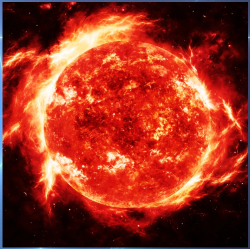
Low-Z Massive Stars
vs
High-Z Massive Stars



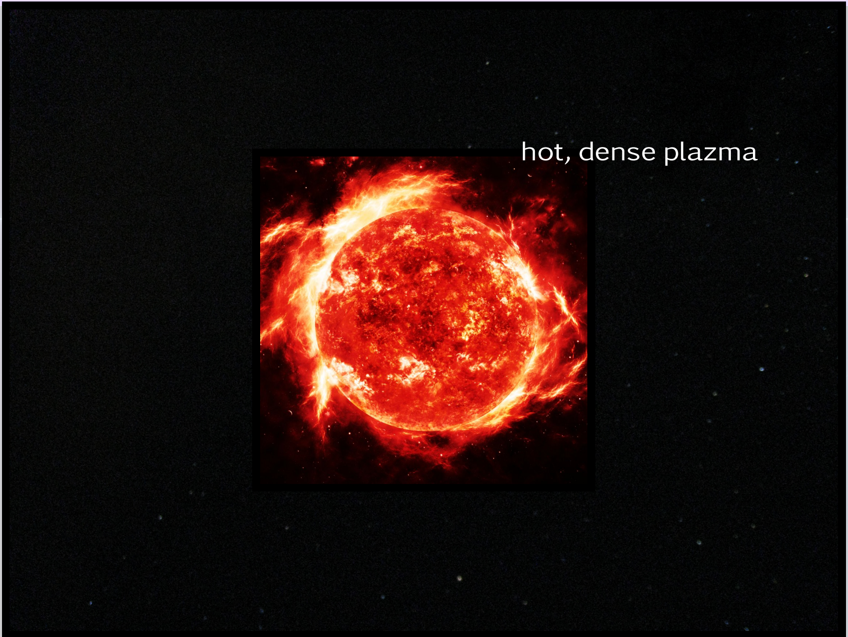
Dorottya Szécsi

SILCC Workshop

Bad Neuenahr-Ahrweiler, 15th March 2019

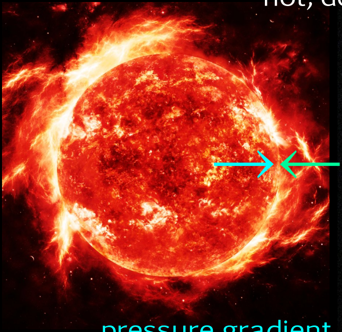
What is a star?

What is a star?



What is a star?

hot, dense plazma



equilibrium: pressure gradient gravity

What is a star?

surface?

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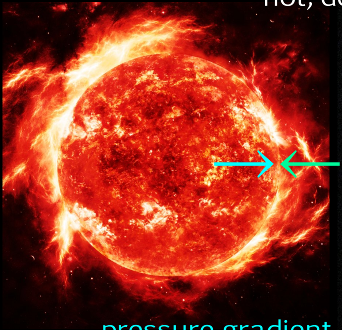

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What is a star?

surface?
→ photons escape
"photosphere"

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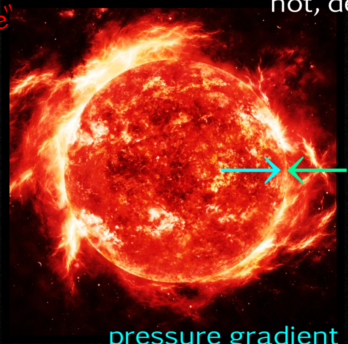

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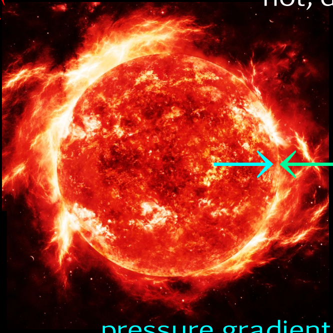

