Application of

Dorottya Szécsi

for admission to the PhD honors program (H2) of the
Bonn-Cologne Graduate School of
Physics and Astronomy

Prof Dr Norbert Langer supervisor
Prof Dr Robert Izzard co-advisor
Prof Dr Claus Kiefer co-advisor

bcgs
Bonn-Cologne Graduate School of Physics and Astronomy

7 th October 2013, Cologne

Summary

Undergraduate research

- since 2008 (Eötvös University, Budapest) – Prof. Dr. Zsolt Bagoly
- background fitting of *Fermi* GRB observations
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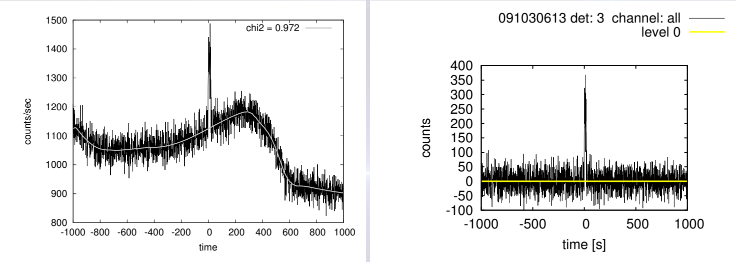
Direction dependent background fitting



- The new model takes into account:
    - angle between detector and burst
    - angle between Sun and detector
    - Earth uncovering
- Numerical fitting
- Lightcurve without background → further analyses

Direction dependent background fitting

A&A 557, A8 (2013)
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Astronomy & Astrophysics

Direction dependent background fitting for the *Fermi* GBM data

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ABSTRACT

Context. We present a method for determining the background of the gamma-ray bursts (GRBs) of the *Fermi* Gamma-ray Burst Monitor (GBM) using the satellite positional information and a physical model. Since the polynomial fitting method typically used for GRBs is generally only indicative of the background over relatively short timescales, this method is particularly useful in the cases of long GRBs or those that have autonomous repoint request (ARR) and a background with much variability on short timescales.
Aims. Modern space instruments, like *Fermi*, have some specific motion to survey the sky and catch gamma-ray bursts in the most effective way. However, GBM bursts sometimes have highly varying backgrounds (with or without ARR), and modelling them with a polynomial function of time is not efficient – one needs more complex, *Fermi*-specific methods. This article presents a new direction dependent background fitting method and shows how it can be used for filtering the lightcurves.
Methods. First, we investigate how the celestial position of the satellite may have influence on the background and define three underlying variables with physical meaning: celestial distance of the burst and the detector's orientation, the contribution of the Sun and the contribution of the Earth. Then, we use multi-dimensional general least square fitting and Akaike model selection criterion for the background fitting of the GBM lightcurves. Eight bursts are presented as examples, of which we computed the duration using background fitted cumulative lightcurves.
Results. We give a direction dependent background fitting (DDBF) method for separating the motion effects from the real data and calculate the duration (T_{90}, T_{50}, and confidence intervals) of the nine example bursts, from which two resulted an ARR. We also summarize the features of our method and compare it qualitatively with the official GBM Catalogue.

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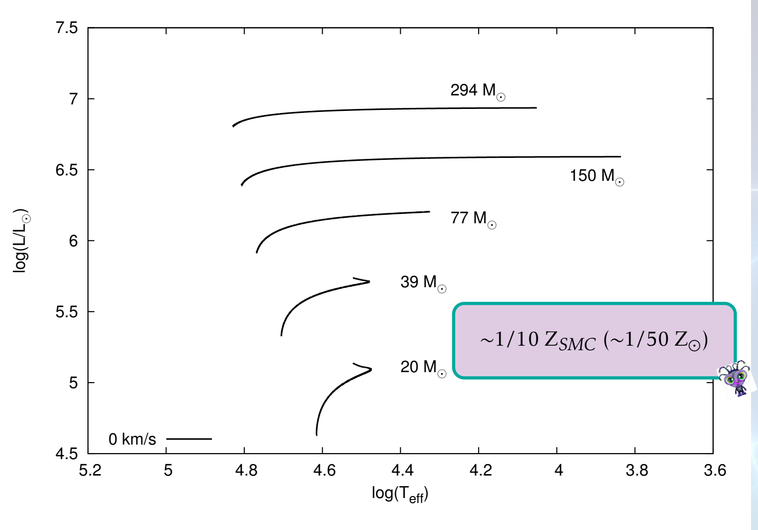
Motivations of PhD topic

