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Directional detection of dark matter using spectroscopy of crystal defects RONALD WALSWORTH, Harvard-Smithsonian, SURJEET RAJENDRAN, NICHOLAS ZOBRIST, UC Berkeley, MIKHAIL LUKIN, Harvard University, ALEX SUSHKOV, Boston University — We propose a method to identify the direction of weakly interacting massive particle (WIMP) dark matter via induced nuclear recoil. The method is based on spectroscopic interrogation of quantum defects in macroscopic solid-state crystals, such as NV centers in diamond. When a WIMP scatters in a crystal, the induced nuclear recoil creates a tell-tale damage cluster, localized to about 100 nm, with an orientation to the damage trail that correlates well with the direction of the recoil and hence the incoming WIMP. This damage cluster induces strain in the crystal, shifting the energy levels of nearby quantum defects. These level shifts can be measured optically making it possible to detect the strain environment around the defect in a solid sample. To localize the millimeter-scale region of a nuclear recoil, one can use conventional WIMP detection techniques such as the collection of ionization/scintillation. This method could allow for directional detection of WIMP-induced nuclear recoils at solid-state densities, enabling probes of WIMP parameter space below the solar neutrino floor.

Ronald Walsworth
Harvard-Smithsonian

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