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Dynamical formation of Gaia BH1 in a young star cluster

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Gaia BH1, the first quiescent black hole detected using data from the Gaia mission presents a challenge to existing binary evolution models due to its unusual characteristics, such as a mass ratio of approximately 0.1 and an orbital period that does not align with typical post-common envelope or non-interacting binary systems.
To investigate its formation, we explore the hypothesis that Gaia BH1 originated from dynamical interactions within a young star cluster (YSC). We use direct *N*-body simulations coupled with binary population synthesis, considering YSCs with initial masses ranging from 300 to 3 × 10^4 solar masses at Solar metallicity.
We find that BH-MS systems that form via dynamical exchanges populate the region corresponding to the main orbital properties of Gaia BH1 (period, eccentricity, and masses). In contrast, none of our isolated binary systems matches the orbital period and MS mass of *Gaia* BH1. Our best matching *Gaia* BH1–like system forms via repeated dynamical exchanges and collisions involving the BH progenitor star, before it undergoes core collapse. YSCs are at least two orders of magnitude
more efficient in forming *Gaia* BH1–like systems than isolated binaries

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