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Love and EMRIs in SPA

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The capture of stellar-mass compact objects by a supermassive black hole is one of the most exciting sources detectable by future space-borne interferometers like LISA. The parameters of these extreme-mass-ratio inspirals (EMRIs) binaries are expected to be inferred with excellent accuracy, allowing for unprecedented tests on the nature of their components. Measuring the tidal Love number of the central object, which encoded its response to tidal deformabilites, could distinguish black holes from exotic compact objects. Unlike black holes, a horizonless compact object might have a tiny but not vanishing tidal deformability due to quantum-gravity corrections at the horizon scale.

In this talk, I will present the results of a Fisher-matrix error analysis of the tidal Love number of the supermassive black hole in an EMRI binary for circular, equatorial orbits. In the extreme-mass ratio limit, the tidal deformability of the central object enters at leading order in the mass-ratio expansion of the gravitational wave phase. We used kludge waveforms at adiabatic order, including the effects of the tidal deformability of the supermassive body and the spin of the smaller companion. Using the Stationary Phase Approximation (SPA), we also developed a new method to compute Fisher matrices in the extreme-mass ratio limit in a fast and accurate way.

Our analysis shows that the error on the tidal Love number for a supermassive black hole with reduced spin $a = 0.9 (a = 0.99)$ is $\sim 10^{-2} (10^{-3})$. These bounds are roughly 5 to 6 orders of magnitude more stringent than current ones on neutron stars. Thus, an EMRI detection by LISA could potentially probe putative quantum corrections down to the Fermi or even Planck scale.

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