“Atomic” physics of the NV centers in diamond
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Despite of the plethora of applications of the diamond NV centers, many of the centers’ basic properties are still poorly understood. This is like experimenting with cold alkali atoms without the full knowledge of their energy levels. We have performed several experiments in an attempt to address this issue. Using optical pumping to a metastable singlet, we studied absorption from this state with various probe lasers, and have investigated the properties of the phonon sideband of the 1.042 micron transition useful for magnetic sensing via absorption [1]. A “new” sharp absorption line has been identified. In another experiment, we studied longitudinal spin relaxation in several dense samples with varying concentration of the NV centers (Fig. 1). We find that at low temperatures, relaxation rates are temperature independent, and are a function of the NV density. At high temperatures, all samples display a universal rapid dependence of the relaxation rate. We have also studied the dependence of the relaxation rates on magnetic field, identifying important role of various cross-relaxation mechanisms. Finally, we will discuss the light-power narrowing of the optically detected magnetic resonance transitions of importance for magnetometers.

Figure 1. Temperature dependence of longitudinal spin-relaxation rates for NV ensembles of various concentrations. The fit parameter $A_1$ depends on the sample, while the other fit parameters appear to be universal.

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