Abstract Submitted
for the DAMOP12 Meeting of
The American Physical Society

Theory of laser cooling of nuclear spins based on coherent population trapping ADI PICK, MICHAEL GULLANS, YIWEN CHU, EMRE TOGAN, Harvard University, SUSANNE YELIN, University of Connecticut, MIKHAIL LUKIN, Harvard University — Nuclear spins, associated with ^{13}C impurities in diamond, can be controlled via optical manipulation of localized atom-like impurities. Specifically, spectroscopic techniques involving coherent population trapping were recently used to control and monitor the nuclear state evolution. In this work, we present the physical mechanism which leads to optical pumping of the nuclear spin ensemble into particular nuclear states. We propose an optimized scheme for achieving maximal control over the system. Specifically, cooling and control of the nuclear environment of the Nitrogen Vacancy Centers in diamond leads to improved electronic coherence properties. In addition, it opens up the possibility of using the nuclear ensemble itself for quantum information applications.

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Date submitted: 27 Jan 2012 Electronic form version 1.4