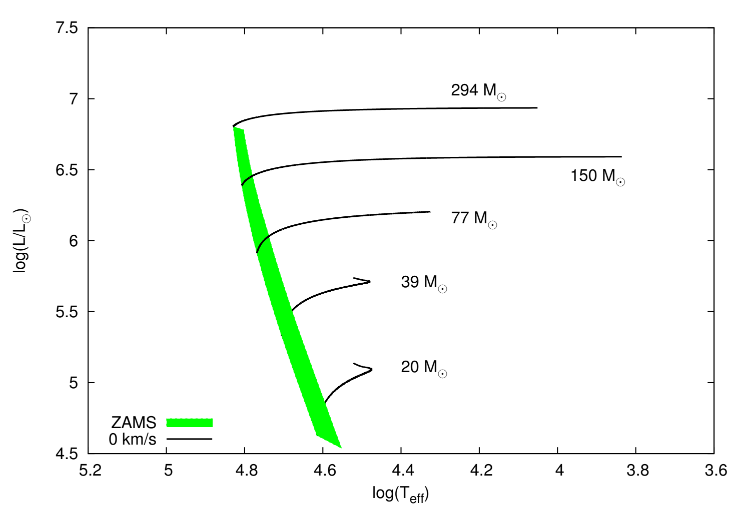
- **Massive Stars**
  - mixing & mass loss = ?
  - Milky Way, LMC, SMC [Brott et al. 2011]
- **Low metallicity**
  - massive stars evolve differently [Yoon et al. 2006]
  - $\rightarrow$ lGRBs, Pair Instability SNe
- **$Z = 0.1 \times Z_{SMC}$**
  - lowest Z to observe stars: **B**lue **C**ompact **D**warf galaxies
  - $\simeq Z_{GC}$ & high-z galaxies

Hertzsprung–Russell diagram



$\sim 1/10\ Z_{SMC}\ (\sim 1/50\ Z_\odot)$

Hertzsprung–Russell diagram



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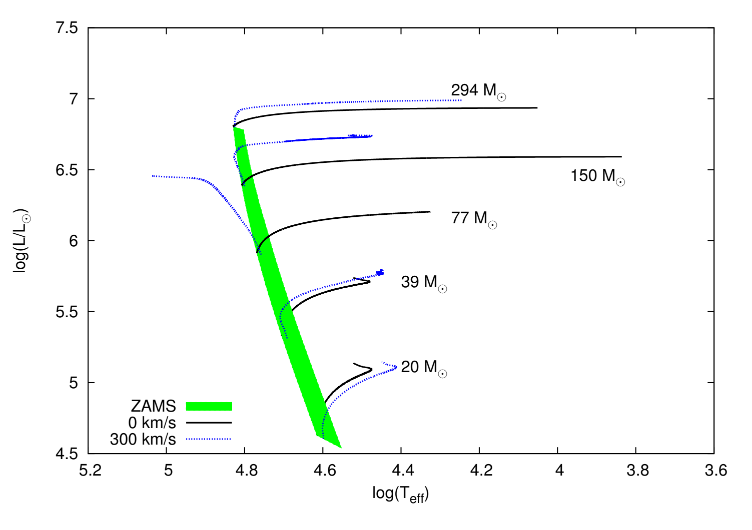

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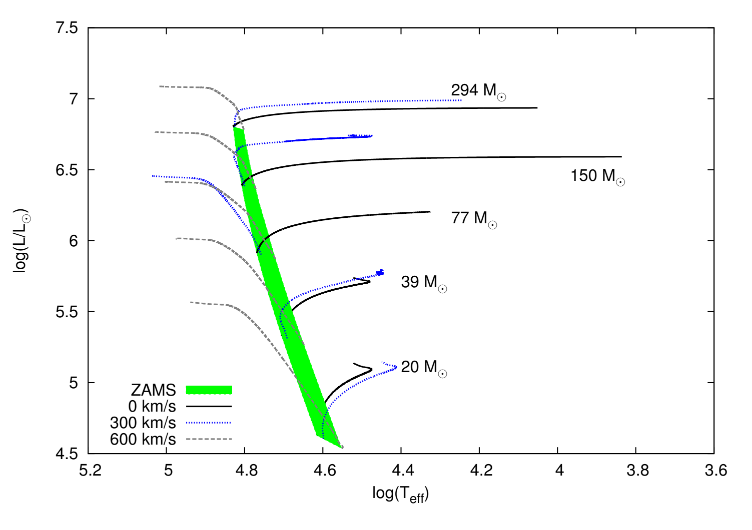

