

Study of microwave magnetic field saturation of CW-EPR multi-photon transitions in the vicinity of Rabi resonance

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Recently it was noted that calculated spectra for continuous wave electron paramagnetic resonance (CW-EPR) under the condition of “weak modulation near the Rabi resonance” ($\omega_2 \ll \omega_1 \approx \omega_{rf}$) where ω_{rf} is modulation frequency with corresponding modulation amplitude ω_2 expressed in frequency units, $\omega_1 = \gamma \hbar B_1$ is Rabi frequency, γ is the electron gyromagnetic ratio and B_1 is intensity of microwave magnetic field), show spectral features related to modulation sideband (MS) (multi-photon transitions) in power saturation procedure[1]. It was shown that for the first harmonic of phase-sensitive detection spectrum detected 90° out-of-phase with respect of the modulation frequency (out-of-phase spectrum) shows inversion of MS lines while passing Rabi resonance condition ($\omega_1 = \omega_{rf}$) during the saturation process (increasing B_1 (ω_1)).

It can be noted that detection of this effect in the close vicinity of Rabi resonance enables the estimation of $B_1 \approx 3.6 \mu\text{T}$ for applied the most usual magnetic field modulation frequency of ($\omega_{rf}/2\pi = 100 \text{ kHz}$).

In order to experimentally detect this effect of inversion of MS lines in the vicinity of Rabi resonance a synthetic diamond crystal containing low concentration P1 (N_s^0) centers ($[N_s^0] < 1 \text{ ppm}$) was examined by employing an ordinary CW-EPR with magnetic field modulation ($\omega_{rf}/2\pi = 100 \text{ kHz}$) [2]. In the detection regime with low modulation field intensity and under the condition that $\omega_2 \ll \omega_{rf}$ detected narrow line components with peak-to-peak linewidth ($\delta_{pp} \approx 6 \mu\text{T}$) of P1 center shows spectral features related to MS. The saturation of the CW-EPR out-of-phase first harmonic signal reveals the most prominent features on the spectrum in the form of the inversion of sidebands lines while passing Rabi resonance condition ($\omega_1 = \omega_{rf}$). The obtained lineshapes of detected signals can be reproduced with simulated spectra in the close vicinity of Rabi resonance at ($\omega_1 \approx \omega_{rf}$) and the corresponding B_1 assigned. The accuracy of estimated B_1 will be discussed and correlated with other well-known saturation methods for determination of B_1 value.

References:

- [1] A. P. Saiko et al., *Journal of Magnetic Resonance* **259**, 47-55 (2015)
- [2] B. Rakvin et al., *App. Phys Lett* **117**(15), 153503 (2020)