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Synchrotron Oscillations Effects on Observations of an RF-solenoid Spin Resonance for a Polarized Deuteron Beam at COSY

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The search for an electric dipole moment (EDM) using a polarized, charged-particle beam in a storage ring requires ring conditions that can maintain a longitudinal, and stable, polarization for times up to 1000 s. The EDM signal is a rotation of this polarization into the vertical direction as a consequence of the radial electric fields present in both electric and magnetic storage rings. A study is beginning at the COoler SYnchrotron (COSY) located at the Forschungszentrum-Jülich to examine the effects of emittance and momentum spread on the spin coherence lifetime. As these effects also appear in the properties of an RF-induced spin resonance, this study began by exciting the 1 − Gγ resonance with fixed and variable frequency RF-solenoid scans and a 0.97-GeV/c polarized deuteron beam. The scintillators from the EDDA detector were used with a thick carbon beam extraction target to provide a continuous record of the vertical polarization component. Subsequent model analysis of the data recorded for many different beam and solenoid conditions demonstrated through good agreement with the data that most of the observed effects originated in the time shift of deuterons passing through the solenoid as they underwent synchrotron oscillations inside first harmonic beam bunching. These effects are distinguishable from the effects of the spin tune spread that arises from finite emittance and momentum spread. The large change in beam bunch size and thus time shift between electron-cooled and uncooled beams produced very different vertical polarization responses to the RF-solenoid. This dependence created a sensitivity to the beam bunch shape that could be used to unfold that shape. The model, which does not include a detailed ring lattice, will be described along with a summary of phenomena observed during the experiment.

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