Gravitational wave spectral synthesis

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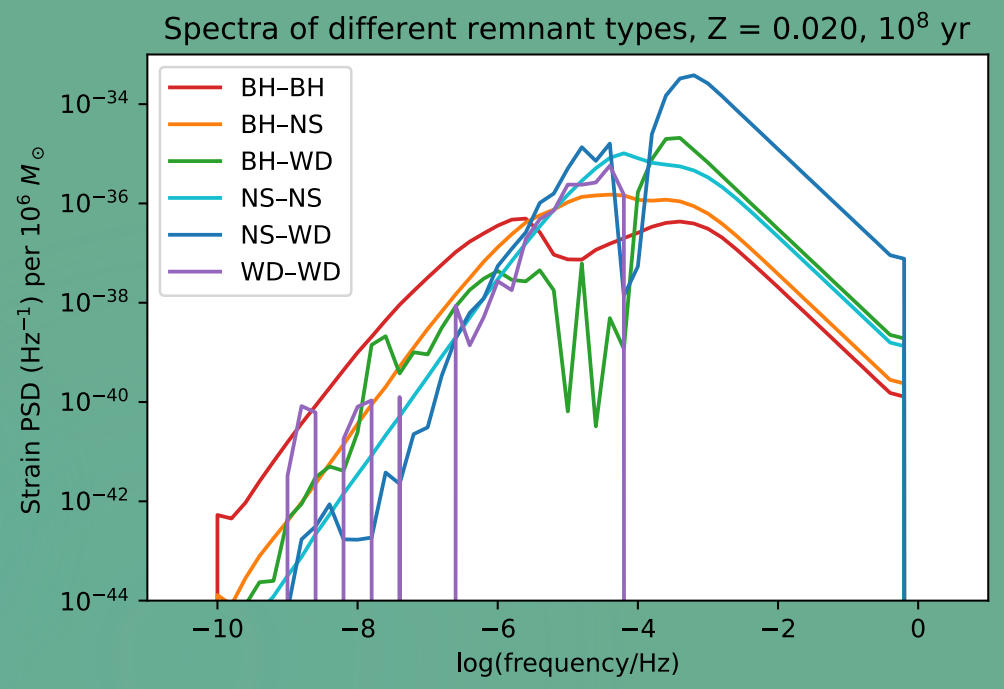
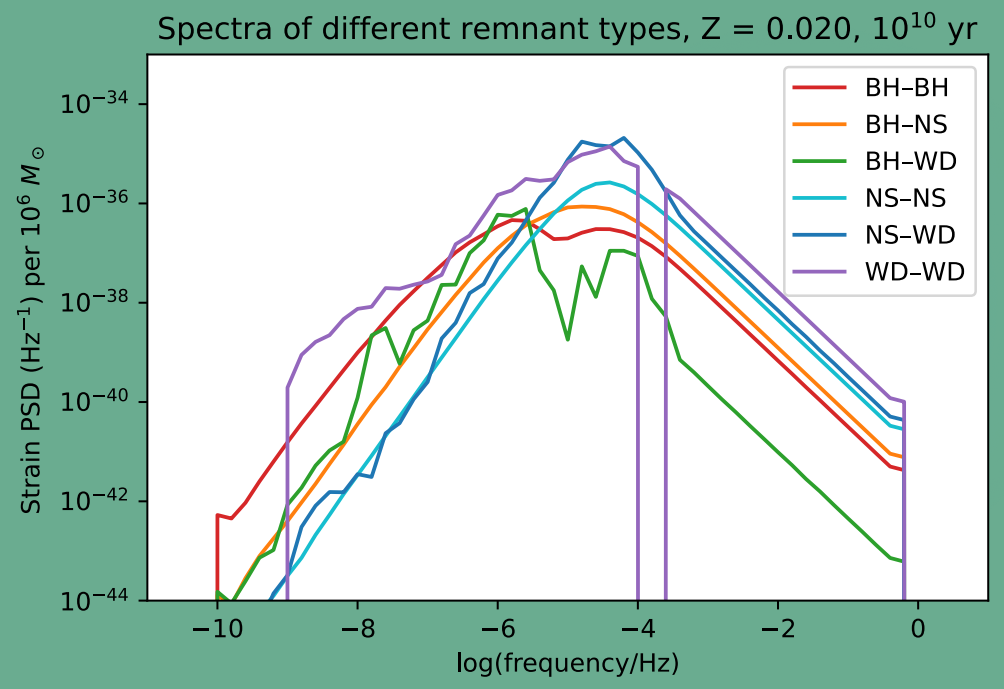
- Simulating the cumulative GW spectrum of all the different binary sources in a stellar population.
- Notably, this includes all types of compact remnants, as well as living stars.
- This gives insights when it is not possible to resolve individual sources.
- Analogous to EM spectral synthesis already performed by BPASS.

