

Taken from:
The Progenitor Evolution Of Type Ia
Supernovae:
The theoretical uncertainties



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Collaborators:

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POPCORN

Inherent differences between BPS codes?

-Input physics?

-Numerical treatments?

Binary population synthesis

- Fits to single star models from detailed stellar evolution codes
- Modified to include effects of binary evolution
- Simulate 1 binary < 1 sec, 10^6 binaries in a few hours

⇒ Tool to study populations

⇒ To investigate uncertain physics, its importance and effects on populations

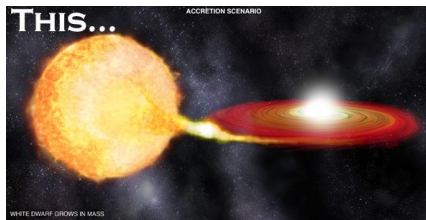
Binary population synthesis

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2 canonical scenario's for type Ia supernovae

Single Degenerate (SD)

Whelan & Iben 1973, Nomoto 1982



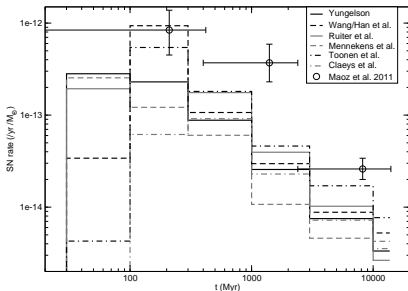
Double Degenerate (DD)

Webbink 1984, Iben & Tutukov 1984

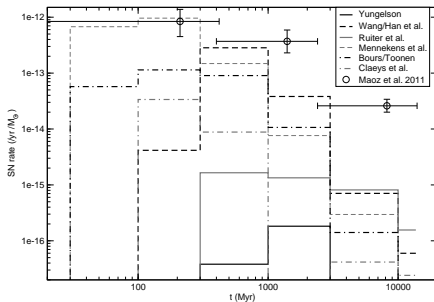


POPCORN (= Population synthesis of Compact Objects Research Network)

Double Degenerate (DD)



Single Degenerate (SD)



(NELEMANS ET AL. 2013)

Four binary population synthesis codes

- Binary_c: Izzard et al.(2004,2006,2009), Claeys et al. (subm.)
- Brussels code: Vanbeveren et al. (1998), Mennekens et al. (2010)
- SeBa: Portegies Zwart et al. (1996), Nelemans et al. (2001) and Toonen et al. (2012)
- StarTrack: Belzycynski et al. (2002,2008), Ruiter et al. (2009)

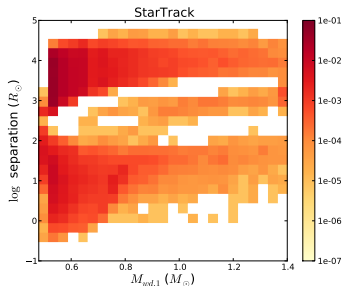
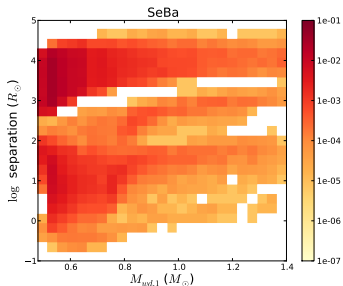
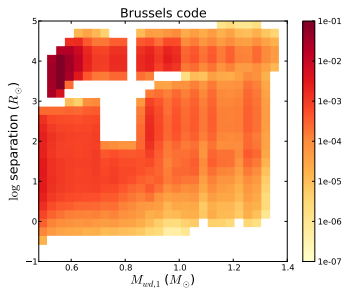
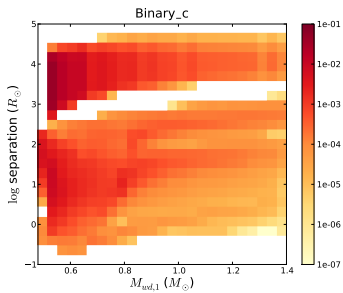
Most simple comparison

- Equalize the assumptions as far as possible, e.g.
 - Common envelope evolution
 - Initial distribution functions
 - Specifics of stable RLOF

