Contribution ID: **133** Type: **Talk**

Searching for dark matter near and under the noise and backgrounds

Thursday 27 March 2025 09:30 (15 minutes)

The characteristic energy of a relic dark matter interaction with a detector scales strongly with the putative dark matter mass. Consequently, experimental search sensitivity at the lightest masses will always come from interactions whose size is similar to noise fluctuations and low energy backgrounds in the detector. In this talk, we will tackle this problem under two essential scenarios, the case when the potential signal rate is much lower than the effective bandwidth of the detector, and the case when the rate is higher.

In the low-rate scenario, individual signal events can be resolved and one needs to correctly calculate the net change in measured differential rate, accounting for both periods of time when the signal is coincident with noise/backgrounds and for the decreased amount of time in which only noise/backgrounds occur. We also show that introducing random events in the continuous raw data stream (a form of "salting") provides a correct and practical implementation.

In the high-rate scenario, signal rate can be constrained with the shot noise power in a triggerless analysis. Particularly, in athermal phonon detectors, the DC noise power is limited by the thermal noise; correlated phonon shot noise, or equivalently the second moment of the baseline noise, can be limited by the cross spectrum density (CSD) with rejection to uncorrelated backgrounds; and finally the third moment of baseline noise gives more sensitivity to high energy signals.

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Session Classification: SESSION 15: Direct detection: Technical Development-2 & Scientific Development