

# Globular Cluster Abundance Anomalies and the Massive Binary Polluter Scenario

**Dorottya Szécsi**  
Nicolas Gonzalez-Jimenez  
Norbert Langer

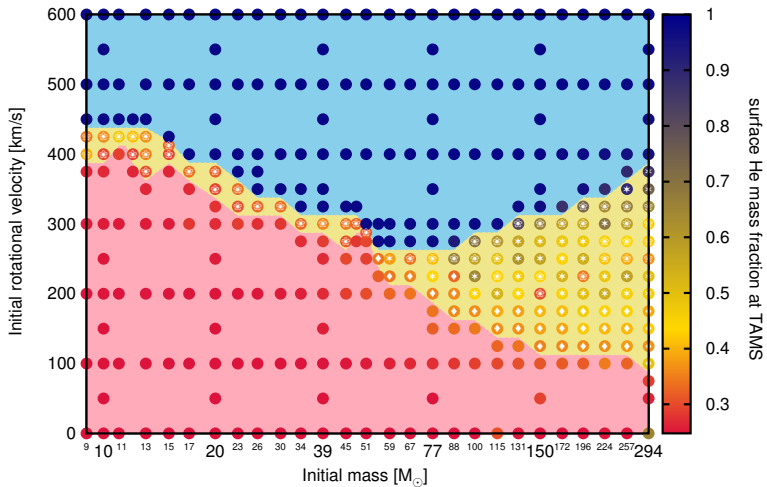


**Binary systems, their evolution and environments**

1-5. September 2014, Ulaan Baatar

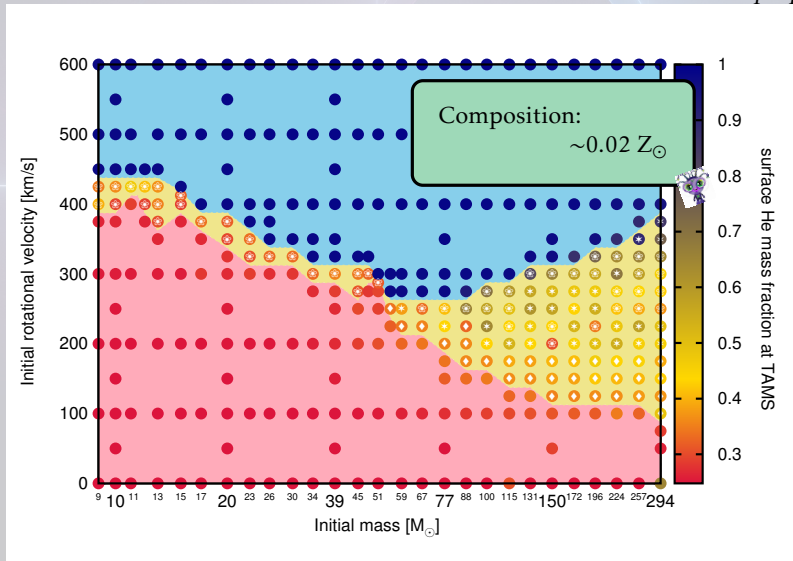
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Szécsi et al. 2014 in prep.



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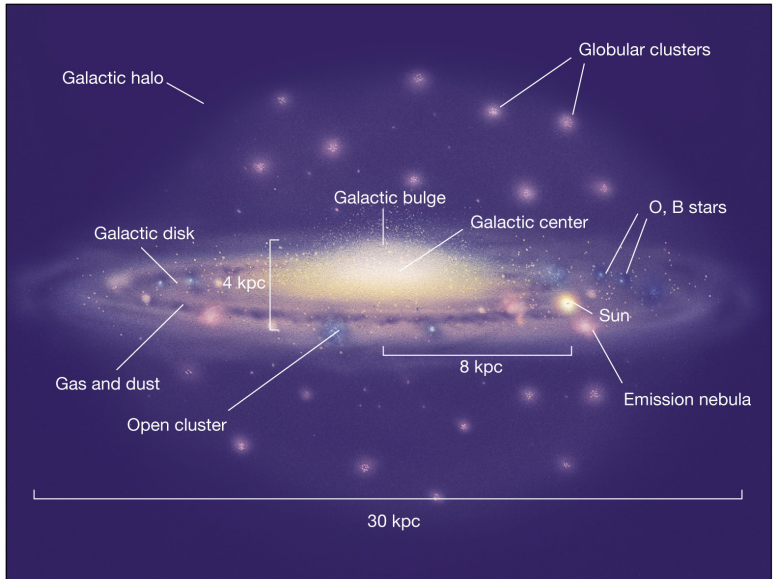


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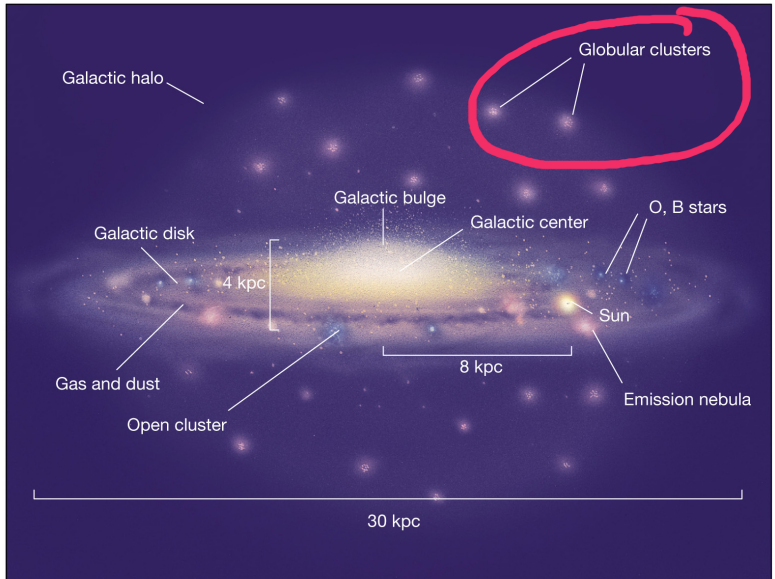
Abundance anomalies observed  
in Galactic Clusters (GCs)