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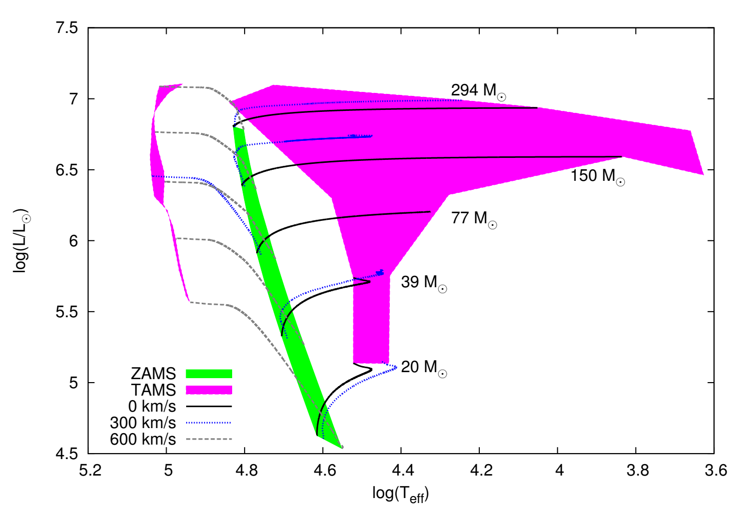

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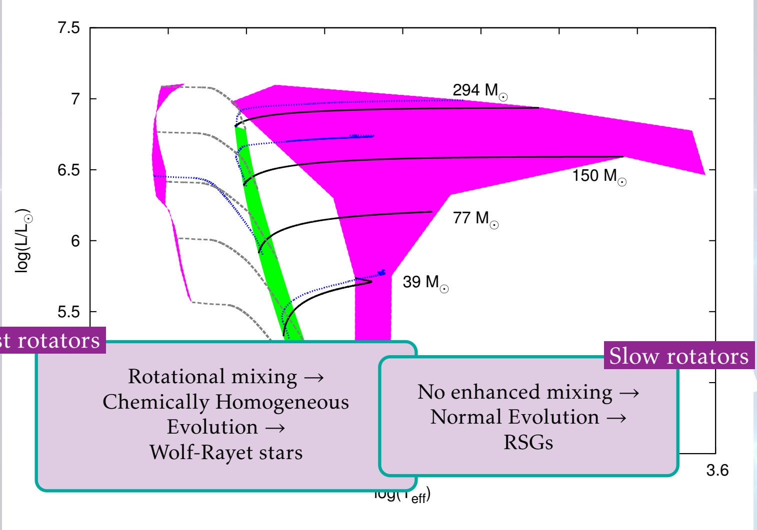


