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Spin misalignment of black hole binaries from young star clusters: implications for the origin of GWTC-2 events

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The recent analysis of gravitational wave data by the Ligo-Virgo collaboration (arXiv:2010.14533) provides evidence of merging binary black holes with non-zero spins.
Spinning binary BHs with aligned spins can result from the tidal spin-up of a Wolf-Rayet binary that survived the common envelope phase. However, tidal spin-up results in spins aligned with the orbital angular momentum, a scenario that is strongly disfavoured by the observations.
We show that post-common envelope binaries in star clusters are likely to undergo a single dynamical encounter with other black holes before merging via gravitational waves. This dynamical interaction can tilt the binary orbital plane, leading to spin-orbit misalignment.
We have investigated the spin properties of merging binary black holes undergoing this pathway in young star clusters, by means of up-to-date binary population synthesis and accurate few-body simulations.
Adopting conservative limits on the binary-single encounter rates, we obtain a local BH merger rate density of 6.6 yr^-1 Gpc^-3.
Assuming low (<0.2) natal BH spins, this scenario can reproduce the distributions of effective spin Xeff and precession parameters Xp inferred from GWTC-2, including the negative values of Xeff and the peak at Xp ~ 0.2.

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