Contribution ID: **23** Type: **not specified**

Superradiant interactions of cosmic relics

In this talk, I will describe three things. First, I will outline the conditions under which the interaction rate of inelastic processes that change the internal state of a system of N targets scales N^2. This is an effect distinct from coherent elastic scattering, but with the same scaling. These inelastic processes are a generalization of Dicke superradiance for light, and we thus refer to them as superradiant interactions. Second, I will present example rates for such processes for various weakly interacting particles, namely, the cosmic neutrino background, axion and dark photon dark matter, as well as reactor, solar and bomb neutrinos. The rates we find can be quite sizable on macroscopic yet small targets. For example, the CνB interacts with a rate of O(0.1 Hz) when scattering off a 10 cm liquid or solid-state density spin-polarized sphere, a 21 order of magnitude enhancement compared to the incoherent inelastic contribution. Finally, I will discuss how superradiant interactions manifest as a source of noise on a system, which points to potential quantum observables for these processes that go beyond traditional energy exchange.

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