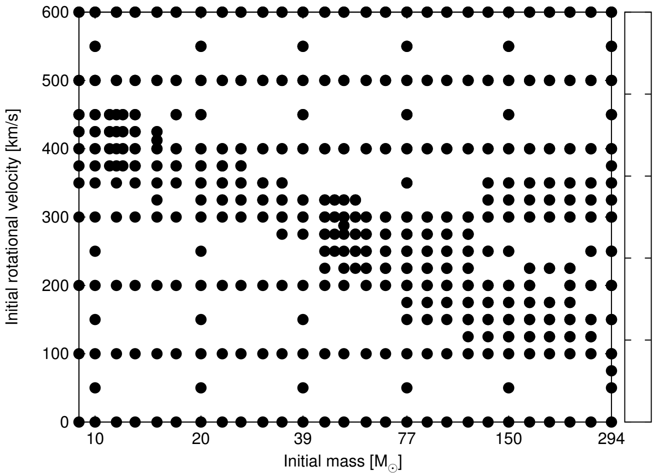
Fast rotators

Rotational mixing →
Chemically Homogeneous Evolution →
Wolf-Rayet stars

Slow rotators

No enhanced mixing →
Normal Evolution →
RSGs

The grid of stellar models



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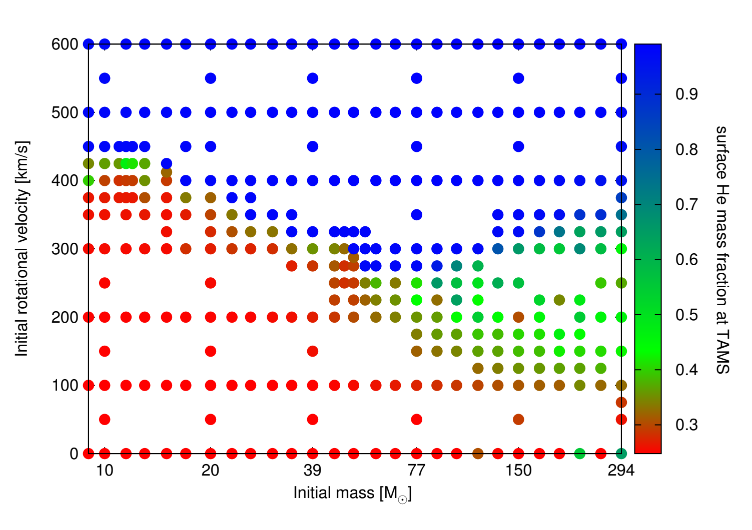

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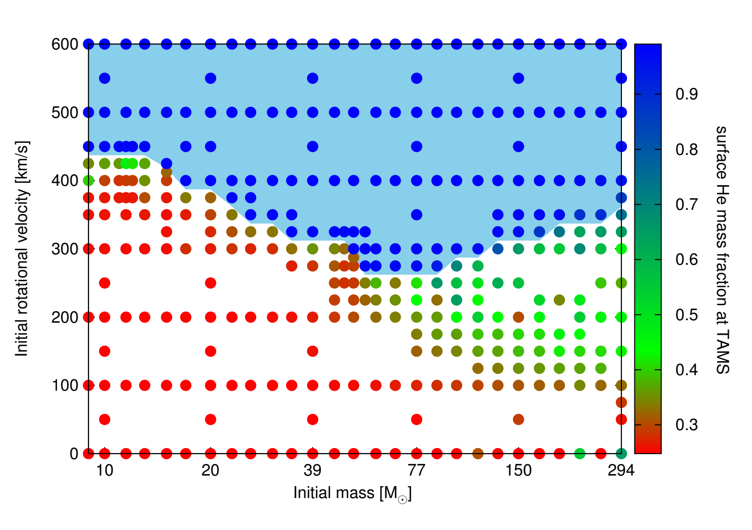

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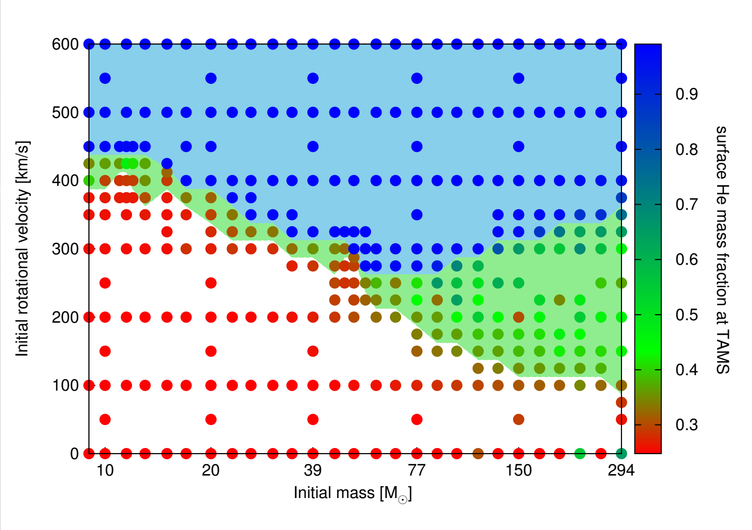