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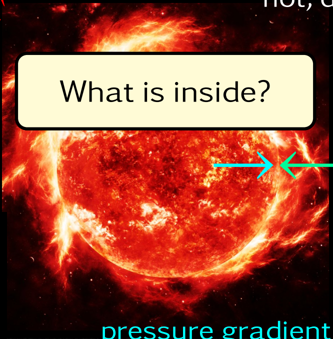
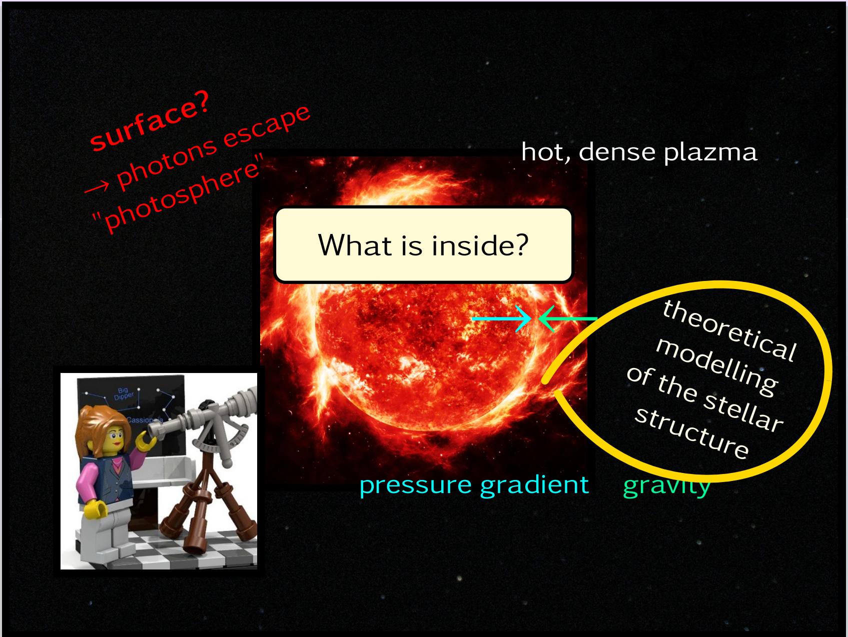


What is inside?

pressure gradient gravity

What is a star?



Theoretical modelling of the stellar structure

$$\frac{\partial r}{\partial m_r} = \frac{1}{4\pi r^2 \rho} \qquad \text{equation of definition of mass} \qquad (9)$$

$$\frac{\partial P}{\partial m_r} = -\frac{G m_r}{4\pi r^4} \qquad \text{equation of hydrostatic equilibrium} \qquad (10)$$

$$\frac{\partial L_r}{\partial m_r} = \epsilon_{\mathrm{pl}} - T\frac{\partial S}{\partial t} \qquad \text{equation of energetic balance} \qquad (11)$$

$$\frac{\partial T}{\partial m_r} = -\frac{G m_r T}{4\pi r^4 P}\nabla \qquad \text{equation of energy transport,} \qquad (12)$$

Guilera et al. 2011

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$$\frac{\partial r}{\partial m_r} = \frac{1}{4\pi r^2 \rho} \qquad \text{mass conservation} \qquad (9)$$

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transport of energy

Guilera et al. 2011

composition change due to nuclear burning ?!

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composition change due to nuclear burning ?!

$$\frac{\partial X_i}{\partial t} = \frac{A_i m_u}{\rho}\left(-\Sigma_{j,k} r_{i,j,k} + \Sigma_{k,l} r_{k,l,i}\right) \qquad (13)$$

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+ Rotation.

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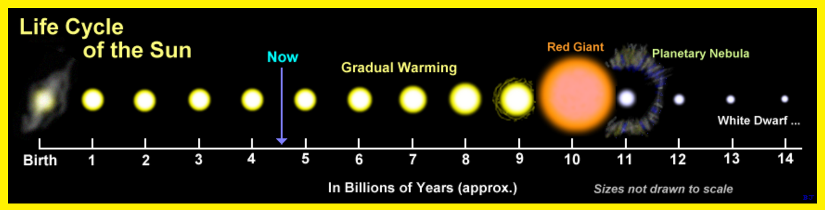