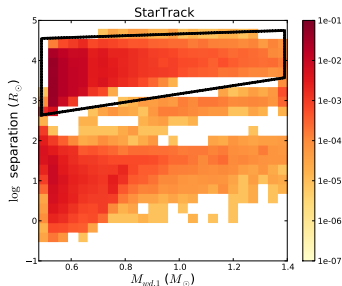
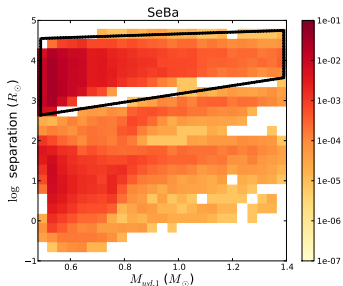
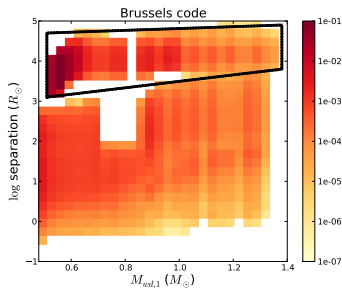
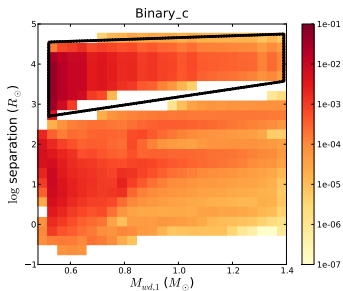
Stellar populations

- Single WD systems with non-degenerate companion
- Double WD systems

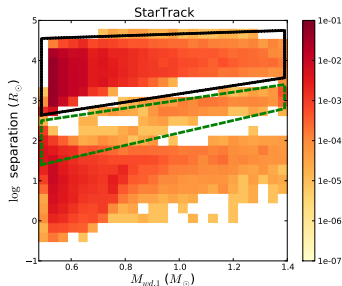
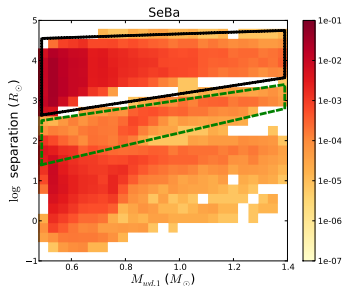
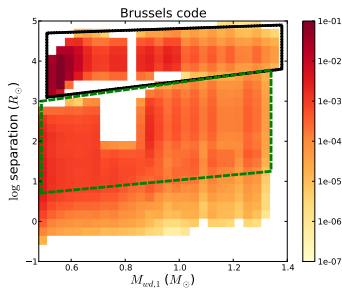
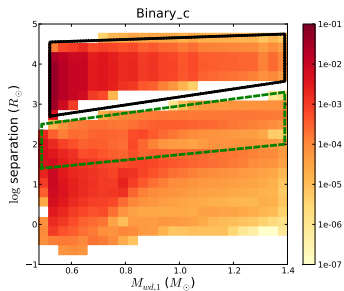
Single WD systems: $\log a$ vs. $M_{\text{WD},1}$



