c. $\Theta|jm\rangle = i^{2m}|j,-m\rangle$.

Since. $\Theta = \eta e^{-i\pi J_y/\hbar} K$

$$\Theta|jm\rangle = \eta e^{-i\pi J_y/\hbar}|jm\rangle$$

$$= \eta \sum_{m'} D_{m'm}(\pi)\,|jm'\rangle.$$

$$D_{m'm}(\pi) = (-1)^{j+m}\delta_{m',-m}$$

$$= \eta \sum_{m'} \delta_{m',-m}(-1)^{j+m}|jm'\rangle$$

~~then~~. $= \eta (-1)^{j+m}|j-m\rangle$

thus, we choose $\eta = (-1)^{-j}$

$$\Theta|jm\rangle = (-1)^m|j-m\rangle$$

11. $\psi = \sum_{lm} F_{lm} Y_l^m(\theta,\phi)$

For non-degenerate state, ψ is real.

$$F_{lm}Y_l^m(\theta,\phi) + F_{l-m}Y_l^{-m}(\theta\phi)$$

$$= F_{lm}^* Y_l^{*m}(\theta,\phi) + F_{l-m}^* Y_l^{*-m}(\theta\phi).$$

$$= (-1)^m F_{lm}^* Y_{l-m}(\theta\phi) + F_{l-m}^*(-1)^m Y_{lm}(\theta\phi).$$

thus. $F_{lm} = F_{l-m}^*(-1)^m$