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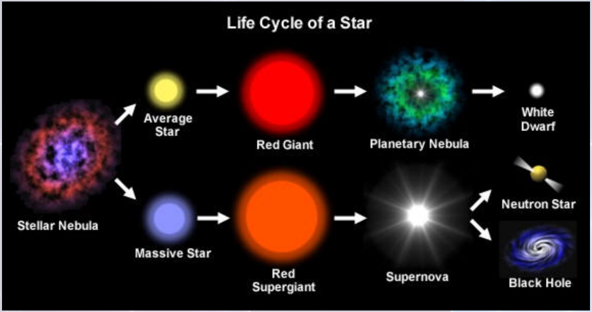
Massive vs. low-mass stars

Massive stars: $\gtrsim 9$ times the Sun ($\gtrsim 9\,M_\odot$)



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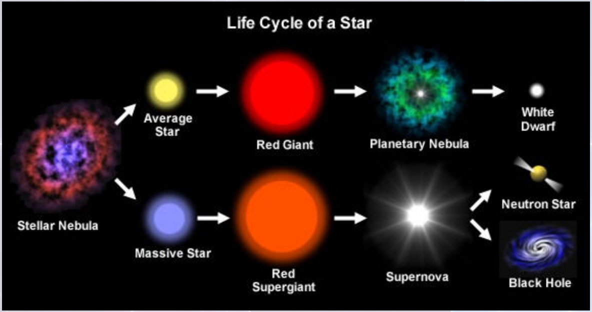

- nuclear reactions, final composition
- number of stars: massive stars are rare
- lifetime: massive stars have shorter lives
- final fate

Matching theory to observations

Surface properties!

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Surface properties! → temperature (i.e. colour) X axis
→ luminosity (i.e. brightness) Y axis

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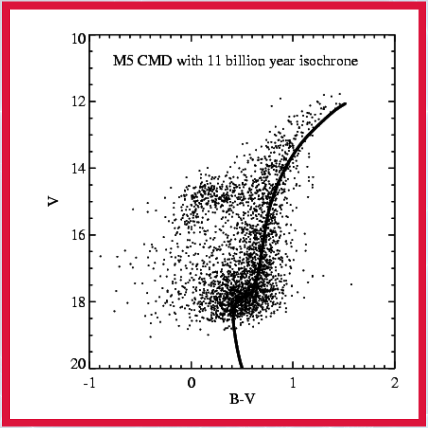
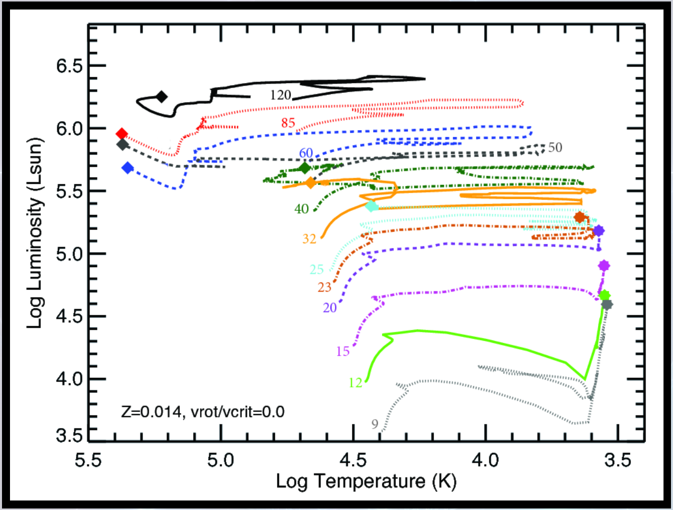


Hertzsprung–Russell diagram (HR diagram)