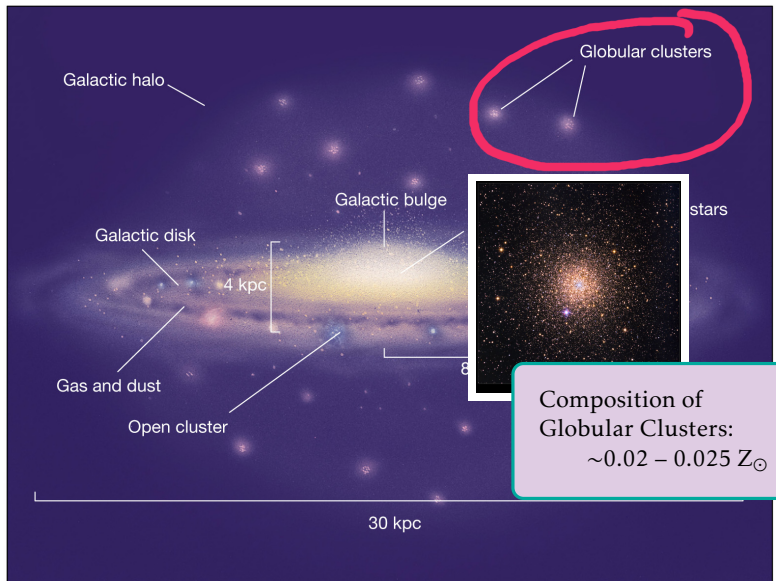
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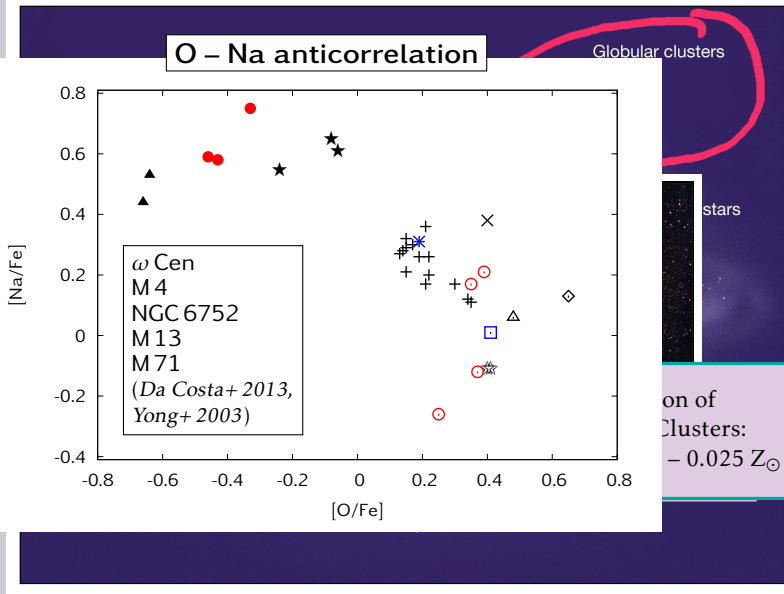
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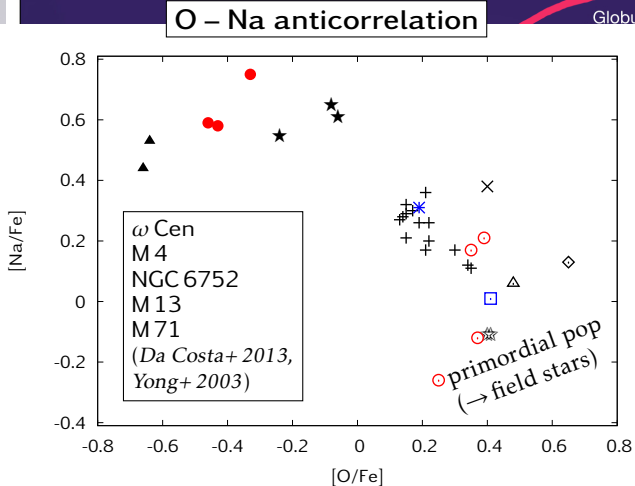
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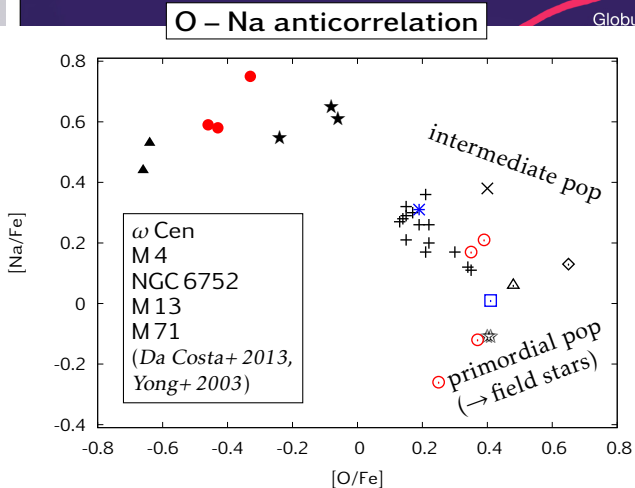
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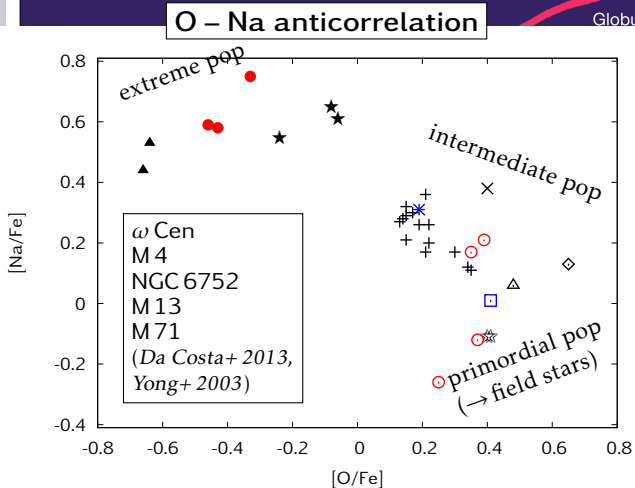
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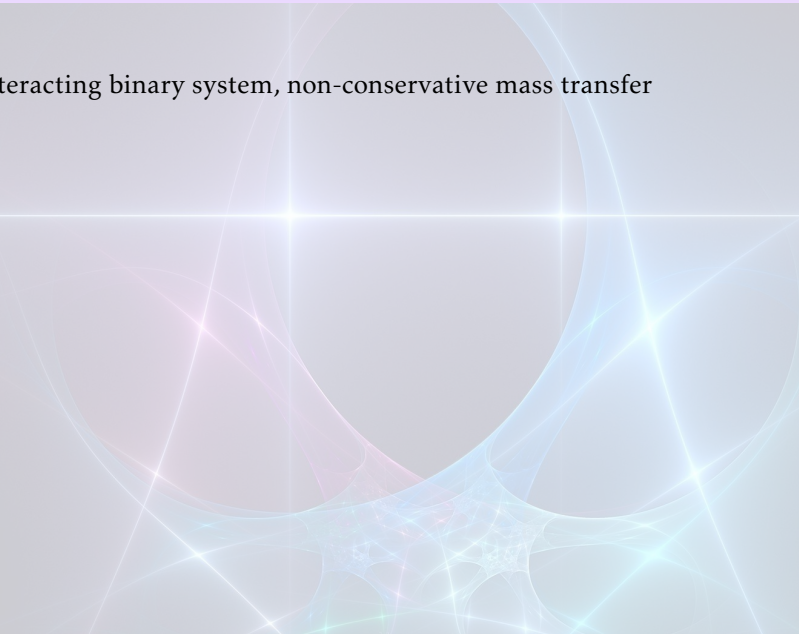
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  - **massive binaries**: non-conservative mass transfer (*De Mink+ 2009*)

