Contribution ID: **25** Type: **not specified**

Thermal Dark Matter and Primordial Black Holes

Saturday 30 April 2022 16:15 (15 minutes)

It is quite conceivable that cosmology may give rise to appreciable populations of both particle dark matter and primordial black holes (PBH) with the combined mass density providing the observationally inferred value $\Omega_{\rm DM} \approx 0.26$. However, previous studies have highlighted that scenarios with both particle dark matter and PBH are strongly excluded γ-ray limits assuming particle dark matter with a velocity independent thermal cross section $\langle \sigma v \rangle \sim 3 \times 10^{-26} {\rm cm}^3/{\rm s}$, as is the case for classic WIMP dark matter. Here we extend these existing studies on s-wave annihilating particle dark matter to ascertain the limits from diffuse γ-rays on velocity dependent annihilations which are p-wave with $\langle \sigma v \rangle \propto v^2$ or d-wave with $\langle \sigma v \rangle \propto v^4$. Furthermore, we highlight that even if the freeze-out process is p-wave it is relatively common for (loop/phase-space) suppressed s-wave processes to actually provide the leading contributions to the experimentally constrained γ-ray flux from the PBH halo.

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Session Classification: Evening Session