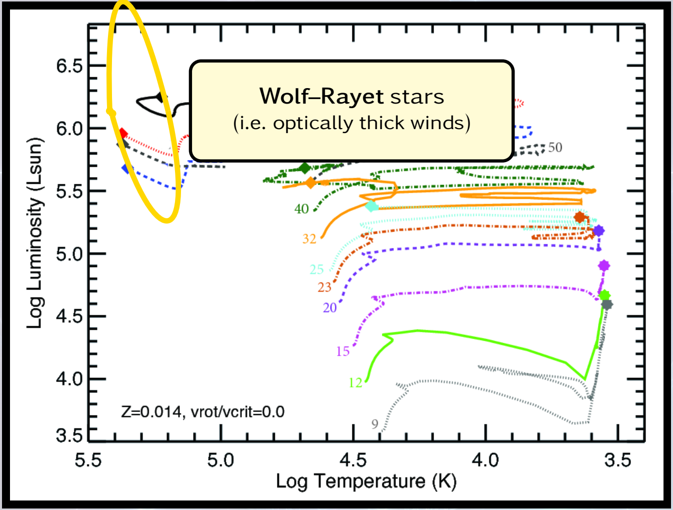
High Metallicity Massive Stars

Hertzsprung–Russell diagram



Groh et al. 2013

Hertzsprung–Russell diagram



Groh et al. 2013

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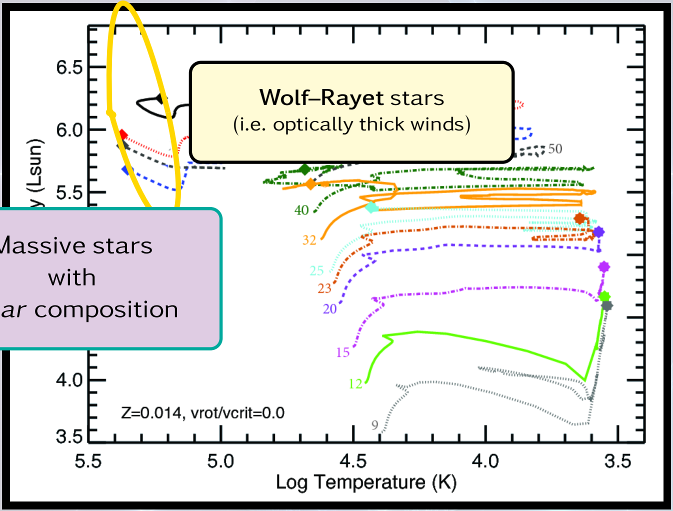

Wolf–Rayet stars
(i.e. optically thick winds)

Massive stars
with
solar composition

Groh et al. 2013

Low Metallicity Massive Stars

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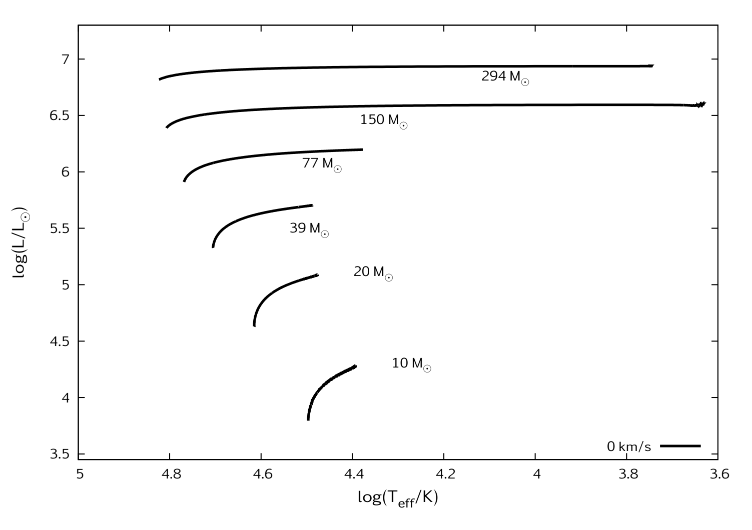
Szécsi et al. 2015 (Astronomy & Astrophysics, v.581, A15)



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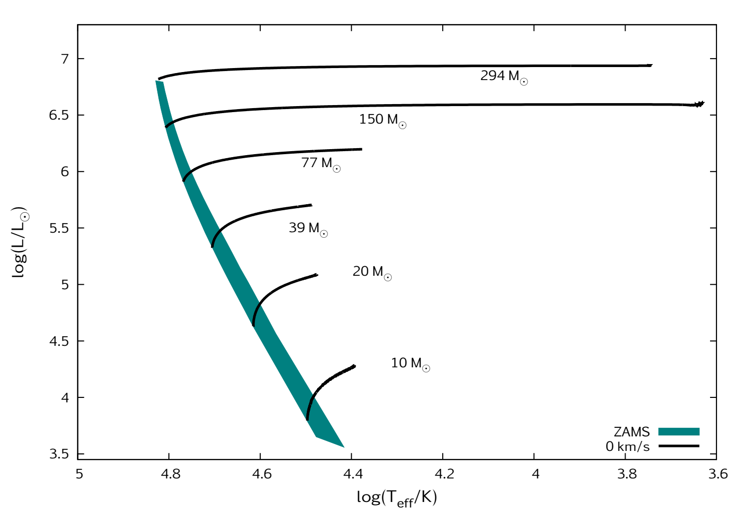

