To compute $[\hat{L}_z, cos arphi]$ we obtain the act of it on a well-behaved wave function $\psi(r, heta, \phi)$

$$\begin{split} \big[\hat{L}_z, cos\varphi\big]\psi(r,\theta,\phi) &= \hat{L}_z\big(cos\varphi\,\psi(r,\theta,\phi)\big) - cos\varphi\,\Big(\hat{L}_z\,\psi(r,\theta,\phi)\Big) \\ &= \frac{\hbar}{i}\frac{\partial}{\partial\phi}\big(cos\varphi\,\psi(r,\theta,\phi)\big) - cos\varphi\,\frac{\hbar}{i}\frac{\partial\psi(r,\theta,\phi)}{\partial\phi} \\ &= \frac{\hbar}{i}\bigg(-sin\varphi\,\psi(r,\theta,\phi) + cos\varphi\,\frac{\partial\psi(r,\theta,\phi)}{\partial\phi} - cos\varphi\,\frac{\partial\psi(r,\theta,\phi)}{\partial\phi}\bigg) = i\hbar sin\varphi\,\psi(r,\theta,\phi) \end{split}$$

 $\psi(r, heta,\phi)$ is arbitrary this means $\left[\hat{L}_z,cosarphi
ight]=i\hbar sinarphi$

Mohammad Behtaj & Adel Sepehri

