Synchronised nuclear spin drive

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Nanoscale nuclear magnetic resonance (NMR) is a technique that enables the study of mater at the nanoscale level. In nanoscale NMR, nitrogen-vacancy (NV) centers can be utilized as highly sensitive magnetic sensors to detect the magnetic fields produced by nearby nuclei. By placing the sample close to the NV ensemble, thermal polarization is replaced by statistical polarization as the dominant signal source. We study correlation spectroscopy methods for nanoscale NMR methods, which involves two “interrogation” pulse sequences during which the NV centers accumulate phase. This process correlates the phases of the oscillating magnetic field and generates oscillations in the readout data. We found that these oscillations depend on the angular distance between the axes along the pulses are applied. Furthermore, we characterize the effect of including a radio frequency pulse over sample's nuclei. Our findings suggest that, in this type of protocols, the outcome does not hinge on the initial random phase of the sample's magnetic field that we aim to detect but rather on the correlation among the initial phases of the drivings applied in various channels.

Figures

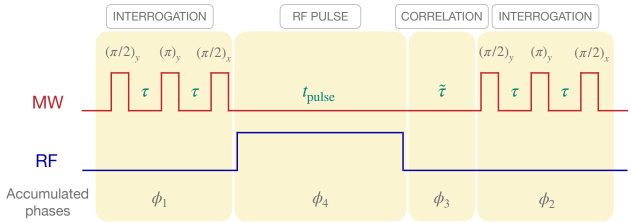

Figure 1: Sequence scheme. Two channels are involved in the sequence. The sequence in the microwave (MW) channel is applied on the NV and the one in the radio frequency (RF) channel is applied on the sample. The sequence is divided into four stages: a first interrogation block, application of an RF pulse on the sample, correlation time and a second interrogation block. In each of these stages the NV accumulate a phase ø.

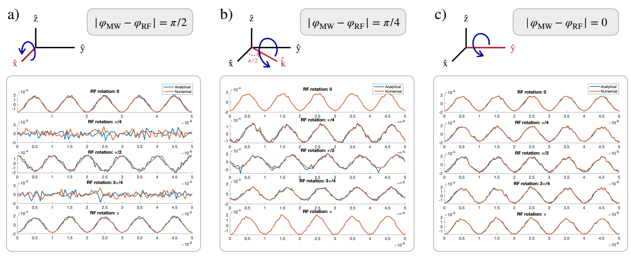

Figure 2: Effect of desynchronization in the initial phases of driving on NV photoluminescence (PL). We investigate PL variations of the NV center for distinct axes of RF pulse application while the first MW pulse is applied along y-axis of the NV. The choice of axes for the drivings is determined by their initial phases. **a)** Application of the RF pulse along the x- axis results in a phase difference of π/2, leading to population inversion in the NV when a π-pulse is applied to the sample. **b)** If the RF pulse is directed along an intermediate axis, k, between x and y we observe changes in the PL phase but not full population inversion. **c)** When both driving axes have the same phase, population inversion is not observed in the NV PL, despite using the same RF pulse on the sample.