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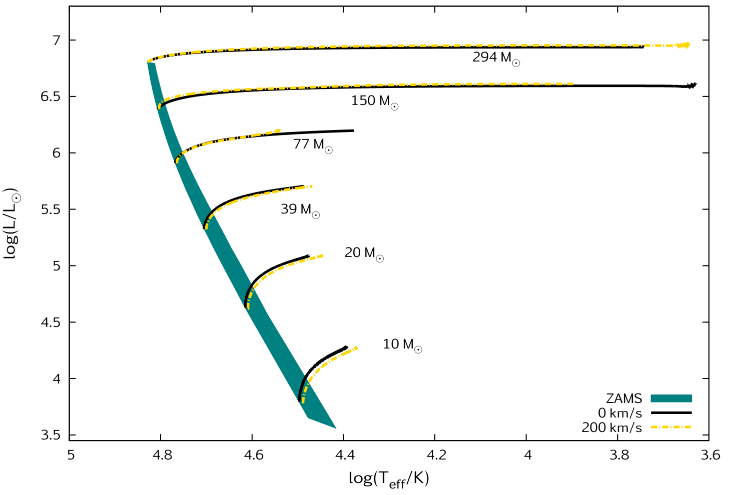

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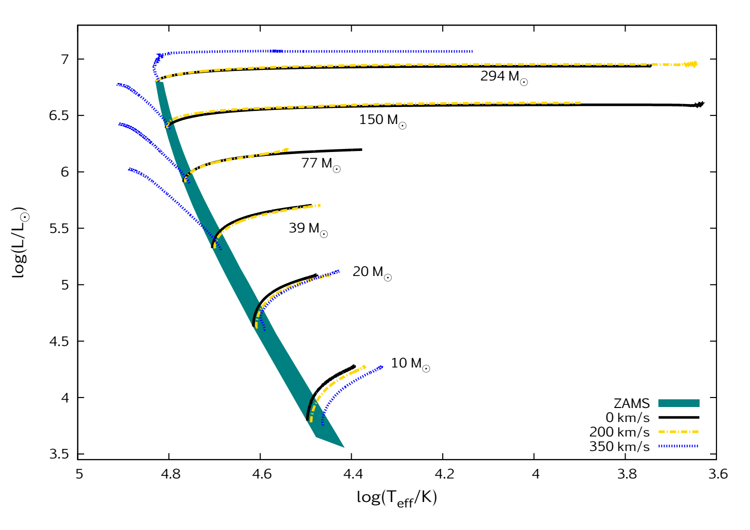

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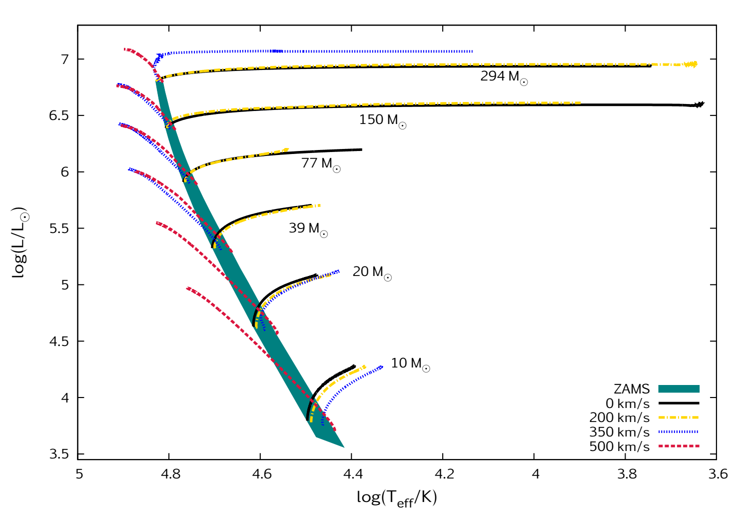