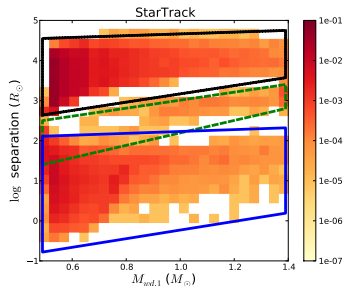
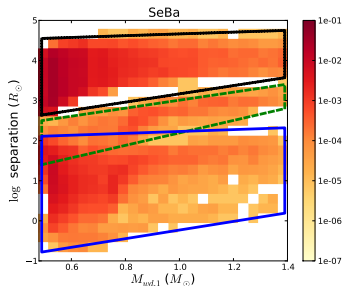
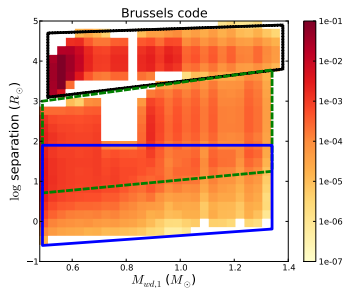
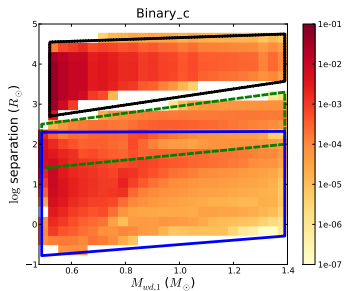
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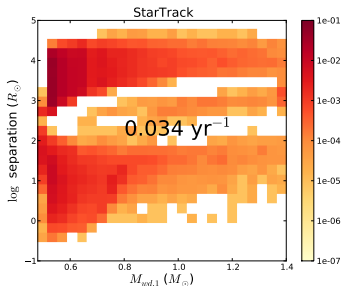
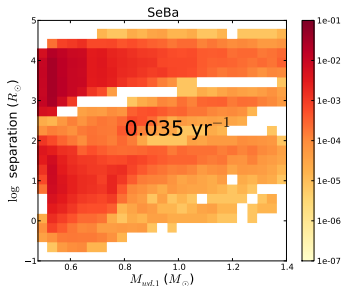
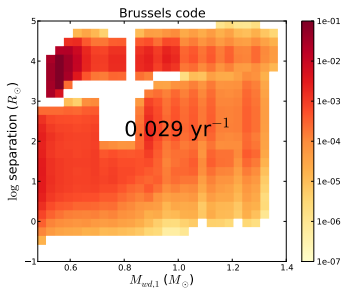
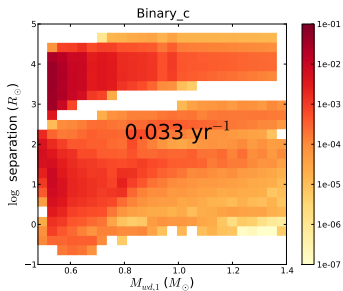
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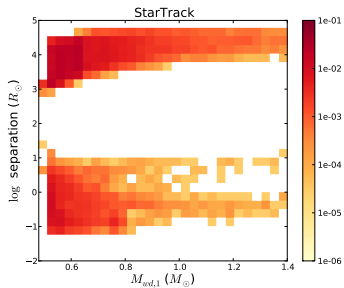
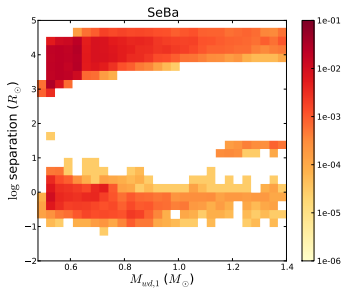
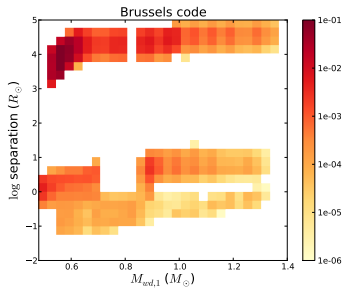
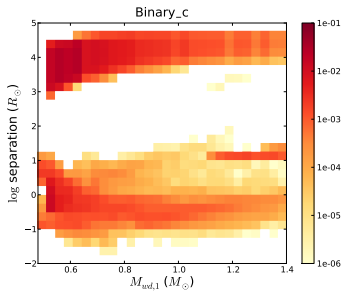
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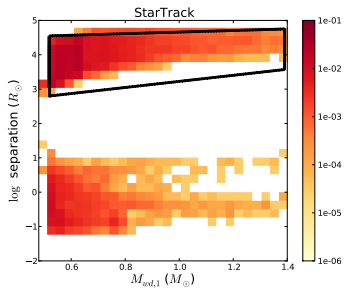
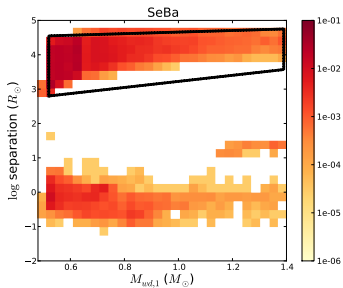
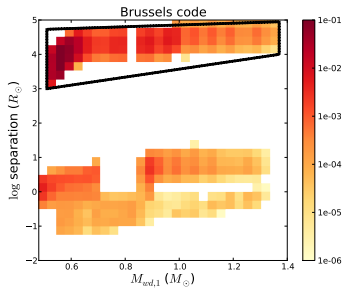
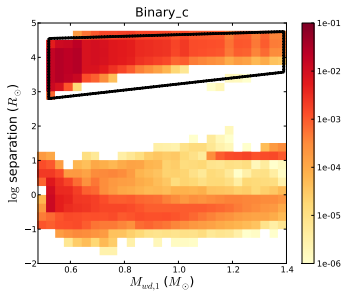
Birthrates (Constant star formation, 100% binaries, $M_{\text{WD}} > 0.48M_{\odot}$)



