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Toward sensitivity of radiopure NaI(Tl) to solar and reactor neutrinos and the possibility of neutrinos and ultra-light dark matter particles detection in the nano-explosive regime

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Only the hypotheses of direct energy depositions by particles as an explanation for seasonal background modulation observed by the DAMA-LIBRA collaboration were experimentally investigated in 20 years of history of this dark matter detection controversy. Alternatively, much lower energy nuclear recoils can trigger releases of energy stored in the material. The demonstration of optical control on energy accumulation and release processes in NaI(Tl) points to the feasibility of this alternative mechanism- the release of self-trapped electrons by low-energy nuclear recoils with subsequent recombination and luminescence. Importantly, these recoils cannot produce luminescence without stored energy/trapped electrons. Our experiments, Ice Cube, and other results indicate that long-living trapped electron states in NaI(Tl) can be selectively produced by exposure to UV light and to atmospheric muons. We discuss underlying condensed matter effects and suggest experiments required for testing the feasibility of nano-explosive detection of low-energy nuclear recoils in NaI(Tl).

By not taking into account the possibility of triggered releases of energy stored in NaI(Tl) we exclude from consideration interactions with ultra-light dark matter particles. This illustrates that model-independent search for dark matter particles requires exact, deterministic models of energy pass-ways in materials; using Bayesian techniques and making indirect and not pronounced assumptions about material properties can lead to biased analysis results and systematic errors.

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