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Progress Towards Directional Detection of Dark Matter using Spectroscopy of Quantum Defects in Diamond

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Nitrogen vacancy (NV) centers in diamond have been identified as a promising future platform for directional detection of weakly interacting massive particle (WIMP) dark matter. A WIMP particle induces nuclear recoil in the diamond, resulting in a direction-dependent sub-micron damage track. This damage track induces crystal stress variations which shift the energy levels of NV centers, enabling localization of the track through spectroscopic interrogation. Subsequently, further nanoscale characterizations to determine the length and direction of the track can be performed. Thus, this method is capable of distinguishing WIMP-induced tracks from tracks produced by known sources, providing a strategy to overcome the background solar neutrino problem. In this talk, I will present an overview of the proposed detection method as well as recent experimental progress in our group towards demonstrating the required imaging techniques, such as high precision strain mapping using quantum interferometry and x-ray diffraction microscopy.

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