Exercise Class 1

Exercise 1

Calculate all possible values of the angular momentum L, of its projection on the z-axis L_z, and of the magnetic dipole momentum along z μ_z of an electron when l = 2, and plot them graphically.

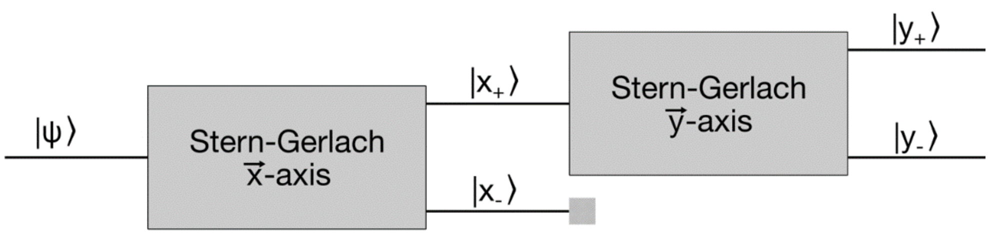
Exercise 2

Consider a qubit $|\psi\rangle = \left(\frac{1}{2} + \frac{i}{2}\right)|0\rangle - \left(\frac{1}{2\sqrt{2}} + i\frac{\sqrt{3}}{2\sqrt{2}}\right)|1\rangle$.

a. Locate the state on the Bloch sphere by calculating the corresponding angles θ, ϕ.
b. Calculate the global rotation angle δ and the equivalent state $|\psi'\rangle$ with purely real α' coefficient.

Exercise 3

Consider the Stern-Gerlach experimental setup in Fig. 1, where the input qubit is prepared in state $|\psi\rangle = \frac{1}{\sqrt{2}}|0\rangle - \left(\frac{1+\sqrt{3}}{4} - i\frac{1-\sqrt{3}}{4}\right)|1\rangle$. Calculate the measurement probability for states $|x_+\rangle$, $|x_-\rangle$ and $|y_+\rangle$, $|y_-\rangle$ after the corresponding experimental setups. Suppose then to collimate the $|x_+\rangle$, $|x_-\rangle$ output beams. Calculate the measurement probability for $|y_+\rangle$, $|y_-\rangle$ after the second SG setup.



Exercise 4

Derive the Pauli operator for direction $\vec{n}$ described by $\theta = \frac{\pi}{2}$, $\phi = \frac{\pi}{4}$, calculate its corresponding eigenvectors and eigenvalues, and plot them on the Bloch sphere.