The background features a large, semi-transparent white circle centered in the upper half. Overlaid on this are intricate, glowing patterns of light blue and pink lines that resemble a complex network or a stylized fractal. The lines are thin and have a soft, ethereal glow, creating a sense of depth and movement. The overall color palette is cool, dominated by blues and pinks, with a light grey background.

## The massive binary polluter scenario

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- deeper layers of primary envelope: nuclearly processed material!
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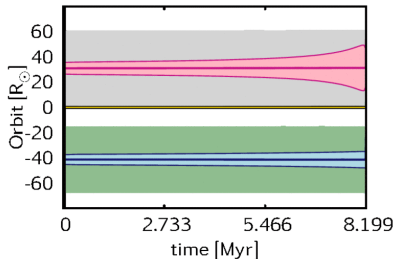
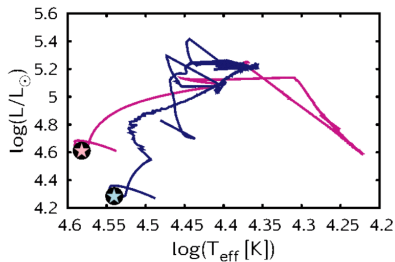
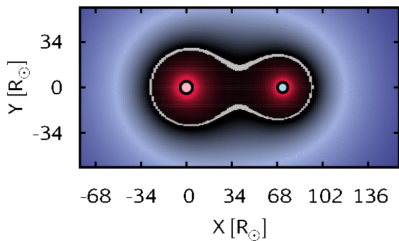


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- *De Mink+ 2009*:  **$20 M_{\odot} + 15 M_{\odot} + 12 \text{ days}$**  ( $\sim 0.025 Z_{\odot}$ )

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$m_1=0.20 M_{\odot}$   $m_2=0.15 M_{\odot}$   $p=12.00$  d

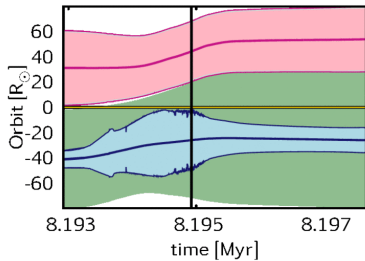
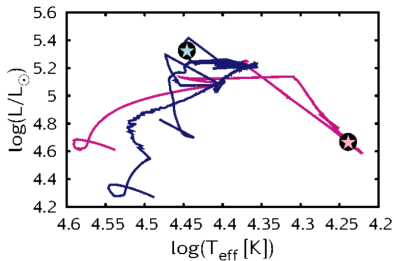
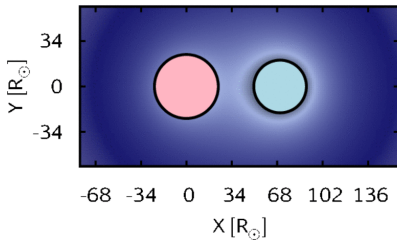


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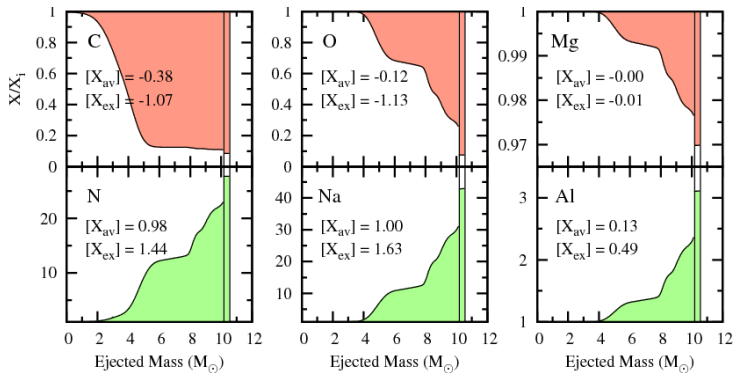
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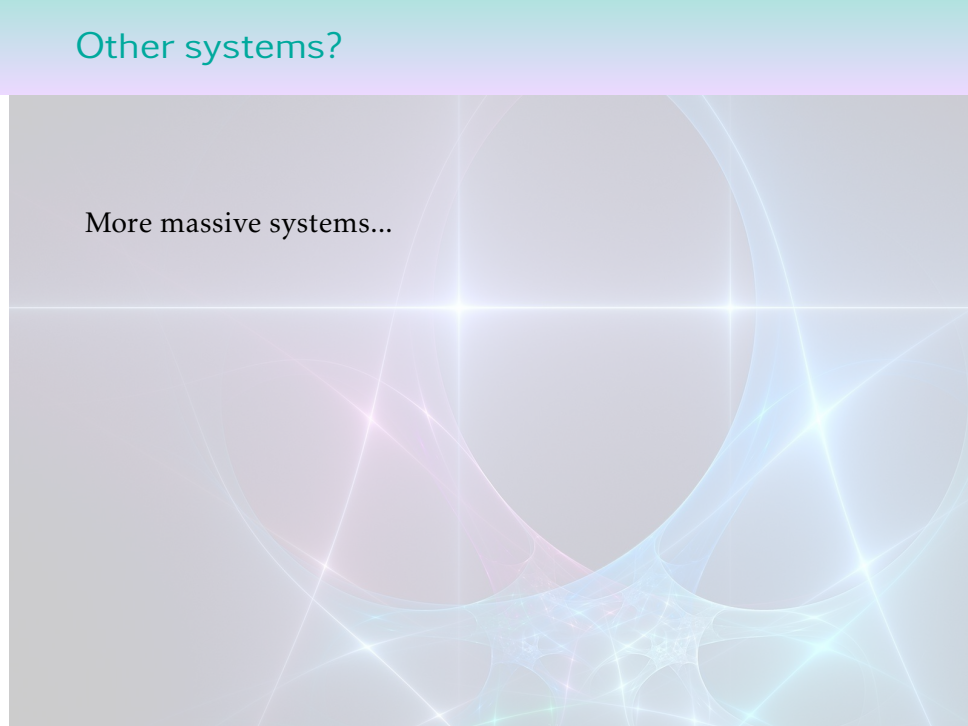
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*de Mink et al. 2009*



## Other systems?

More massive systems...