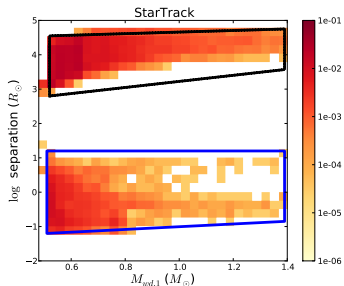
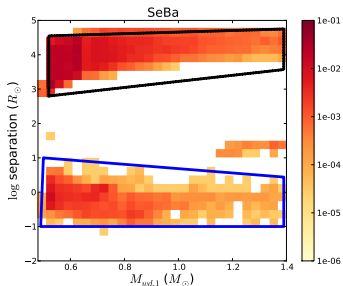
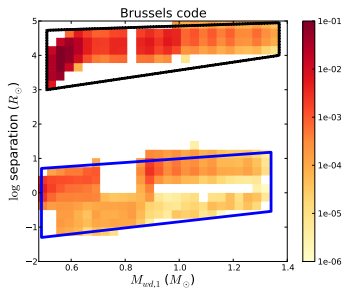
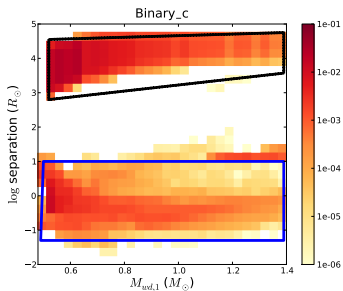
Double WD systems: $\log a$ vs. $M_{\text{WD},1}$



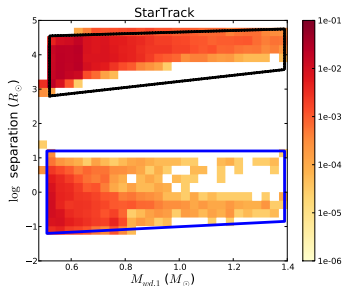
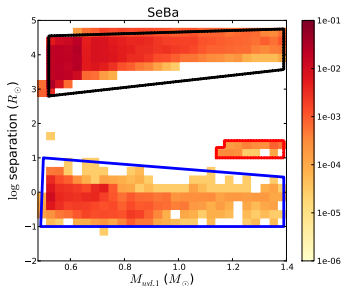
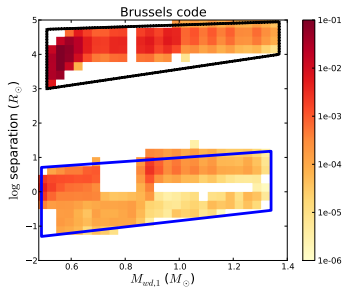
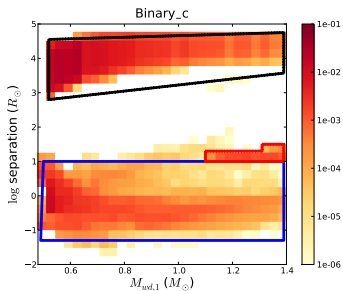
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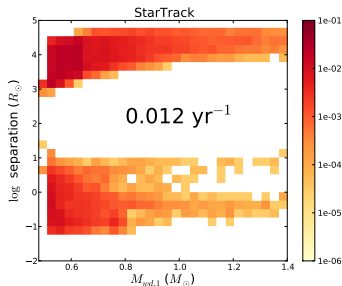
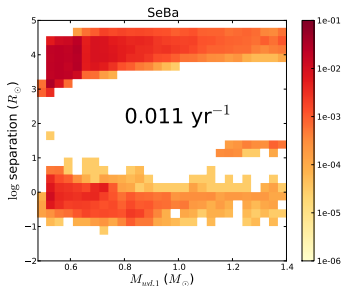
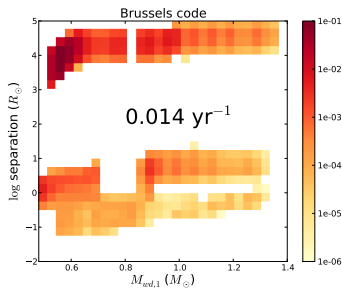
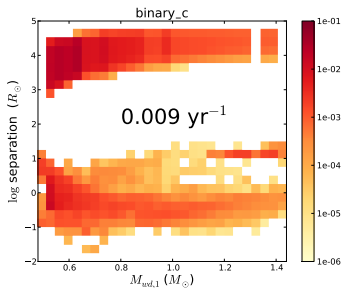
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Double WD systems: $\log a$ vs. $M_{\text{WD},1}$



Birthrates (Constant star formation, 100% binaries, $M_{\text{WD},1} > 0.48M_{\odot}$)



- Similarities:

- Same evolution paths found at similar regions in mass and separation
- Similar birthrates of single and double WD systems

- Differences:

→ Due to variations in the input physics

- Initial-final mass relation
- Stability of mass transfer
- Survival of mass transfer
- Helium star evolution

Toonen, Claeys, Mennekens, Ruiters 2014, A&A, 562A, 14T

Conclusion

- POPCORN:
 - Same evolution paths found at similar regions in mass and separation
 - Small differences: due to variations in the input physics

Thank you!