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The Poisson clustering of primordial black holes and implications for whether they provide the dark matter in the asteroidal or solar mass range

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If most of the dark matter comprises primordial black holes (PBHs), then numerous constraints imply that they must be in either the asteroidal or solar mass range. Although the first possibility arises naturally if the PBHs formed at the QCD transition, it is sometimes claimed that this possibility is excluded by microlensing surveys and the frequency of gravitational-wave events. However, one would expect PBHs to form dark clusters due to the Poisson fluctuations in their initial distribution, these clusters surviving until the present epoch in some circumstances, and this could invalidate such claims. More generally, PBH-induced Poisson fluctuations lead to the formation of virialised bound clusters with PBH halos much earlier than in the standard CDM picture. Such clusters would be disrupted by various dynamical processes (eg. by being subsumed within larger clusters) but they would be expected to survive and reside within the Milky Way for some range of cluster parameters. However, they would be destroyed at sufficiently small Galactocentric distances due to tidal disruption or collisions and some fraction of their mass would be lost even at large Galactocentric distances. This leads to both a smooth and clustered population of PBHs, with important implications for microlensing and gravitational-wave observations. The undisrupted clusters could also be identified with the observed Ultra Faint Dwarf Galaxies, since these have a mass and radius compatible with the PBH scenario.

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