The background features a large, semi-transparent circle in the upper center. A horizontal white line crosses the circle. The lower half of the image is filled with a complex, glowing network of lines in shades of blue, cyan, and magenta, resembling a fiber optic or neural network structure. The overall aesthetic is futuristic and digital.

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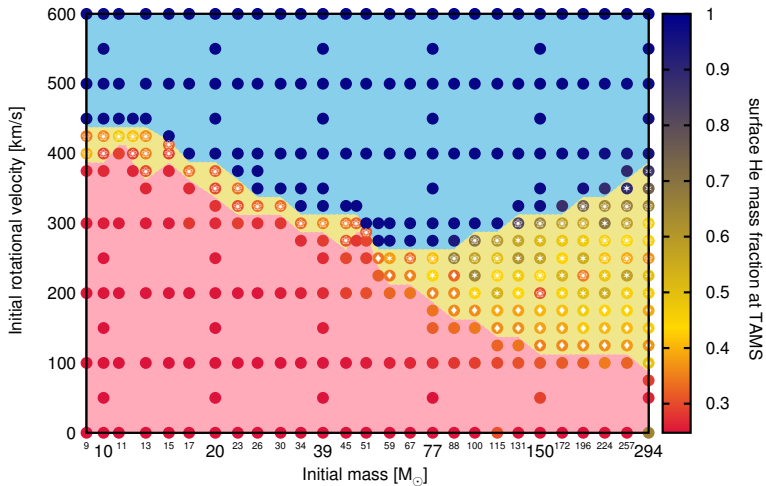
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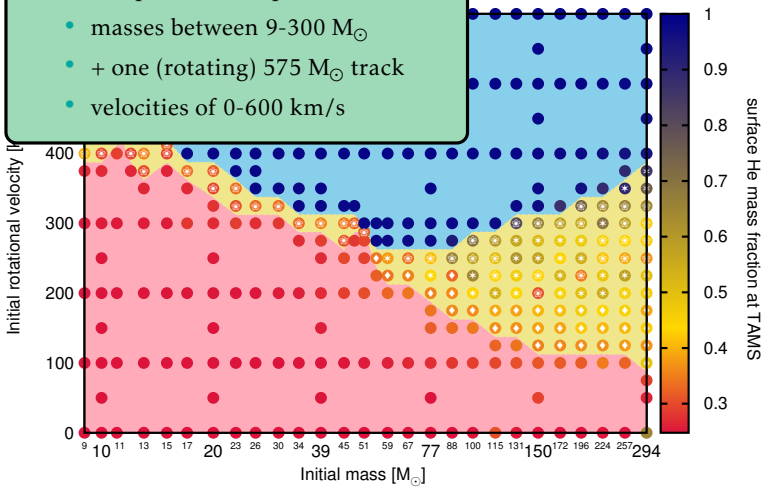
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# A grid of low metallicity *single* stars

Szécsi et al. 2014 in prep.

- composition comparable to GCs
- masses between 9-300  $M_{\odot}$
- + one (rotating) 575  $M_{\odot}$  track
- velocities of 0-600 km/s

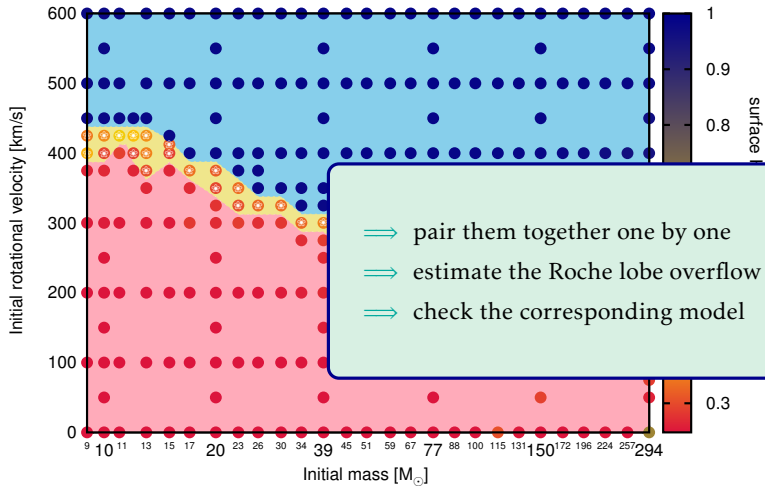


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Single star approach  
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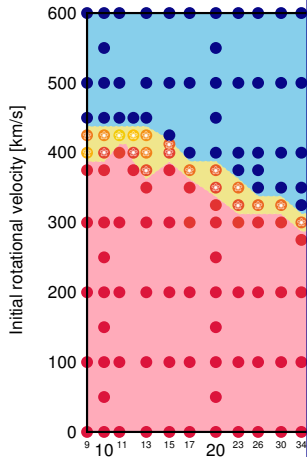
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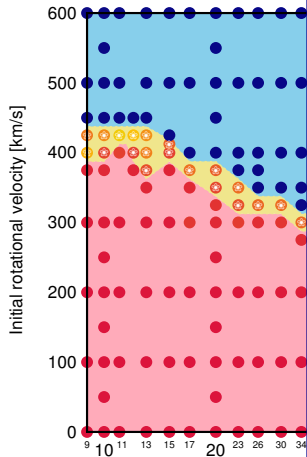


20  $M_{\odot}$  + 15  $M_{\odot}$  + 12 days:



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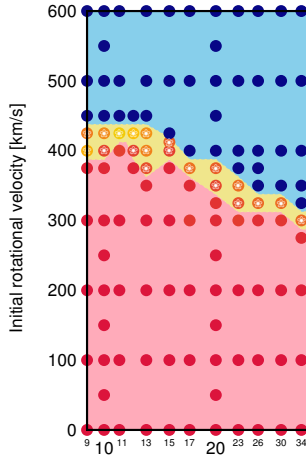
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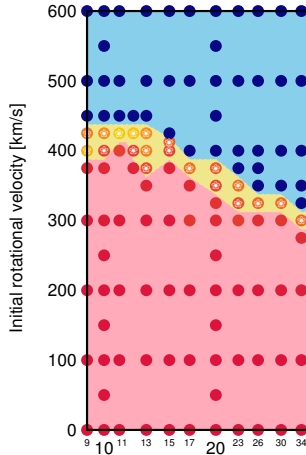
$\Rightarrow$  initial orbital separation:  $A = 72 R_{\odot}$





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Szécsi et al. 2014 in prep.