BPASS

- Binary Population and Spectral Synthesis
- https://bpass.auckland.ac.nz
- Code suite which simulates the evolution of a population of binary and single-star systems from a wide range of initial conditions.
- We use v2.2.1, with GW population synthesis code Tui.
- Our simulations are for a stellar population formed in a single starburst with an initial population of 10^6 $M_\odot$, at a distance of 1 kpc (globular cluster-like).

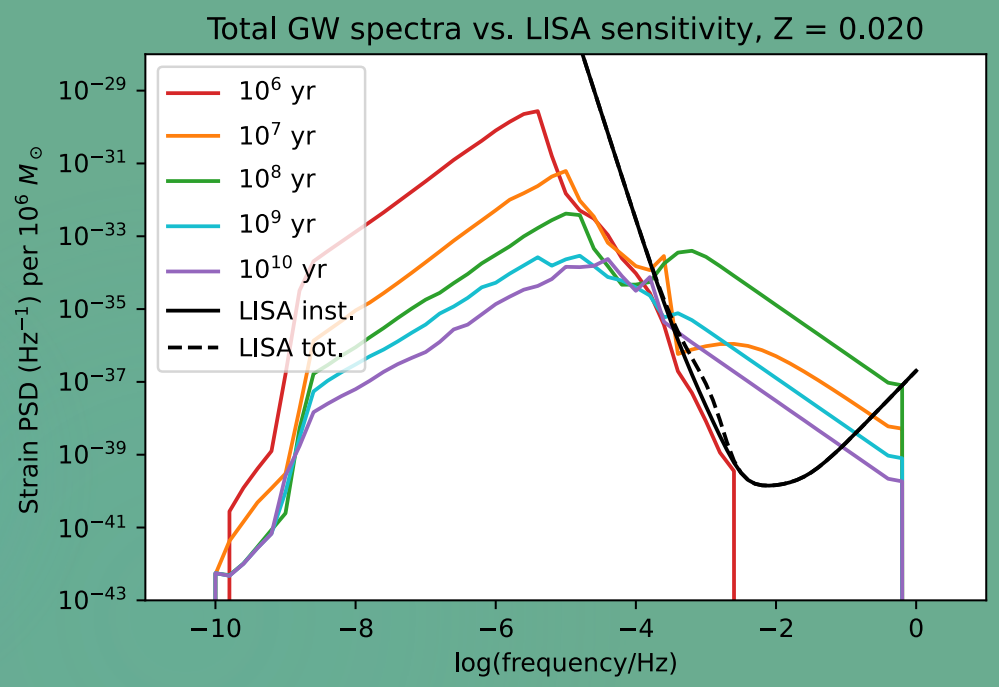
Spectra of different remnant types

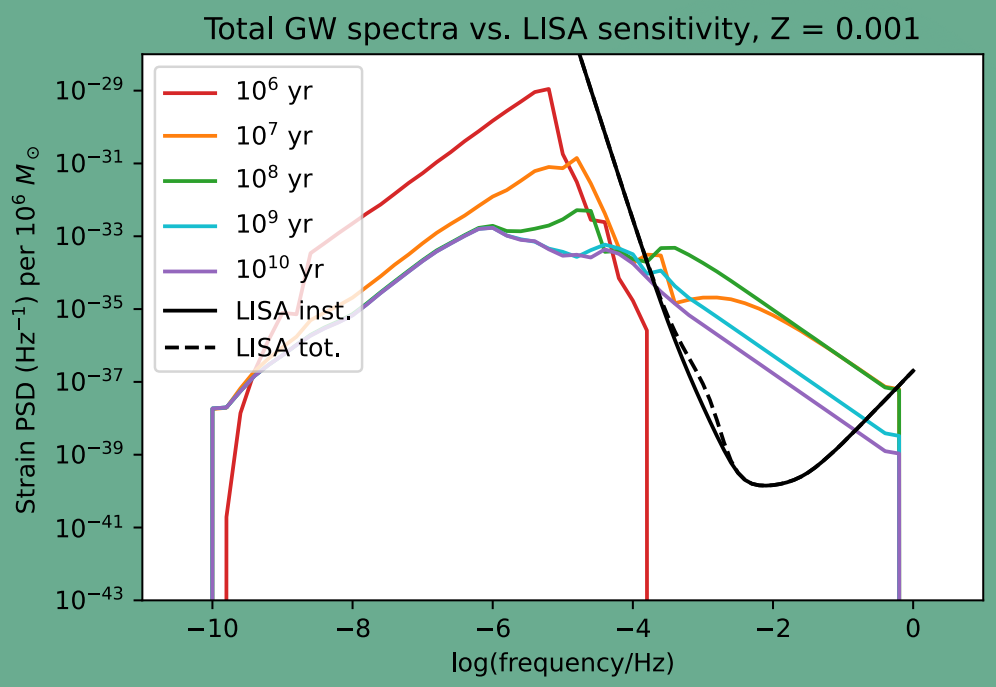




NS–WD highest at 10^8 years, followed by BH–WD. No WD–WD in LISA frequency range yet.
WD–WD highest at 10^{10} years, followed by NS–WD.

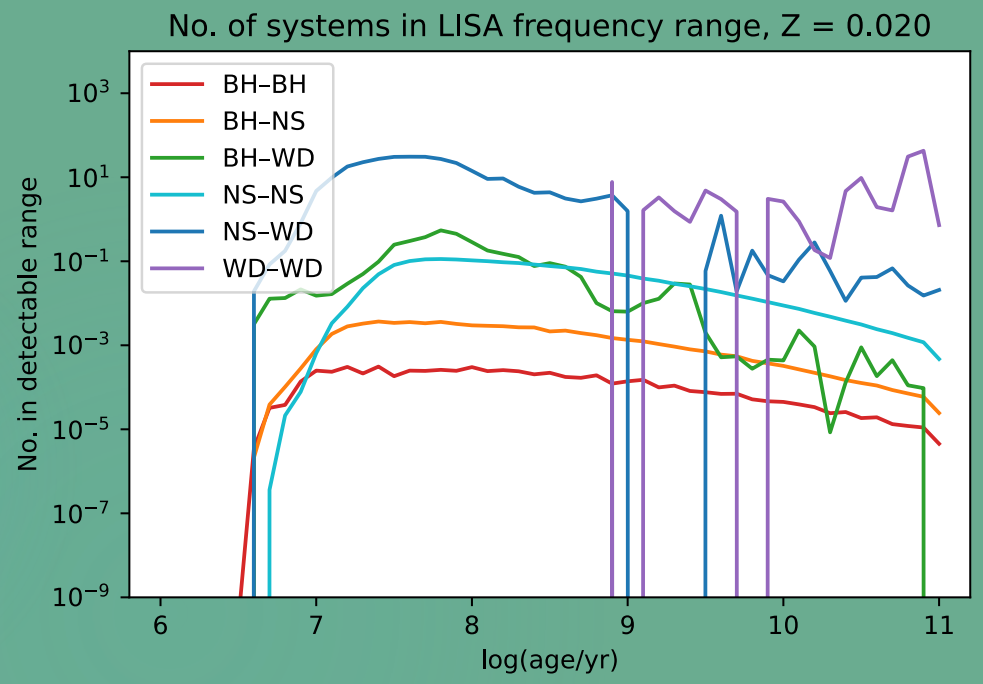
Total spectrum compared to LISA sensitivity

