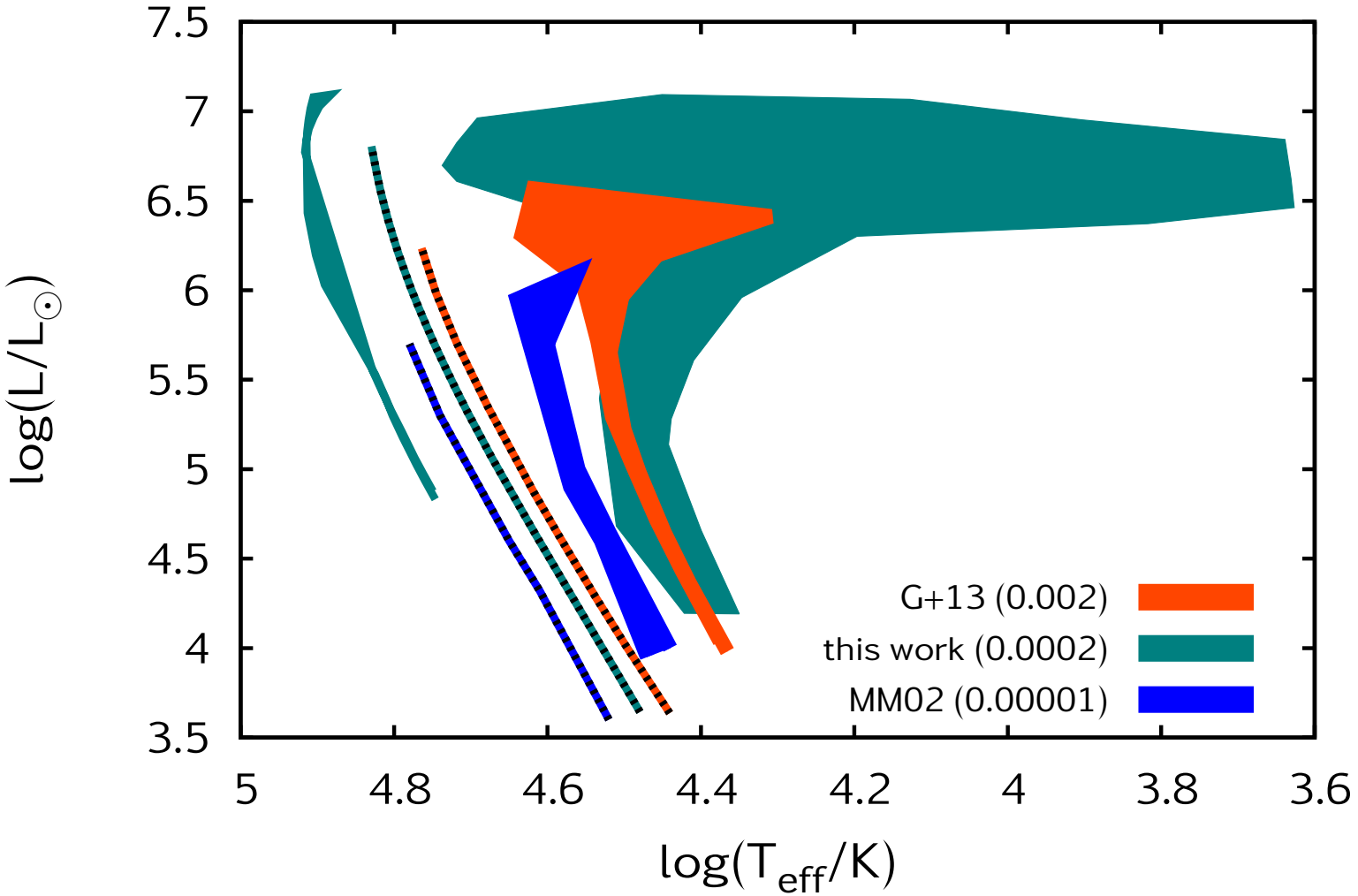


Appendix: Comparison to previous models



