

## Abstract

The first stars to form in the Universe may be powered by the annihilation of weakly interacting dark matter particles. These so-called dark stars, if observed, may give us a clue about the nature of dark matter. Here we examine which models for particle dark matter satisfy the conditions for the formation of dark stars. We find that in general models with thermal dark matter lead to the formation of dark stars, with few notable exceptions: heavy neutralinos in the presence of coannihilations, annihilations that are resonant at dark matter freeze-out but not in dark stars, some models of neutrinophilic dark matter annihilating into neutrinos only and lighter than about 50 GeV. In particular, we find that a thermal DM candidate in standard Cosmology always forms a dark star as long as its mass is heavier than about 50 GeV and the thermal average of its annihilation cross section is the same at the decoupling temperature and during the dark star formation, as for instance in the case of an annihilation cross section with a non-vanishing s-wave contribution.