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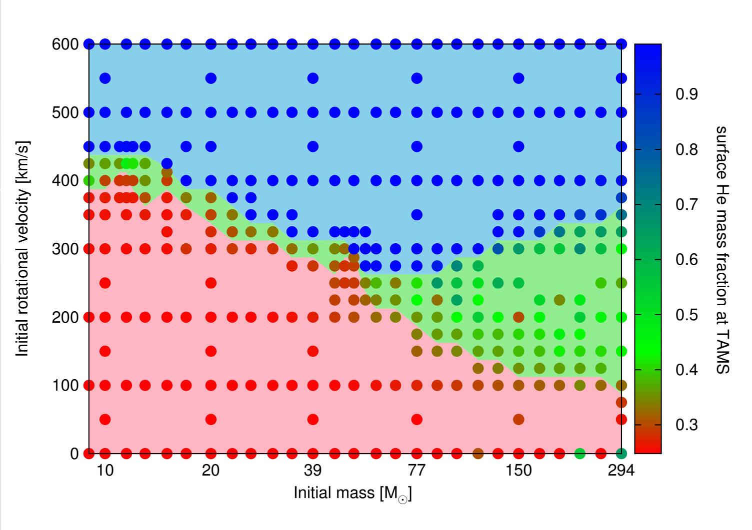

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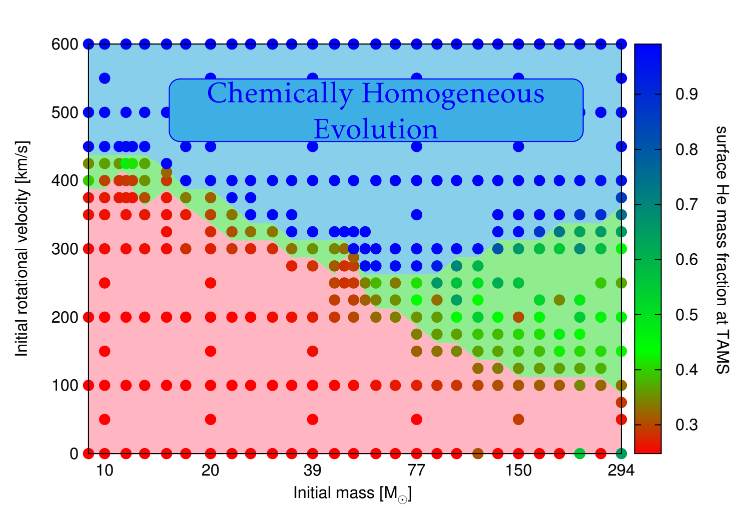
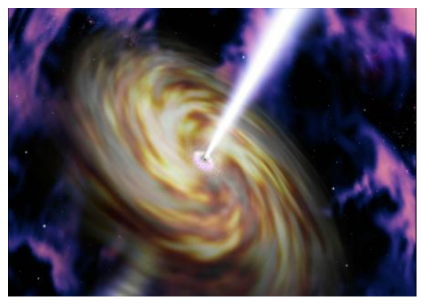
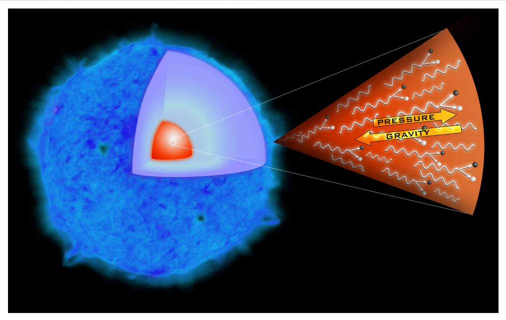


