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Simulations of the Birth and Early Growth of Supermassive Black Holes

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Our work uses cosmological simulations to study the formation and early growth of direct collapse black holes. In the pre-reionization epoch, molecular hydrogen (H_2) causes gas to fragment and form Population III stars, but Lyman-Werner radiation can suppress H_2 formation and allow gas to collapse directly into a massive black hole. The critical flux required to inhibit H_2 formation, J_{crit}, is hotly debated, largely due to the uncertainties in the source radiation spectrum, H_2 self-shielding, and collisional dissociation rates. Here, we test the power of the direct collapse model in a non-uniform Lyman-Werner radiation field, using an updated version of the SPH+N-body tree code Gasoline with H_2 non-equilibrium abundance tracking, H_2cooling, and a modern SPH implementation. We vary J_{crit} from 30 to 10^4 J_{21} to study the effect on seed black holes, focusing on black hole formation as a function of environment, halo mass, metallicity, and proximity of the Lyman-Werner source. We discuss the constraints on massive black hole occupation fraction in the quasar epoch, and implications for gravitational wave astronomy.