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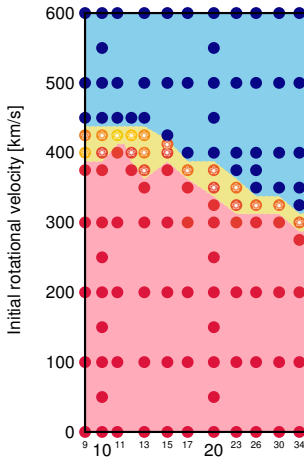
**Single star approach:**

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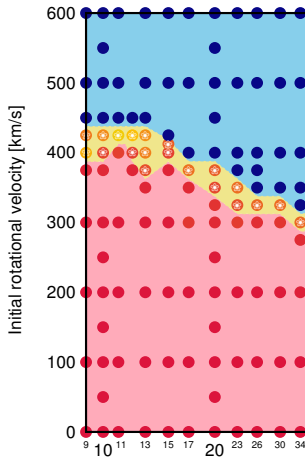
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$$RL_1 = A \frac{0.49q^{2/3}}{0.6q^{2/3} + \ln(1 + q^{1/3})}$$



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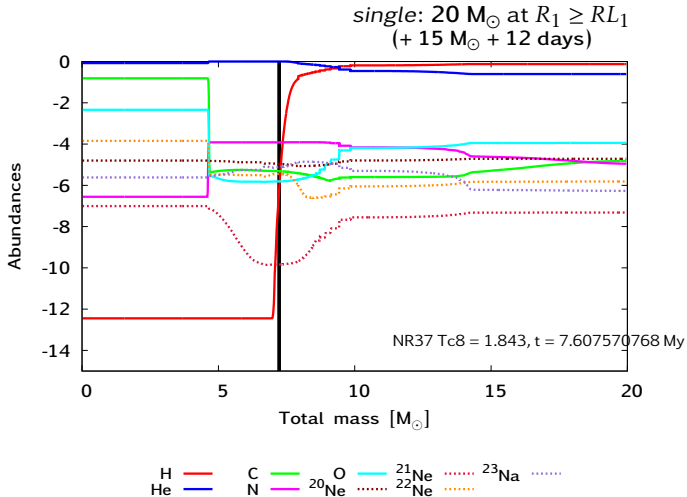
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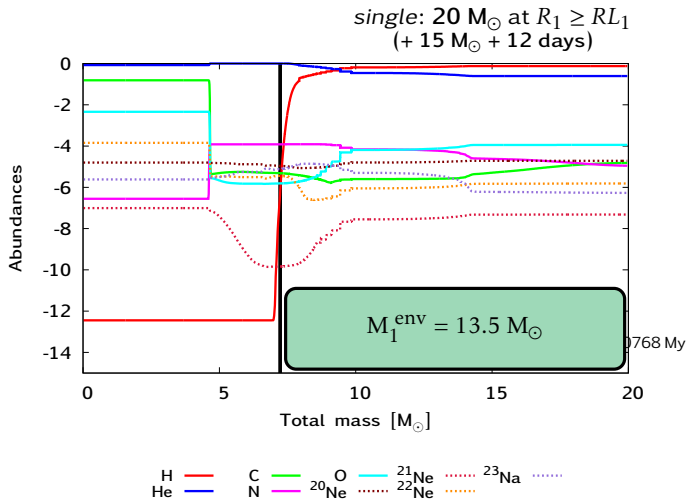
- ⇒ when  $R_1 \geq RL_1$ : check size and composition of the primary envelope



# Composition and size of primary envelope

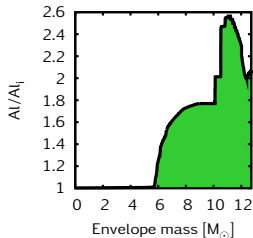
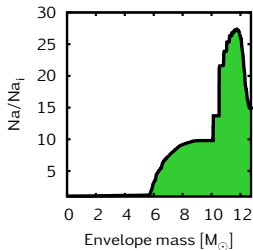
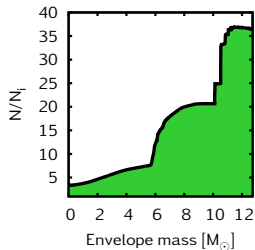
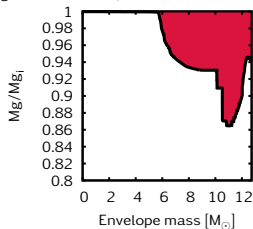
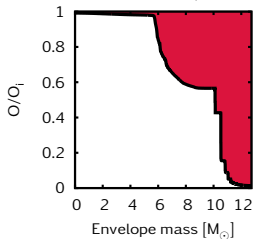
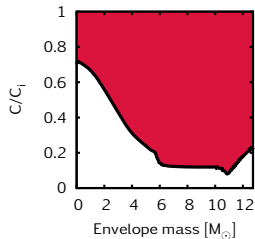


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single:  $20 M_{\odot}$  at  $R_1 \geq RL_1$   
(+  $15 M_{\odot}$  + 12 days)



# Single star approach

Assumptions:



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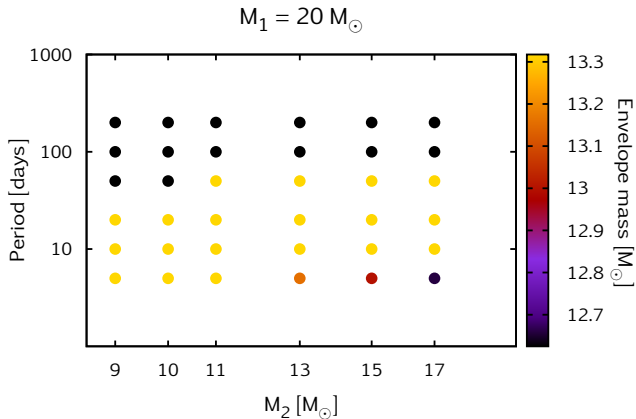
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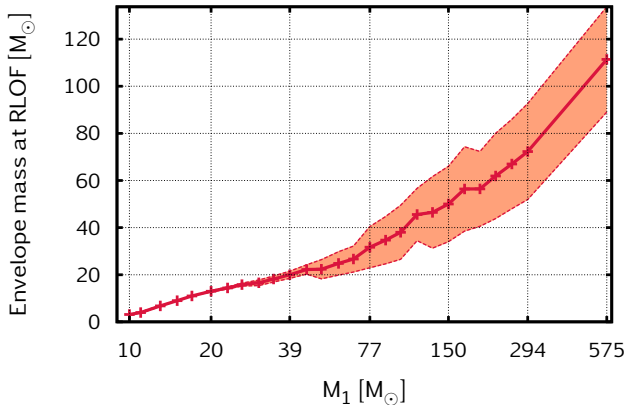
- detailed calculations of single stars are less difficult → cover a **broad parameter space**
- in case of simulating binaries: **it helps to decide** which masses, mass ratios and periods to simulate and what to expect
- give **constraints on the massive binary polluter scenario** even without detailed binary simulations

