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Dark matter spikes with strongly self-interacting particles

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An unavoidable prediction of scenarios with Dark Matter (DM) self-interactions is the existence of number changing processes that convert n initial DM particles into m final ones ($n \to m$ processes), possibly accompanied by Standard Model particles. We argue that the $n \to m$ processes could be probed in DM spikes at the center of galaxies, where the high density may allow sizable rates. We systematically study the implications of the $n \to m$ processes in DM spikes, including other possible interactions involving DM, such as annihilation and self-scattering. We find that for $n \geq 3$, the spike is significantly depleted for $n \to m$ cross-sections favored by DM production via thermal freeze-out. On the other hand, the semi-annihilation of two DM particles into one DM particle and one Standard Model particle preserves in general the structure of the spike. Such density modifications significantly affect phenomenological studies of both astrophysics and particle DM processes around DM spikes.

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