

The operator \hat{L}_z that represents the z -component of angular momentum, the operator \hat{L}^2 that represents the total angular momentum, and the operator \hat{H} that represents the energy for the rigid rotor (a particle confined to the unit sphere) have eigenvalues given by

$$\hat{L}_z |\ell, m\rangle = m\hbar |\ell, m\rangle \quad (1)$$

$$\hat{L}^2 |\ell, m\rangle = \ell(\ell + 1)\hbar^2 |\ell, m\rangle \quad (2)$$

$$\hat{H} |\ell, m\rangle = \frac{\hbar^2}{2I} \ell(\ell + 1) |\ell, m\rangle \quad (3)$$

Find the matrix representations for these operators.