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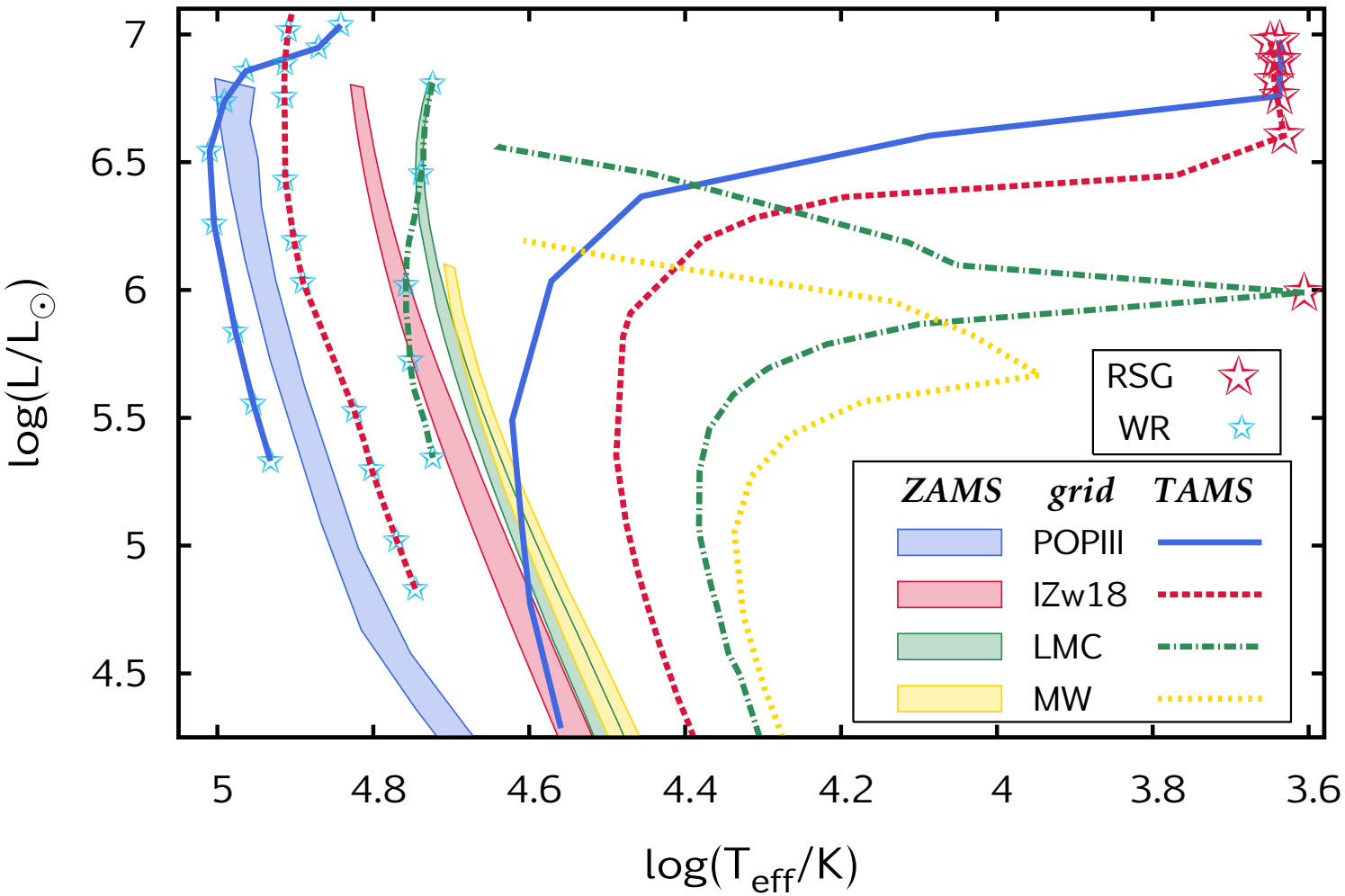
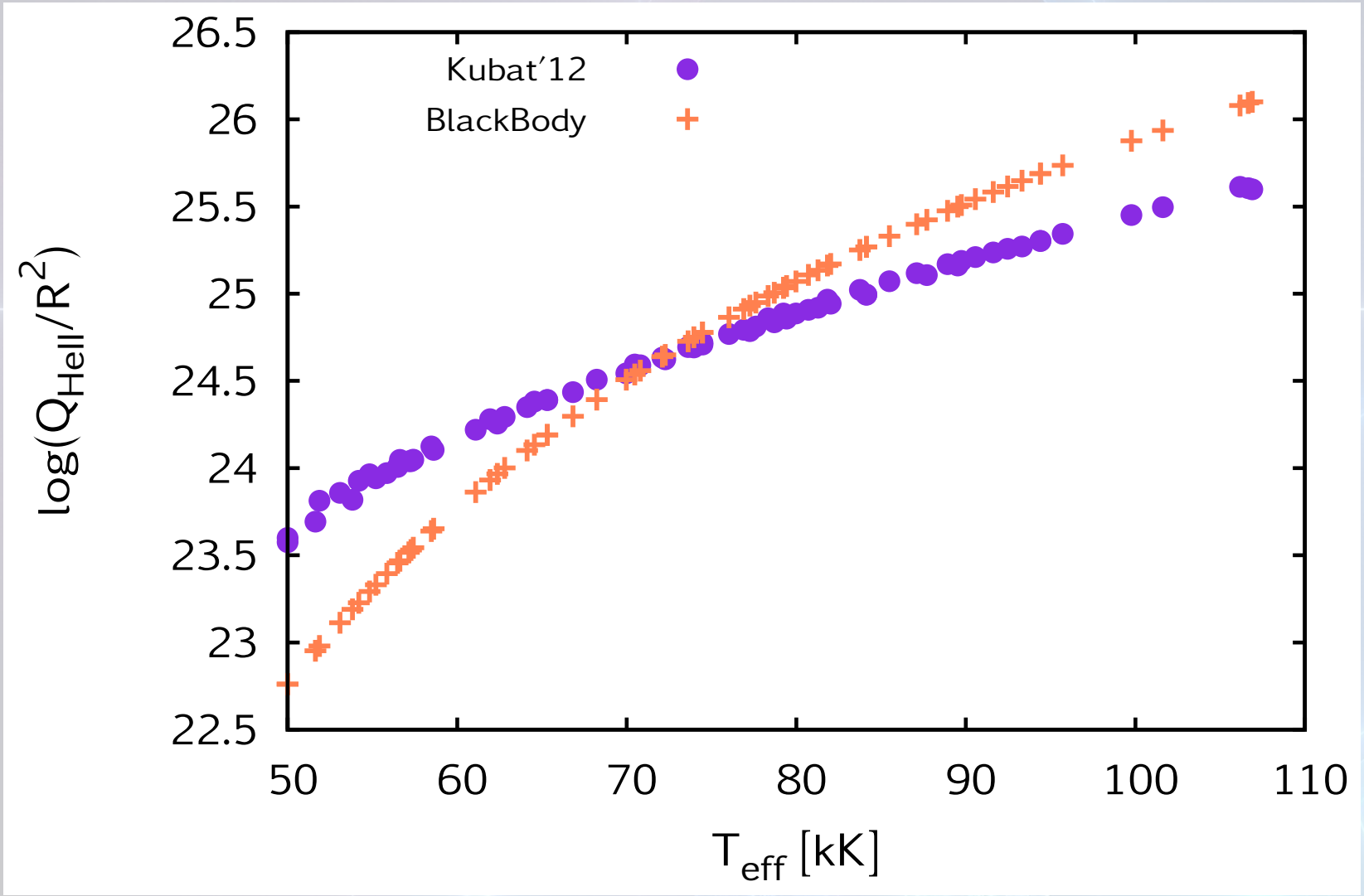


Appendix: Validity of the BlackBody approxim.



Appendix: Initial Composition