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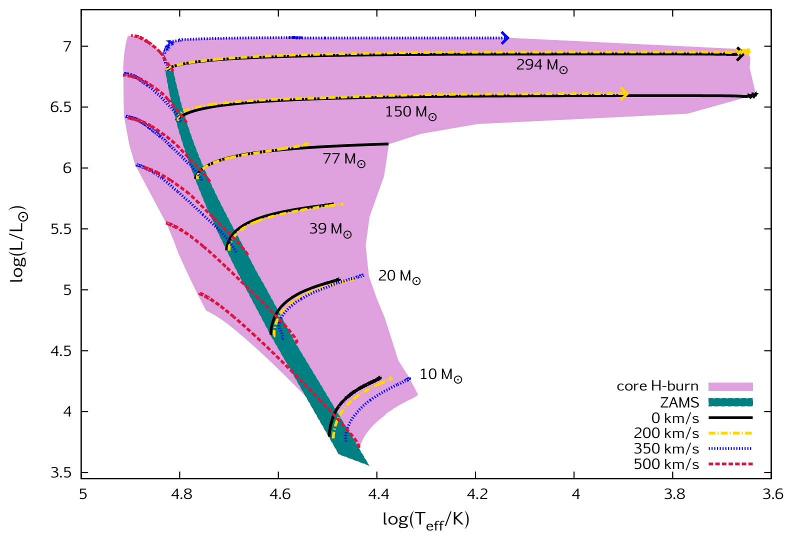
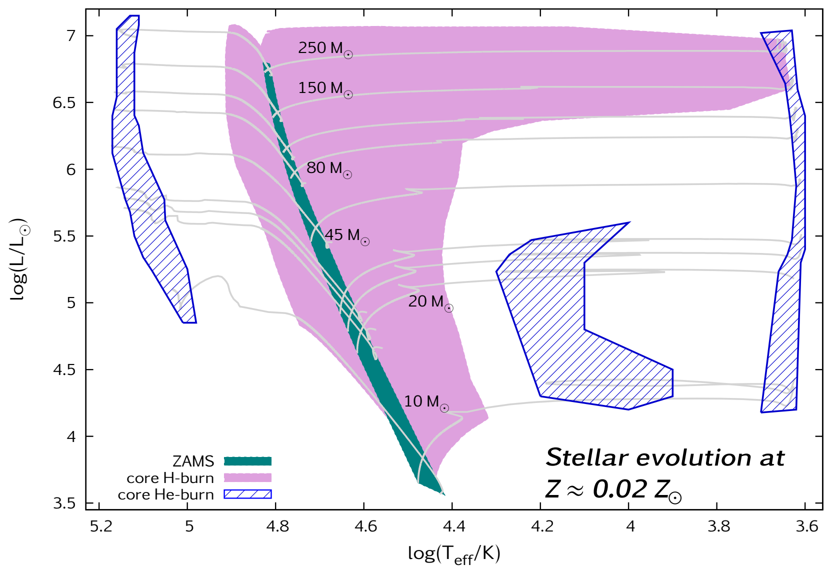


Low Z Massive Stars – the whole picture



(Szécsi+15,'16)

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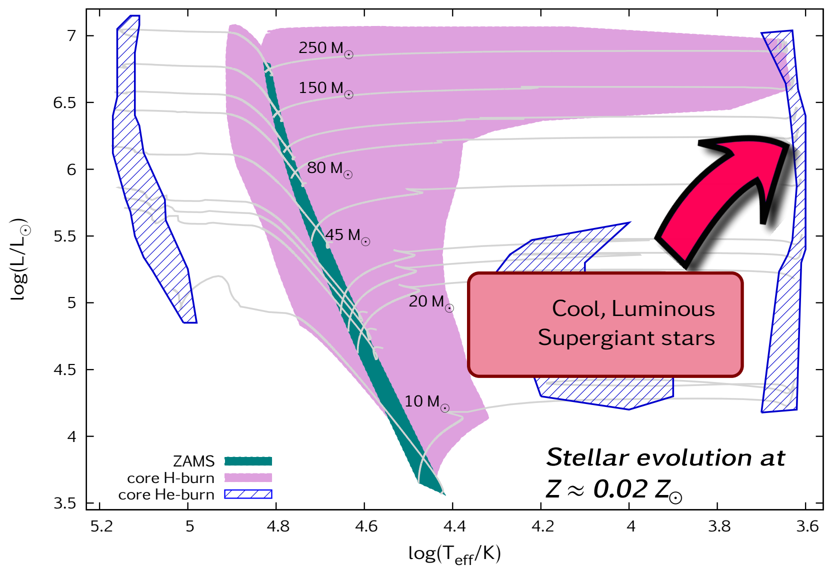

