

Title: Effect of Population III Multiplicity on Dark Star Formation

Abstract: We numerically study the mutual interaction between dark matter (DM) and Population III (Pop III) stellar systems in order to explore the possibility of Pop III dark stars within this physical scenario. We perform a cosmological simulation, initialized at $z \sim 100$, which follows the evolution of gas and DM. We analyze the formation of the first minihalo at $z \sim 20$ and the subsequent collapse of the gas to densities of 10^{12} cm^{-3} . We then use this simulation to initialize a set of smaller-scale 'cut-out' simulations in which we further refine the DM to have spatial resolution similar to that of the gas. We test multiple DM density profiles, and we employ the sink particle method to represent the accreting star-forming region. We find that, for a range of DM configurations, the motion of the Pop III star-disk system serves to separate the positions of the protostars with respect to the DM density peak, such that there is insufficient DM to influence the formation and evolution of the protostars for more than ~ 5000 years. In addition, the star-disk system causes gravitational scattering of the central DM to lower densities, further decreasing the influence of DM over time. Any DM-powered phase of Pop III stars will thus be very short-lived for the typical multiple system, and DM will not serve to significantly prolong the life of Pop III stars.