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Dynamical evolution of primordial black hole clusters with lognormal mass distribution

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Black holes formed in the early Universe (primordial black holes, PBHs) may simultaneously explain several astrophysical anomalies. These include, for example, the existence of supermassive black holes in the young Universe ($z > 6$, Mazzucchelli C. et al., (2017, ApJ)) and black holes with masses of $\sim 30M_{\odot}$ detected by gravitational-wave observatories (Mazzucchelli C. et al., (2017, ApJ)) that fall into the “forbidden” mass gap for remnants of stellar collapse Mazzucchelli C. et al., (2017, ApJ). PBHs may also contribute a fraction of the dark matter (DM), although for solar mass range it is already constrained by $\leq 10\%$ Mazzucchelli C. et al., (2017, ApJ).

In the basic scenario, it is assumed that PBHs are spatially uncorrelated. However, if PBHs are derived from large non-Gaussian tails of density contrast, they can be spatially clustered at birth (Animali et al., (2024, JCAP)). There are other models that lead to clustering such as the modified Affleck-Dine mechanism (Animali et al., (2024, JCAP)). The clustering of PBHs would change the merger history of PBHs, therefore it is important to study such systems.

We present a numerical study of dynamical evolution of isolated primordial black hole clusters. We use mass distribution of PBHs derived from LIGO-Virgo-Kagra data fit (Dolgov et al., (2020, JCAP); Dolgov et al., (2020, JCAP)). The evolution of clusters was computed using the direct N-body code **NBODY6++GPU** and takes into account orbit-averaged gravitational wave emission. We explore how the parameters of such clusters affect the merger rate and masses of merging binaries.

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