Excercises nEDM – lecture

highRR lecturing week (group of three students)

1. Derive the sensitivity equation
$$\sigma(d_n) = \frac{\hbar}{2\alpha ET\sqrt{N}}$$
for electric dipole moment searches using the cosine approximation and Poisson statistic for neutron counts
2. Design an ultracold neutron detector which is sensitive to spin states of the neutrons
    - Describe how neutrons can be detected
    - Make a drawing of the detector, name all parts and their function
    - Speculate on possible limitations of your detector and propose tests you would like to make to verify the performance.
    - Summarize in two slides your detector for a short seminar
3. Select one of the listed systematic effects below. Discuss the effect between the three of you and try to estimate its impact on a measurement. Speculate what is needed to control or correct the effect and try to quantify the irreducible systematic error. Summarize your findings on slides for a short seminar
    - Leakage currents
    - Incoherent scattering length of co-habiting magnetometer isotopes (^{199}Hg, ^{3}He, ^{129}Xe)
    - Berry phase, aka geometric phase, of neutron in a non-uniform magnetic field
    - Berry phase, aka geometric phase, of Hg/Xe in a non-uniform magnetic field
    - Effect of $\pi/2$ – pulse (mercury) on neutron Ramsey fringe without relative phase control
    - … own idea?

Literature:

Baker et al., PRL**97** (2006) 131801 Improved Experimental Limit on the Electric Dipole Moment of the Neutron doi:10.1103/PhysRevLett.97.131801

Baker et al., NIMA **736** (2014) 184 Apparatus for measurement of the electric dipole moment of the neutron using a cohabiting atomic-mercury magnetometer doi:10.1016/j.nima.2013.10.005

Abel et al., PRA **99** (2019) 042112 Magnetic-field uniformity in neutron electric-dipole-moment experiments doi:10.1103/PhysRevA.99.042112

Abel et al., PRL **124** (2020) 081803 Measurement of the electric dipole moment of the neutron doi:10.1103/PhysRevLett.124.081803

Internal notes nEDM-collaboration
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