W40a On the spin distribution of merging binary black holes from star clusters

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The astrophysical origin of merging black hole binaries is still a mystery. Two main pathways are usually advocated: isolated binaries merging in the field, and dynamically interacting binaries formed in star clusters. The coarse localization of gravitational wave events cannot indicate the environment in which the binary formed, but discerning among these two scenarios can be possible via the progenitor binary parameters that are observable via gravitational wave interferometry, namely masses, eccentricity, and spin. However, present models of the aforementioned formation pathways do not indicate an appreciable difference in the mass distributions, and eccentricity is unlikely to be inferred with current ground-based detectors. On the other hand, the magnitude and orientation of black hole spins is a promising indicator of the formation history of merging binaries. Black hole binaries from isolated binaries will likely have spins aligned with the orbit due to tidal spin-up, while binaries ejected from star cluster will have some degrees of misalignment. We quantify the projected spin distributions of black hole binaries ejected from globular and open cluster by combining population synthesis and gravitational few-body simulations. The projected spin distribution of binaries ejected via strong three-body encounters correlates non-trivially with the eccentricity and ejection velocity distributions. Using such information, we can link the estimated black hole spin to the formation pathway, thus leading to a more detailed picture of their environments and origins.