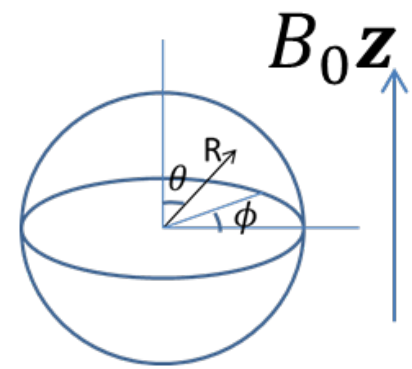
Inclass 24.1. An electron (mass m_0)is confined to move in a spherical shell with radius R. Determine the eigenfunctions and eigenvalues of the system placing in a magnetic field $\boldsymbol{B} = B_0\hat{\boldsymbol{z}}$. (Recall that the Hamiltonian of the system without the external magnetic field is $\frac{L^2}{2m_0R^2}$.)

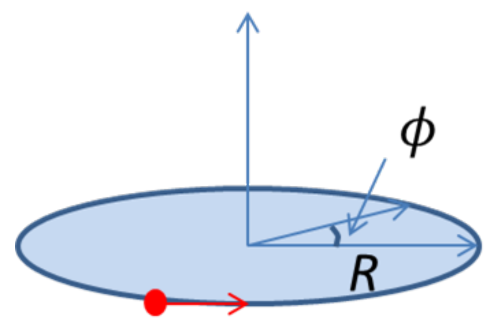


Inclass 24.2. Consider an electron of mass m_0 confined to move in a circle in the x-y plane with radius R. The system is placed in a magnetic field $\boldsymbol{B} = B_0\hat{\boldsymbol{z}}$. Consider only the magnetic interaction energy $-\boldsymbol{\mu} \cdot \boldsymbol{B}$. Ignore the kinetic energy term.

At $t = 0$, the wavefunction has the form: $\psi(\phi) = A cos\phi$.

(a) Determine the normalization factor A.

(b) Determine the wavefunction at time t later.

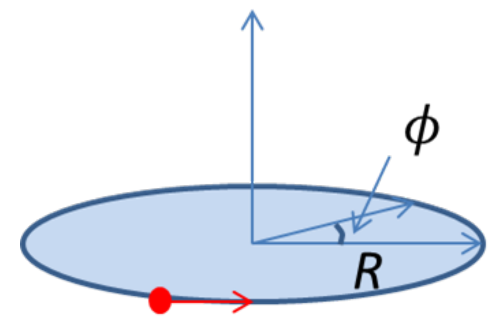


Inclass 24.3. Consider an electron of mass m_0 confined to move in a circle in the x-y plane with radius R. The system is placed in a magnetic field $\boldsymbol{B} = B_0\hat{\boldsymbol{z}}$. Consider only the magnetic interaction energy $-\boldsymbol{\mu}\cdot\boldsymbol{B}$. Ignore the kinetic energy term. The wavefunction is given by: $\psi(\phi,t) = \frac{1}{\sqrt{2}}[\varphi_1\, e^{-i\frac{E_1}{\hbar}t} + \varphi_2 e^{i\frac{E_2}{\hbar}t}]$, where

$$\varphi_1 = \frac{1}{\sqrt{2\pi}}e^{i\phi} \text{ and } \varphi_2 = \frac{1}{\sqrt{2\pi}}e^{-i\phi}$$

(a) Determine the matrix of the energy operator using $\varphi_1 = \begin{pmatrix}1\\0\end{pmatrix}$ and $\varphi_2 = \begin{pmatrix}0\\1\end{pmatrix}$ as the basis.

(b) Determine the expectation of the energy for the wavefunction $\psi(\phi,t) = \frac{1}{\sqrt{2}}[\varphi_1\, e^{-i\frac{E_1}{\hbar}t} + \varphi_2 e^{i\frac{E_2}{\hbar}t}]$.



Inclass 24.4. Determine the energy spectrum of a H-atom placing in a magnetic field $\boldsymbol{B} = B_0\hat{\boldsymbol{z}}$. Consider only $n = 2, l = 1$ state.

$$H = H_0 - \frac{e}{2m_0}\boldsymbol{L} \cdot \boldsymbol{B} = H_0 + \frac{e}{2m_0}B_0 L_z,$$

$$H_0 = \frac{-\hbar^2}{2m_0}\nabla^2 + V(r),$$

and $\hat{H}_0\Psi = E_n\Psi$.