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Dark Bondi Accretion Aided by Baryons and the Origin of JWST Little Red Dots

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The gravothermal core collapse of self-interacting dark matter halos provides a compelling mechanism for seeding supermassive black holes in the early Universe. In this scenario, a small fraction of a halo, approximately 1% of its mass, collapses into a dense core, which could further evolve into a black hole. We demonstrate that this process can account for the origin of JWST little red dots (LRDs) observed at redshifts $z \sim 4$–11, where black holes with masses of $10^7\,\mathrm{M}_\odot$ can form within $500\,\mathrm{Myr}$ after the formation of host halos with masses of $10^9\,\mathrm{M}_\odot$. Even if the initial collapse region triggering general-relativistic instability has a mass on the order of one solar mass, the resulting seed can grow into an intermediate-mass black hole via Eddington accretion of baryonic gas. Subsequently, it can continue to grow into a supermassive black hole through dark Bondi accretion of dark matter particles. In this scenario, the majority of the black hole's mass originates from dark matter accretion rather than baryonic matter, naturally explaining the overmassive feature of LRDs.

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