# Single star approach: size of primary envelope

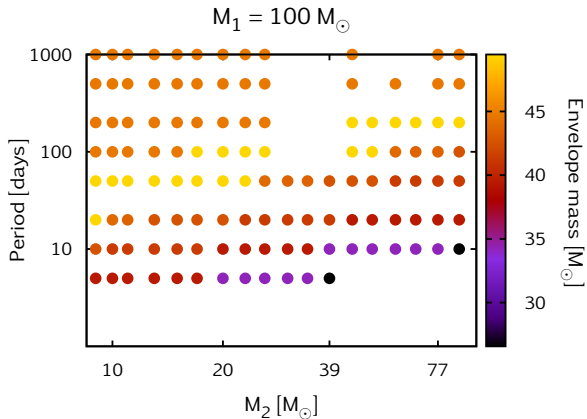




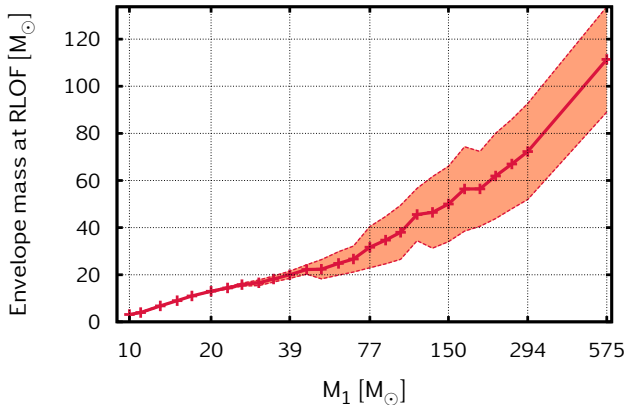
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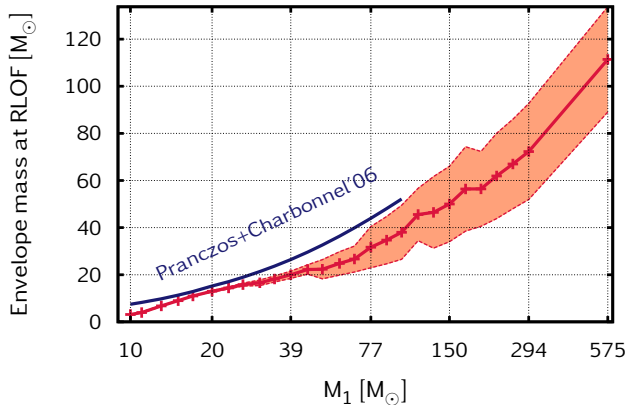
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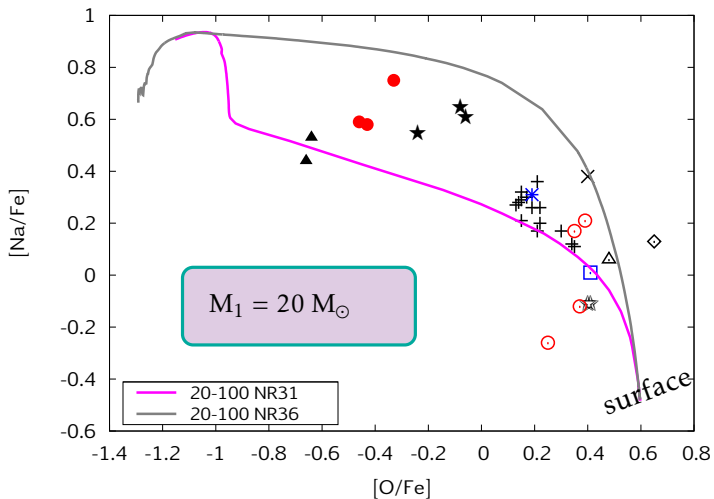


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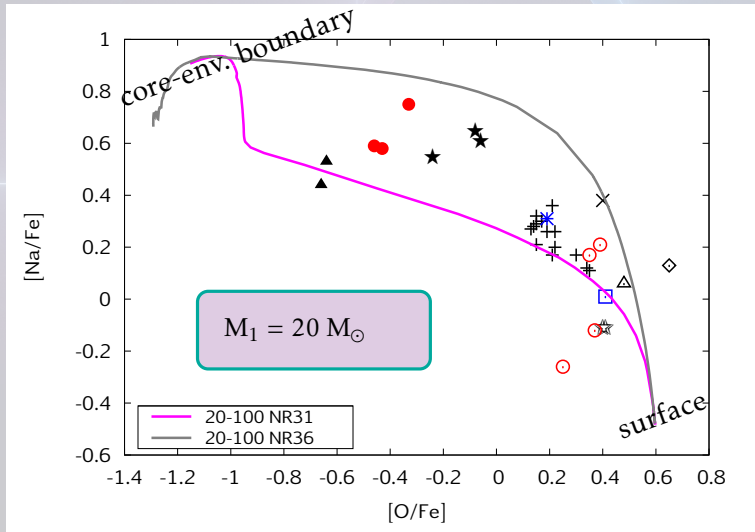
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O – Na anticorrelation



