9. it is $\phi^*(-\vec{p}')$.

$$\phi(\vec{p}') = \langle \vec{p}' | \alpha \rangle$$

$$\phi(\vec{p}') = \langle \vec{p}'\theta | \theta\alpha \rangle^*$$

$$= \langle -\vec{p}' | \theta\alpha \rangle^*$$

or $\phi^*(-\vec{p}') = \langle \vec{p}' | \theta\alpha \rangle$

10. a) $\mathcal{D}(R) |jm\rangle$

$$= \sum_{m'} |jm'\rangle \, \mathcal{D}_{m'm}(R).$$

$$\Theta \mathcal{D}(R) |jm\rangle = \sum_{m'} \mathcal{D}^*_{m'm}(R) \, \Theta |jm'\rangle$$

$$= \sum_{m'} \mathcal{D}^*_{m'm}(R) \, (i)^{2m'} |j -m'\rangle$$

On the other hand

$$\Theta D(R) |jm\rangle$$

$= D(R) \, \underline{\Theta |jm\rangle}$ (because $e^{i\vec{\theta}\cdot\vec{J}}$ does not change $i \to -i$, $\vec{J} \to -\vec{J}$).

$$\cancel{= \sum_{m'} \mathcal{D}_{m'm}(R) (-1)^{m+j} \, j\, m}$$

$$= D(R) \, (-1)^m |j -m\rangle$$

$$= \sum_{m'} D_{m' -m}(R) \, (-1)^m |j -m'\rangle$$

Compare. $D^*_{m'm}(R) = (-1)^{m-m'} D_{-m' -m}(R)$