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Cooling Nuclear Spins in Diamond via Dark State Spectroscopy ADI PICK, MICHAEL GULLANS, EMRE TOGAN, YIWEN CHU, Harvard University, SUSANNE YELIN, University of Connecticut, MIKHAIL LUKIN, Harvard University, CUA TEAM, ITAMP TEAM — Optical cooling methods in atomic physics, developed over the last half century, enable reaching temperatures as low as a few nK. Some of these methods can be applied for cooling spin ensembles in solid state systems. We describe a method for cooling the nuclear spins of^{13}C impurities in diamond, via optical manipulation of the electronic spin associated with an NV$^-$ center. We present the physical mechanism which leads to optical pumping of the nuclear spin ensemble into particular nuclear states. The method relies on optically driving three electronic levels in the Λ configuration, and on using the formation of dark states under the conditions of Coherent Population Trapping, (CPT). The dynamics of the nuclear ensemble during this cooling process can be described analytically by using statistical tools, including anomalous random walk models and Levy flights. I survey the theoretical results of the model and discuss some predictions for experimental signatures of Levy flights in this system.

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