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Optimizing TES detection systems for extremely low background dark matter searches

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Transition Edge Sensors (TES) are superconducting microcalorimeters that can be used for single-photon detection at extremely low backgrounds. When they are within their superconducting transition region ($\sim$ 140 mK for the TES in this work) small temperature fluctuations - like the energy deposited by single photons - lead to large variations in resistance. These variations can be measured using Superconducting Quantum Interference Devices (SQUIDs). This exciting technology will be used as a single-photon detector for the upcoming ALPS II experiment, a light-shining-through-walls experiment at DESY Hamburg, searching for Axion-Like Particles (ALPs), which are possible Dark Matter (DM) candidates. At ALPS II, the detector needs to detect single photons with a wavelength of 1064 nm at a rate of $\sim 10^{-5}$ Hz leading to very stringent dark count requirements. Therefore, the main challenges in commissioning a TES for ALPS II involve determining and increasing its detection efficiency and reducing dark counts as well as backgrounds introduced by e.g. black-body radiation. Due to the very low dark count rates in our setup, our TES system might be viable for direct DM searches at sub-MeV masses using electron-scattering of DM in the superconducting material, as well.
In this work, the commissioning of a TES for the ALPS II experiment will be outlined, followed by an outlook on the possible application of TESs as detectors for direct DM searches.

Category

Particle / Astroparticle / Cosmology (Experiment)

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