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The role of massive star binarity in the creation of upper mass-gap and intermediate-mass black holes in dense star clusters

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Isolated evolution of massive stars is expected to leave a "gap" in the mass spectrum of black holes (BHs) at birth between ~40-120 Msun due to (pulsational) pair-instability supernovae ((P)PISN). Recent detections of gravitational waves (GWs) from mergers of BHs with pre-merger source-frame individual masses in this so-called upper mass-gap, have created immense interest in a detailed understanding of their astrophysical formation environments and pathway(s). It has been previously shown that inside dense star clusters, mass-gap BHs and even intermediate-mass BHs (IMBHs) may form via dynamical channels- through repeated mergers of BHs or through BHs formed from massive stars with unusual core to envelope mass ratios formed via past collisions. Using a controlled set of detailed star-by-star multi-physics simulations, we investigate the role of massive-star binarity, defined as the fraction of massive (> 15 Msun) stars present in the star cluster existing in binary systems as opposed to singles, in the formation of massive BHs. For this purpose, we simulate star clusters with identical individual stellar population, but with a varying fraction of massive stars in binaries. We find that the number of massive BHs as well as the mass of the most massive BH that form via stellar collapse of stellar collision products are sensitive to the massive-star binarity of the star cluster. However, BH-BH mergers dominate the production of massive BHs over the cluster's lifetime. The massive BHs formed via BH-BH mergers are independent of the massive-star binarity. However, the demographics of the population of BH-BH mergers is again sensitive to the massive-star binarity. I will present our key results from this study.

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