Dark Matter accretion on Neutron Stars

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Due to their extreme density and low temperature, neutron stars (NS) are efficient probes to unveil interactions between standard model and dark matter (DM) particles. From elastic scatterings on NS material, DM can get gravitationally trapped by the star. The cooling of DM through further collisions may lead to the formation of a dense core which could collapse into a black hole, thus destroying the whole NS. From the observation of old NS, such a scenario leads to very stringent constraints on the parameter space of asymmetric DM. In this work we reexamine this possibility in detail. This includes: (a) a new detailed determination of the number of DM particles captured, properly taking into account the fact that neutrons form a highly degenerate Fermi material; (b) the determination of the time evolution of the DM density and energy profiles inside the NS, which allows us to understand how, as a function of time, DM thermalizes with NS material; (c) the determination of the corresponding constraints which hold on the DM-neutron cross section, including for the case where a large fraction of DM particles have not thermalized; (d) the first determination of the stringent constraints which also hold in a similar way on the DM-muon cross section, particularly relevant for leptophilic DM models; and (e) the use of realistic NS equations of state in determining these constraints.