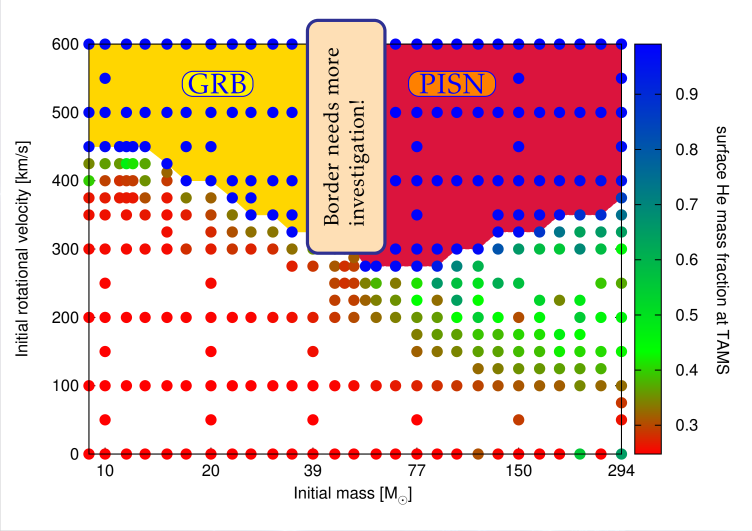
Angular momentum – long duration GRB



Pair instability supernova

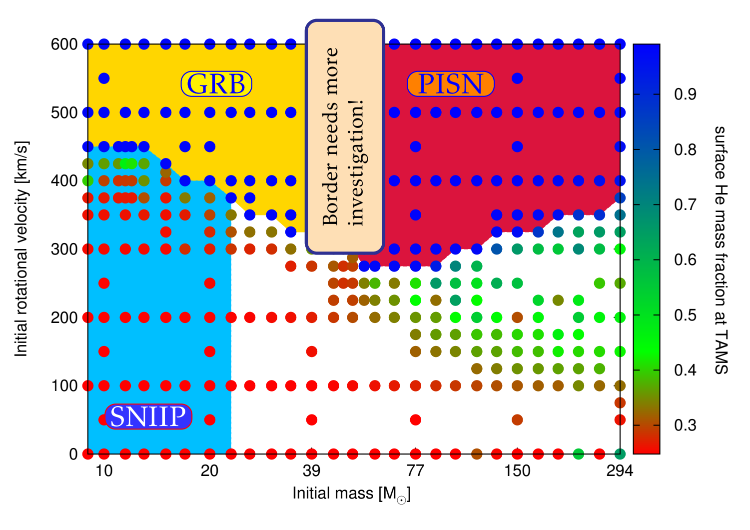


Final fates



GRB
PISN
Border needs more investigation!
Initial rotational velocity [km/s]
0
100
200
300
400
500
600
10
20
39
77
150
294
Initial mass [M$_\odot$]
surface He mass fraction at TAMS
0.3
0.4
0.5
0.6
0.7
0.8
0.9