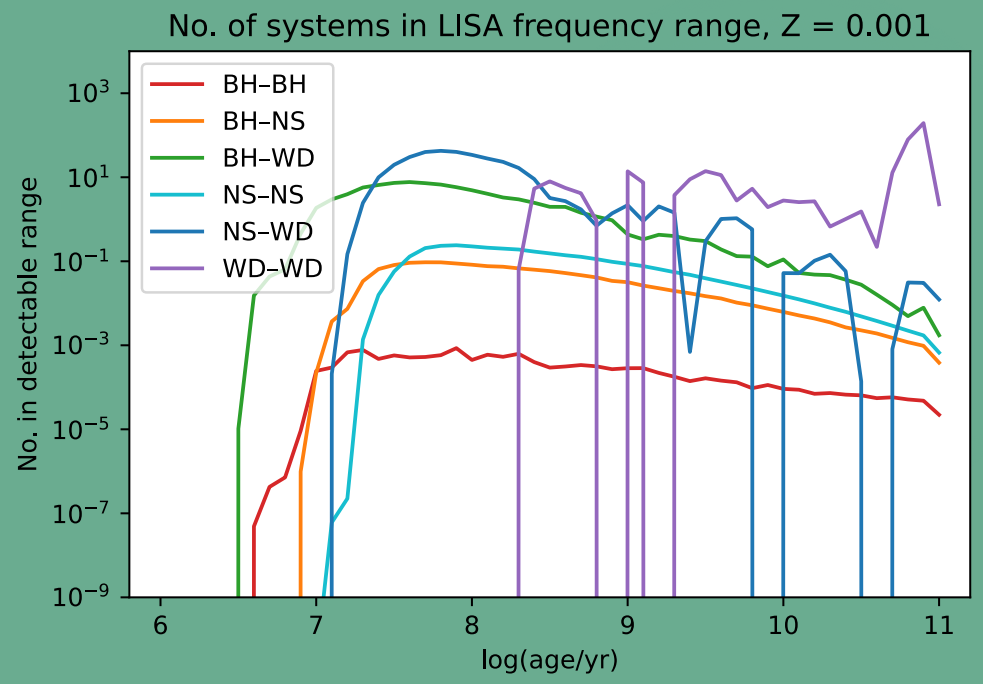




GW spectrum is above LISA noise for frequencies above $10^{3.8}$ Hz for both metallicities.
Living stars have the highest strain power, but at frequencies too low for LISA (but not μAres).
Shape of spectrum similar for Z = 0.020 and Z = 0.001, with small differences.

Number of systems in LISA frequency range





NS–WD most numerous remnant binary type until 10^9 years, after which it is WD–WD.
Overall, more systems for Z = 0.001 than for Z = 0.020, except for the earliest timebins.
BH–WD relatively more numerous at Z = 0.001.

Caveats

- For 10^6 $M_\odot$ population at 1 kpc, typically only O(10) sources within LISA band, so spectrum would not be smooth but composed of distinct peaks (for LMC-sized population, spectrum may be smooth).
- NS–WD and BH–WD rates influenced by implementation of mass transfer in latest version of BPASS (stable mass transfer, super-Eddington accretion, see Briel+ 2022).
- Binary population includes only isolated binaries, not dynamical evolution (as in globular clusters).
- BPASS does not include certain physical effects, such as magnetic wind braking which would affect WD–WD rate.