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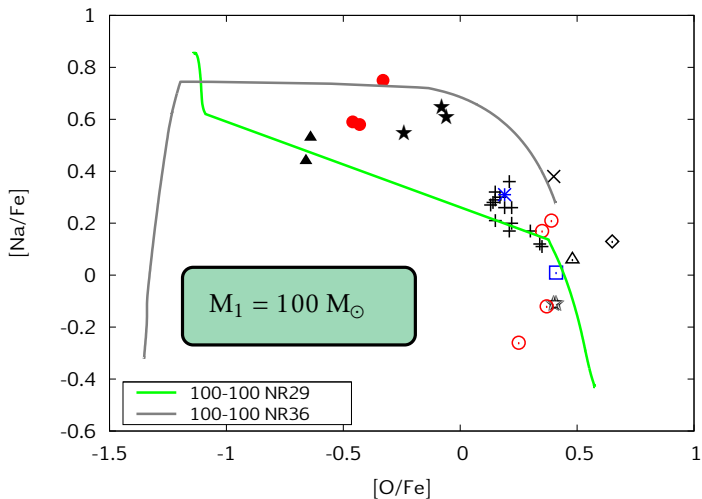


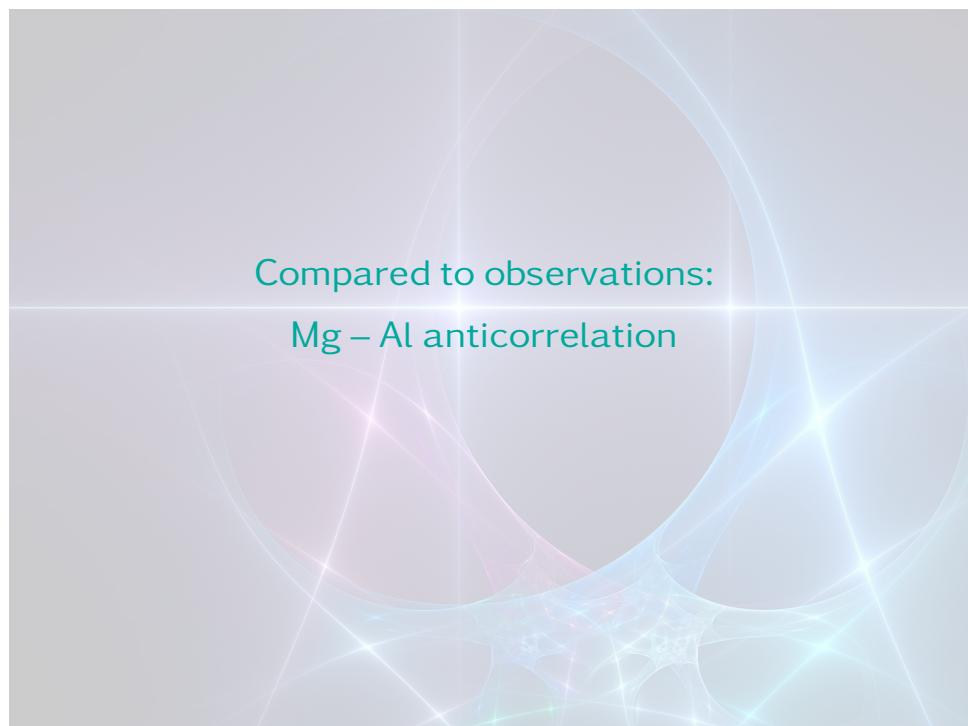
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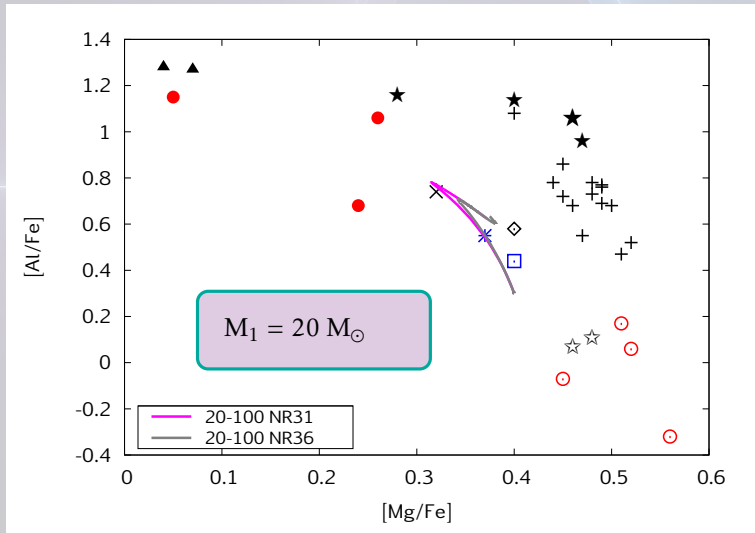
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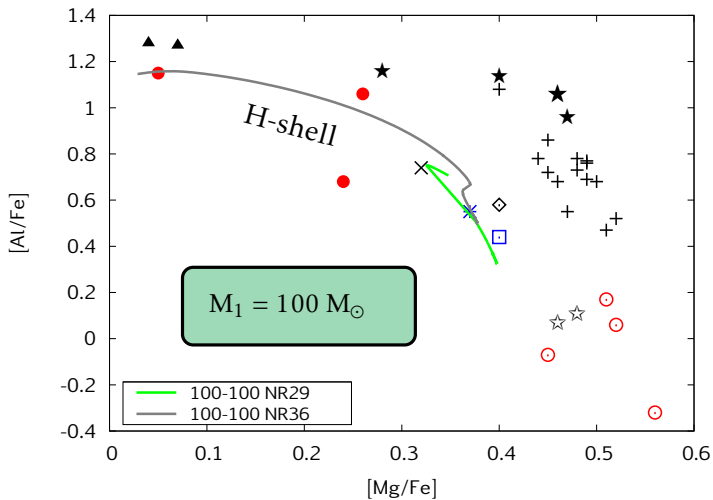
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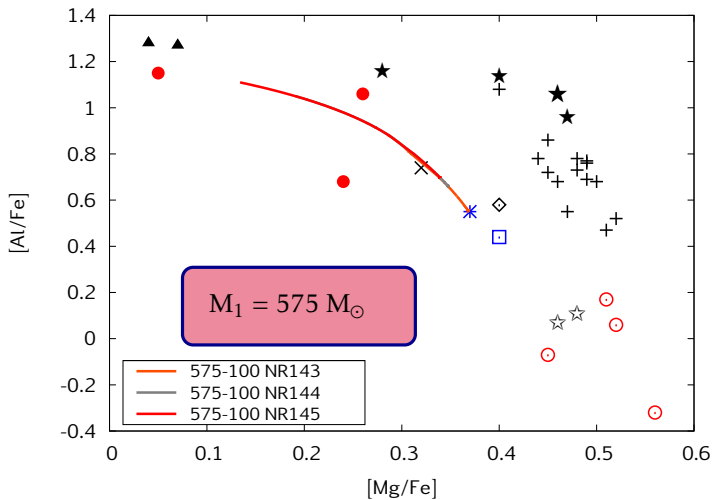




