BPASS predictions of Galactic LISA sources compared to other stellar evolution codes

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Two papers

- P. Tang, J. J. Eldridge, R. Meyer, A. Lamberts, G. Boileau and **W. G. J. van Zeist**, "Predicting gravitational wave signals from BPASS white dwarf binary and black hole binary populations of a Milky Way-like galaxy model for LISA," 2024, *MNRAS*, *534*(3), pp. 1707-1728, DOI: 10.1093/mnras/stae2154
- **W. G. J. van Zeist**, G. Nelemans, S. F. Portegies Zwart and J. J. Eldridge, "Evaluating the gravitational wave detectability of globular clusters and the Magellanic Clouds for LISA," 2024, *accepted by A&A*, arXiv:2409.09159

Stellar evolution codes

- BPASS (Binary Population and Spectral Synthesis) is a stellar evolution/population synthesis code.
- Specifically, it is a code suite that simulates the evolution of a population of binary and single-star systems from a wide range of initial conditions.
- It is a detailed population synthesis code, as opposed to a rapid one (like SeBa, BSE, COMPAS).
- Detailed codes simulate stellar structure in detail during the evolution, at the cost of greater computational time per system which means fewer choices of initial parameters can be explored.

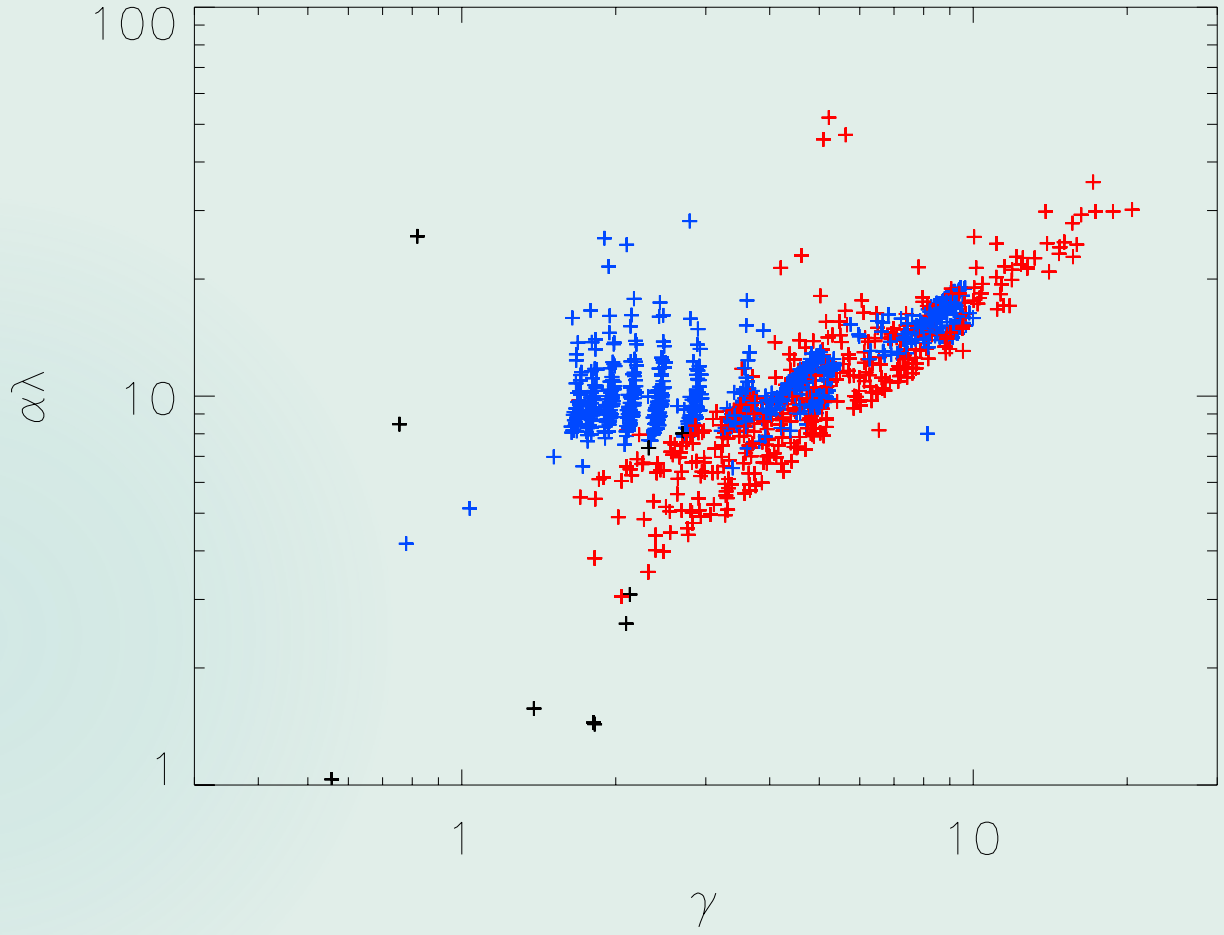
Predictions of LISA-detectable WD binaries

- Tang+ (2024) compared a BPASS galaxy model to a BSE galaxy model, comparing their predictions of LISA-detectable WD binaries in the MW disk.
- van Zeist+ (2024) compared BPASS predictions for LISA-detectable WD binaries in globular clusters to predictions that used SeBa and BSE.
- Both studies found that BPASS predicts 20 to 40 times fewer LISA-detectable WD binaries than SeBa/BSE. However, the *total* number of WDBs is similar across the codes. The difference is in their period/frequency distribution.

Mass transfer and CEEs

- Though the total number of WD binaries is similar, BPASS has fewer high-frequency/short-period WDBs than SeBa/BSE.
- We found that this mainly results from differences in the treatment of the stability of mass transfer and the modelling of common-envelope events (CEEs).
- In BPASS, mass transfer is more likely to be stable than in SeBa/BSE, meaning fewer CEEs occur.
- CEEs themselves are also modelled differently in BPASS, not via an α or γ-prescription, but with the stellar structure modelled in detail. The CEE in BPASS tends to be more efficient than in SeBa/BSE, meaning less angular momentum is lost and the orbits after CEE tend to be wider.

Effective CEE parameters in BPASS



SeBa uses $\alpha\lambda = 2$ and $\gamma = 1.75$.

Figure: van Zeist+ (2024)

Current work: comparing to EM observations

- These are just comparisons between models, but is there a way to verify these models by comparing to real observations, so that we can see which is closer to reality?
- There are no GW observations of WD binaries yet, but there does exist a (relatively small) sample of Galactic DWDs that have been observed in EM.
- Currently, I am working on a study in which I take the WDB predictions of a BPASS galaxy model and a SeBa galaxy model, and compare these to the EM-observed sample.

Summary

- Tang+ (2024) compared BPASS and BSE models for the MW disk. van Zeist+ (2024) compared BPASS and SeBa/BSE models for the Magellanic Clouds and GCs.
- Both studies found that BPASS predicts 20 to 40 times fewer LISA-detectable WD binaries than the other codes. This is caused by mass transfer being more stable in BPASS, and CEEs more efficient.
- Currently, I am working to see which of these models is closer to reality by comparing them to samples of WD binaries that have been observed in EM.