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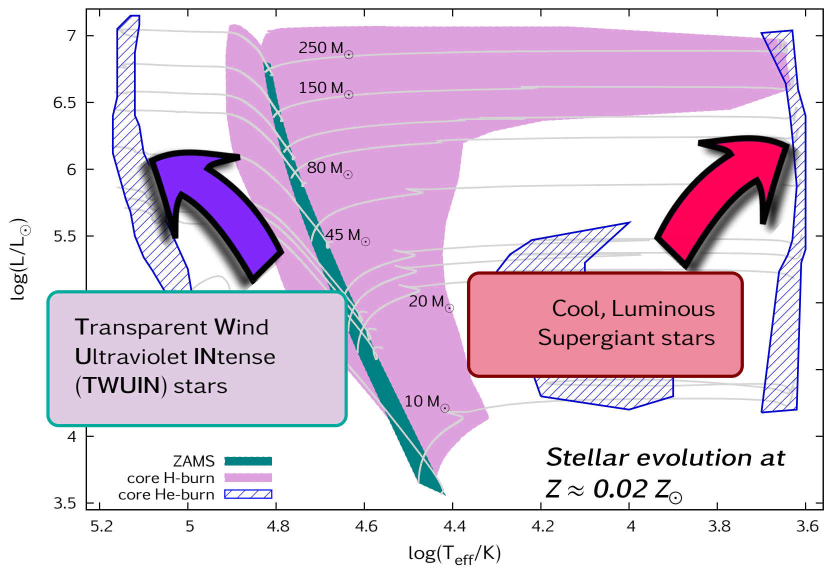

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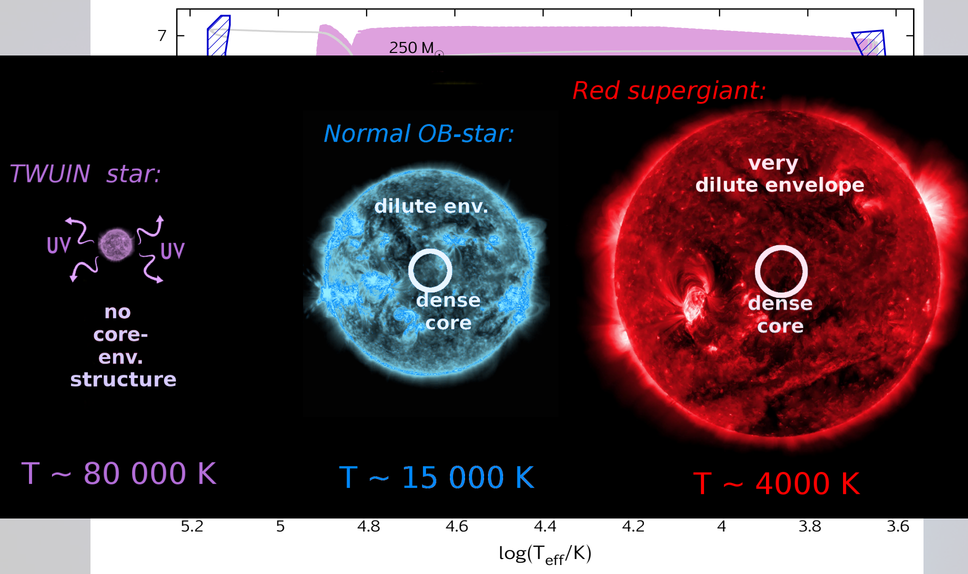

