1. Properties of angular momentum (Homework)

Compute the following commutators, using the fundamental commutation relations between position and momentum

(a) \([L_x, L_y]\), what is the general form?
(b) \([L^2, L_x]\),
(c) \([L_y, p^2]\),
(d) \([L_z, x]\).

2. Rotation of a di-amotic molecule (Oral)

To a good approximation we can describe a di-atomic molecule rotating in the rest frame of center of gravity at equal distance between the two rotating atoms (rigid Rotator). Due to the symmetry of the molecule we have two identical moments of inertia \((I_x = I_y = I_\perp)\), and a different third moment \((I_z = I_\parallel)\).

(a) Give the Hamiltonian in terms of the angular momentum operators \(L^2\) und \(L_z\).
(b) Compute the eigenvalues and eigenvectors.

3. Expectation values of angular momentum (Oral)

We consider a system with the eigenstates \(|l, m\rangle\) of \(L^2\) and \(L_z\).

(a) Calculate the expectation values \(\langle L_x \rangle = \langle l, m | L_x | l, m \rangle\) and \(\langle L_y \rangle\).
(b) Calculate \(\Delta L_x\) and \(\Delta L_y\).

(Tip: Use \(L_x = (1/\hbar) [L_y, L_z]\) and \(L_y = (1/\hbar) [L_z, L_x]\). Note that \(L_z\) is hermitian.)