Physics 491: Recitation #5
September 13, 2022

1. If the Bohr magneton is approximately 6×10^{-5} eV/T, estimate the size of the nuclear magneton. The g-factors for the proton and nuetron are $+5.86$ and -3.83 respectively. What does this mean?

2. What is the spin-matrix $[s_x]$ in the +z basis? The spin-matrix is Hermitian. Start by writing the most general, $2x2$ Hermitian matrix. Use the $[s_x]$ eigenvectors in this basis from class,

$$|\pm x\rangle \rightarrow \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ \pm 1 \end{pmatrix}_z$$

   It is convenient to define the dimensionless (Pauli) matrix σ_x as $(\hbar/2)\sigma_x = [s_x]$

3. The expectation value of the spin is a Euclidean vector. Suppose an electron is in the state with $\langle s_z \rangle = +\hbar/2$, that is the state $|+z\rangle$. What is $\langle s'_z \rangle$ where the z' makes an angle θ with respect to the z axis? With respect to the z' axis eigenstates $|\pm z'\rangle$, the electron state can be written as (this is just another basis)

$$|+z\rangle = \alpha\,|+z'\rangle + \beta\,|-z'\rangle$$

   Calculate $\langle s'_z \rangle$ in terms of the probabilities α^2 and β^2 and determine these probabilities in terms of the angle θ.