4 (a) Both $e^{2i\phi}$ and $e^{-2i\phi}$ are eigenfunctions of $\hat{L}_z = \left(-i\hbar\frac{\partial}{\partial\phi}\right)$ with eigenvalues $2\hbar$ & $-2\hbar$ respectively.

Measurements of L_z on this system will yield these two values with equal probability (because their coefficients are the same)

Hence $\langle L_z \rangle = \frac{1}{2}\left[2\hbar + (-2\hbar)\right] = 0$

Similarly $\langle L_z^2 \rangle = \frac{1}{2}\left[(2\hbar)^2 + (-2\hbar)^2\right] = 4\hbar^2$