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Black Hole Accretion and Spin-up through Stellar Collisions in Dense Star Clusters

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Despite the rising number of binary black hole (BH) mergers detected as gravitational wave (GW) sources by LIGO/Virgo, the evolutionary origin of these events remains a mystery. A growing body of evidence suggests that many of these events originated in dense stellar environments like globular clusters (GCs). Dense environments can produce qualitatively different properties of binary BH mergers compared to systems that merge in isolation, allowing us to disentangle the origins of GW sources. In this talk, I will present insights from N-body simulations of dense star clusters, emphasizing the frequency of collisions between BHs and massive stars. These interactions can lead to significant accretion of material tidally ripped away from stars, which can then spin up and/or grow the BHs significantly while also producing potentially observable transients. This would provide an alternative to stable mass transfer in binaries as a way of spinning up stellar BHs, assuming that they are born spinning slowly (as now considered very likely), with important implications for the interpretation of GW signals from merging BH binaries. Depending on the GC's properties, we find that as many as 50% of all binary BH mergers feature at least one BH component that was spun up through stellar collisions. Although mass accretion efficiency is highly uncertain, collisions with young massive stars may conceivably lead to highly spinning BHs which could be a key observable signature distinguishing them as dynamically-driven BH mergers. These findings hold particular significance as the upcoming observing run O4 for the LIGO-Virgo/Kagra collaboration promises to offer unprecedented constraints on the distribution of BH masses and spins in the coming years.

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