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Theory of nuclear spin dephasing and relaxation by optically illuminated nitrogen vacancy center. PING WANG, WEN YANG, Zhongguancun Software Park II, No. 10 West Dongbeiwang Road, Haidian District, Beijing 100094, China — Dephasing and relaxation of the nuclear spins coupled to the nitrogen-vacancy (NV) center during optical initialization and readout is an important issue for various applications of this hybrid quantum register. Here we present both an analytical description and a numerical simulation for this process, which agree reasonably with the experimental measurements. For the NV center under cyclic optical transition, our analytical formulas not only provide a clear physics picture, but also allows controlling the nuclear spin dissipation by tuning an external magnetic field. For more general optical pumping, our analytical formulas reveal significant contribution to the nuclear spin dissipation due to electron random hopping into/out of the $m = 0$ (or $m = \pm 1$) subspace. This contribution is not suppressed even under saturated optical pumping and/or vanishing magnetic field, thus providing a possible solution to the puzzling observation of nuclear spin dephasing in zero perpendicular magnetic field [M. V. G. Dutt *et al.*, Science **316**, 1312 (2007)]. It also implies that enhancing the degree of spin polarization of the nitrogen-vacancy center can reduce the effect of optical induced nuclear spin dissipation.

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