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Table-top experiments

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We propose a high statistics experiment to search for invisible decay modes in nuclear gamma cascades. A radioactive source (such as ^{60}Co or ^{24}Na) that triggers gamma cascades is placed in the middle of a large, hermetically sealed scintillation detector, enabling photon identification with high accuracy. Invisible modes are identified by establishing the absence of a photon in a well-identified gamma cascade. We propose the use of fast scintillators with nanosecond timing resolution, permitting event rates as high as 10^7 Hz. Our analysis of the feasibility of this setup indicates that branching fractions as small as 10^{-14}-10^{-12} can be probed. This experimental protocol benefits from the fact that a search for invisible modes is penalized for weak coupling only in the production of the new particle. If successfully implemented, this experiment is an exquisite probe of particles with mass below approximately 4 MeV that lie in the poorly constrained supernova "trapping window"that exists between 100 keV and 30 MeV. Such particles have been invoked as mediators between dark matter and nucleons, explain the proton radius and (g-2)μ anomalies, and potentially power the shock wave in Type II supernovae. The hadronic axion could also be probed with modifications to the proposed setup.

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