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Model-independent constraints on the QCD axion from supernovae

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The QCD axion solves the strong CP problem and is one of the most searched for DM candidates. As of today, astrophysical observations, such as neutron star cooling and energy loss from supernovae, place the strongest bounds.
This bound generally depends on the specific QCD axion model under consideration. However, it also depends on couplings that are model-independent and still present when all the model-dependent couplings are tuned away, as in the case of the so-called astrophobic axion.
In my talk, I will show the dominant axion production mechanism in a SN considering only model-independent couplings. This will lead to a orders of magnitude stricter bound than in current literature, where the operator responsible for the dominant model independent contribution has been neglected so far. Additionally, I will explore the full non-trivial momentum dependence of the axion-nucleon coupling in zero- and finite-density environments. This dependence is induced by one-loop corrections to the coupling that can be systematically calculated within the framework of chiral perturbation theory, both at zero density and in thermal field theory.

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