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Measuring Individual Masses of Binary White Dwarfs with Space-based Gravitational-wave Interferometers

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Unlike gravitational waves from merging black holes and neutron stars that chirp significantly over the observational period of ground-based detectors, gravitational waves from binary white dwarfs are almost monochromatic. This makes it extremely challenging to measure their individual masses. Here, we take a novel approach of using finite-size effects and applying certain universal relations to measure individual masses of binary white dwarfs using LISA. We found quasi-universal relations among the mass, moment of inertia, and tidal deformability of a white dwarf that do not depend sensitively on the white dwarf composition. These relations allow us to rewrite the moments of inertia and tidal deformabilities in the waveform in terms of the masses. We then carried out a Fisher analysis to estimate how accurately one can measure the individual masses from the chirp mass and finite-size measurements. We found that the individual white dwarf masses can be measured with LISA for a 4-year observation if the initial frequency is high enough (~0.02Hz) and either the binary separation is small (~1kpc) or the masses are relatively large (m⊠0.8M⊠). This opens a new possibility of measuring individual masses of binary white dwarfs with space-based interferometers.

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