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# Neutrino point source searches for dark matter spikes

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Any dark matter spikes surrounding black holes in our Galaxy are sites of significant dark matter annihilation, leading to a potentially detectable neutrino signal. In this paper we examine $10 - 10^5 M_\odot$ black holes associated with dark matter spikes that formed in early minihalos and still exist in our Milky Way Galaxy today, in light of neutrino data from the ANTARES and IceCube detectors. In various regions of the sky, we determine the minimum distance away from the solar system that a dark matter spike must be in order to have not been detected as a neutrino point source for a variety of representative dark matter annihilation channels. Given these constraints on the distribution of dark matter spikes in the Galaxy, we place significant limits on the formation of the first generation of stars in early minihalos—stronger than previous limits from gamma-ray searches in Fermi Gamma-Ray Space Telescope data. The larger black holes considered in this paper may arise as the remnants of Dark Stars after the dark matter fuel is exhausted; thus neutrino observations may be used to constrain the properties of Dark Stars. The limits are particularly strong for heavier WIMPs. For WIMP masses $\sim 5\,\text{TeV}$, we show that $< 10\%$ of minihalos can host first stars that collapse into BHs larger than $10^3 M_\odot$.

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