Final fates



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SNIIP
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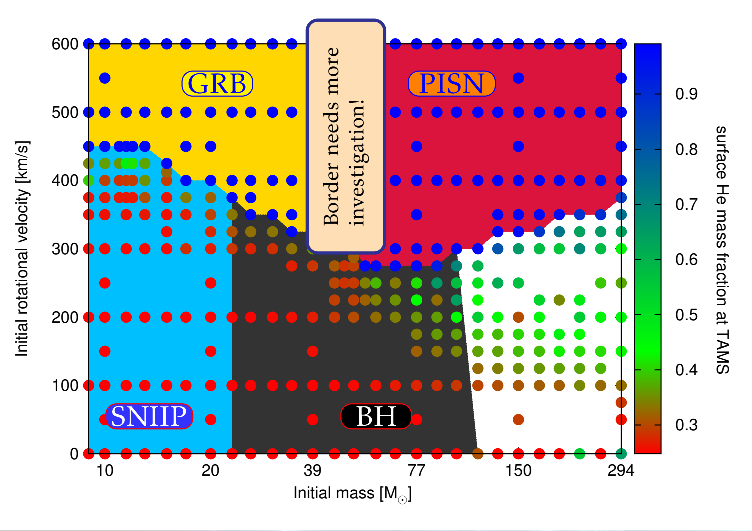
GRB
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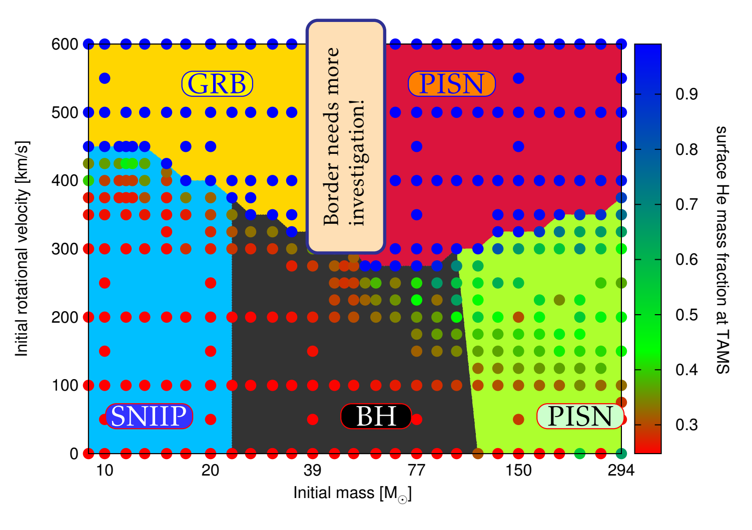
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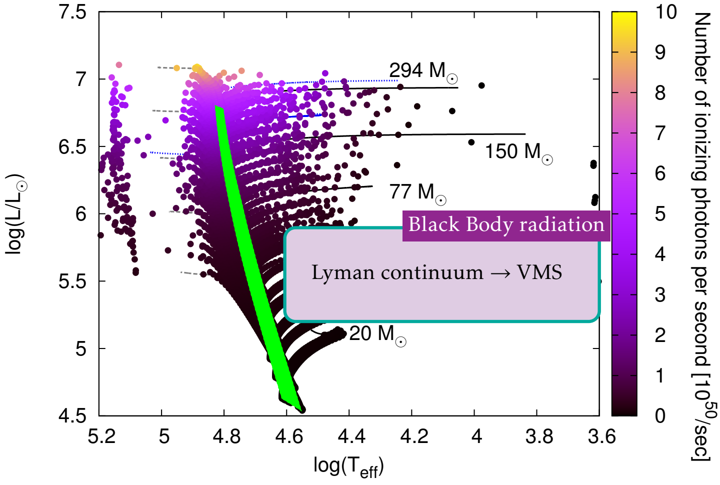
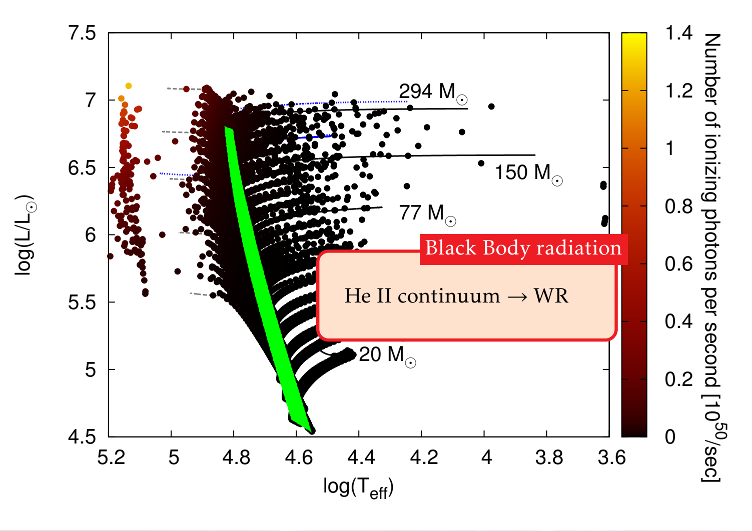
Photoionization fluxes



Black Body radiation

Lyman continuum → VMS

Photoionization fluxes



Black Body radiation

He II continuum → WR

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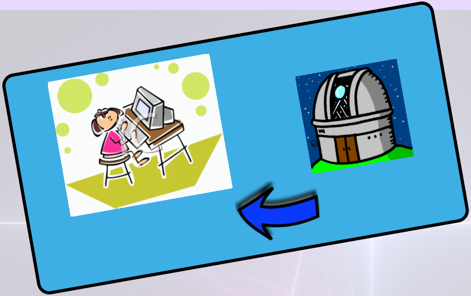

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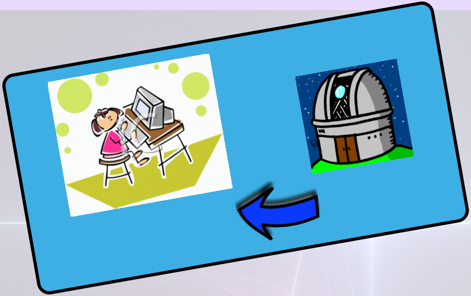

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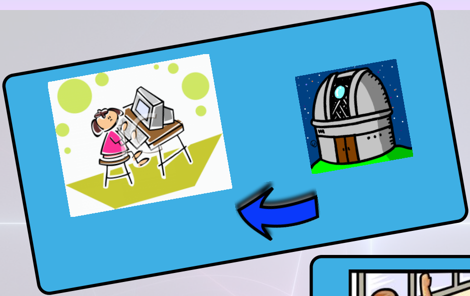

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