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Seeds to success: growing heavy black holes in dense star clusters

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Dense stellar clusters provide ideal conditions for the formation of intermediate-mass black holes (IMBHs), i.e. heavy black holes with masses between 100 and 100,000 solar masses. These objects may arise from (i) runaway stellar collisions in light and compact clusters, or (ii) hierarchical binary black hole (BBH) mergers within massive and dense clusters. Assessing the efficiency of both processes remain computationally challenging for N-body / Monte Carlo codes either due to (i) the sheer number of models required to define statistically robust results or (ii) to the huge number of stars composing the cluster.
Semi-analytic population synthesis codes offer an efficient and new alternative to exploring IMBH formation in such environments. In this talk, I will present results from simulations of over 10 million BHs in young, globular, and nuclear clusters at various metallicities performed using the semi-analytic code B-POP. I will identify which cluster conditions favor IMBH formation, discuss how formation timescales relate to the IMBH host properties, and examine possible overlaps with IMBH observations at both low and high redshifts. Finally, I will overview potential implications of IMBH formation in our Galaxy and possible gravitational wave (GW) signatures of their production in massive clusters.

Primary author: PAIELLA, Lavinia (GSSI)

Presenter: PAIELLA, Lavinia (GSSI)

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