The impact of realistic models of mass segregation on the event rate of extreme-mass ratio inspirals and cusp re-growth

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One of the most interesting sources of gravitational waves (GWs) for LISA is the inspiral of compact objects on to a massive black hole (MBH), commonly referred to as an "extreme-mass ratio inspiral" (EMRI). The small object, typically a stellar black hole (bh), emits significant amounts of GW along each orbit in the detector bandwidth. The slowly, adiabatic inspiral of these sources will allow us to map space-time around MBHs in detail, as well as to test our current conception of gravitation in the strong regime. The event rate of this kind of source has been addressed many times in the literature and the numbers reported fluctuate by orders of magnitude. On the other hand, recent observations of the Galactic center revealed a dearth of giant stars inside the inner parsec relative to the numbers theoretically expected for a fully relaxed stellar cusp. The possibility of unrelaxed nuclei (or, equivalently, with no or only a very shallow cusp) adds substantial uncertainty to the estimates. Having this timely question in mind, we run a significant number of direct-summation $N-$body simulations with up to half a million particles to calibrate a much faster orbit-averaged Fokker-Planck code. We then investigate the regime of strong mass segregation (SMS) for models with two different stellar mass components. We show that, under quite generic initial conditions, the time required for the growth of a relaxed, mass segregated stellar cusp is shorter than a Hubble time for MBHs with $M_\bullet \lesssim 5 \times 10^6 M_\odot$ (i.e. nuclei in the range of LISA). SMS has a significant impact boosting the EMRI rates by a factor of ~ 10 for our fiducial models of Milky Way type galactic nuclei.

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