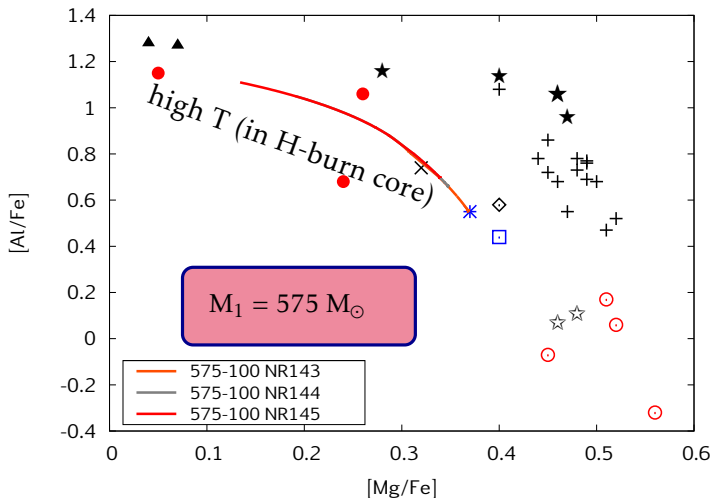
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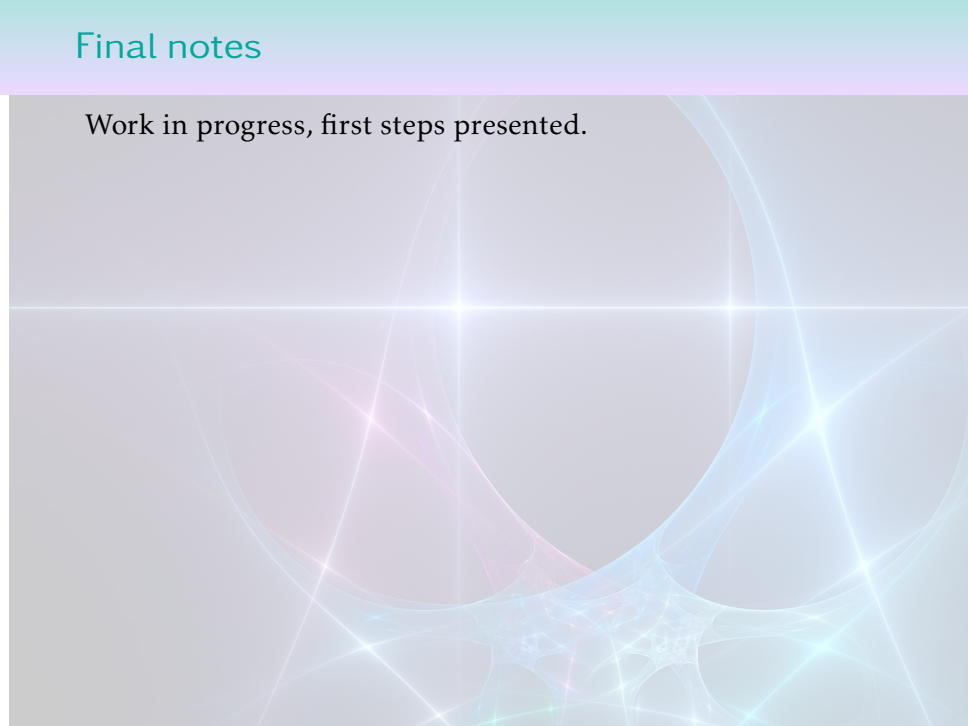
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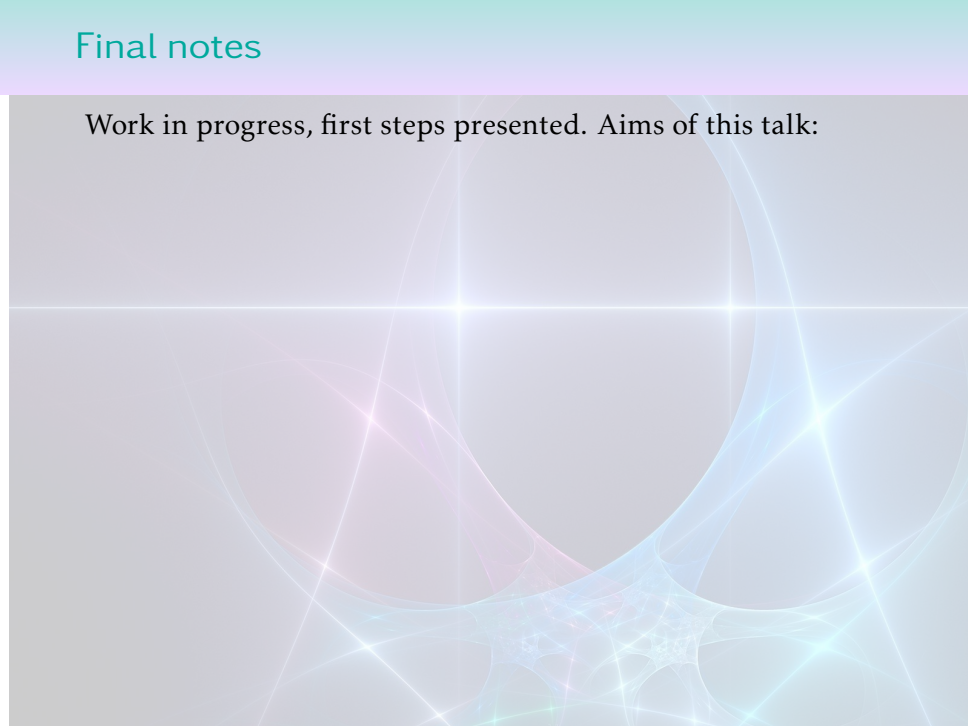
# Final notes

Work in progress, first steps presented.

The background of the slide is a light gray gradient. It features a complex, abstract pattern of glowing, translucent lines in shades of blue, cyan, and magenta. These lines form a network of interconnected shapes, resembling a stylized molecular structure or a complex web. A prominent feature is a bright, multi-pointed starburst or lens flare effect located near the center of the image, where several lines intersect. The overall aesthetic is clean, modern, and technical.

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The background of the slide is a light gray gradient. It features a complex, abstract pattern of glowing, semi-transparent lines and shapes. A prominent feature is a large, bright white circle in the upper right quadrant. A horizontal white line crosses the center of the slide. The overall aesthetic is futuristic and technical, with a color palette dominated by light blues, purples, and whites.



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Thank you  
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