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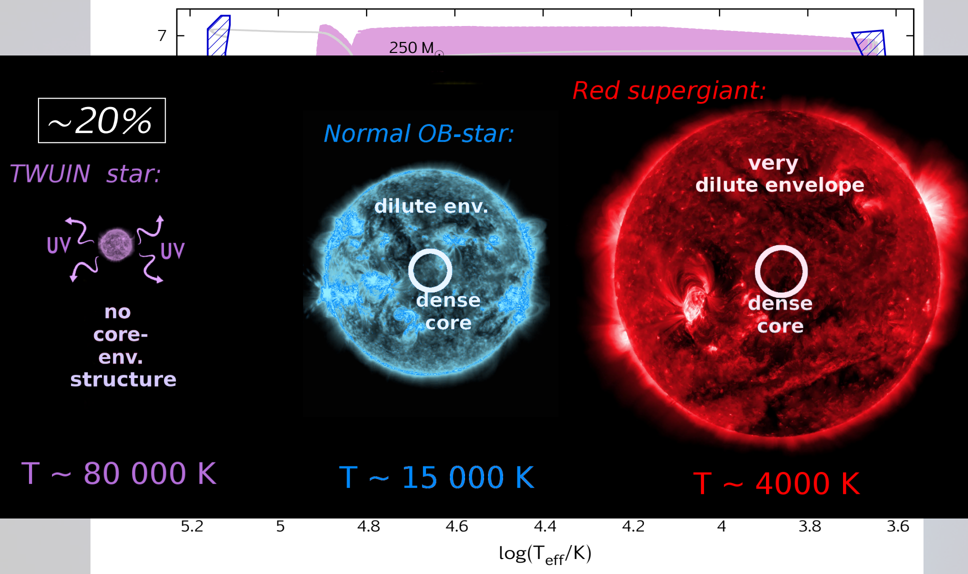

(Szécsi+15,'16)

IMF matters...

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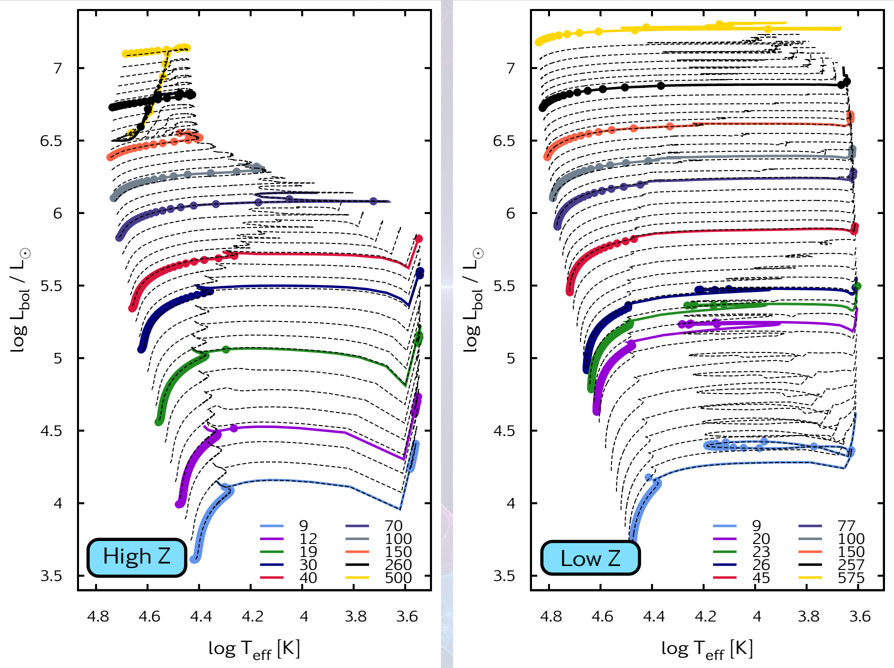
"population synthesis"



(Szécsi&Wünsch'19)

Low-Z starforming regions today

Compact Dwarf Galaxies

- local universe
- clues for strong ionizing sources
- TWUIN stars may play a role! :)
- 20% is enough apparently...

Szécsi+15,+15b,'17, Kubátová&**Szécsi**+19

Low-Z starforming regions today

Thank you for your attention!

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Szécsi+15,+15b,'17, Kubátová&Szécsi+19