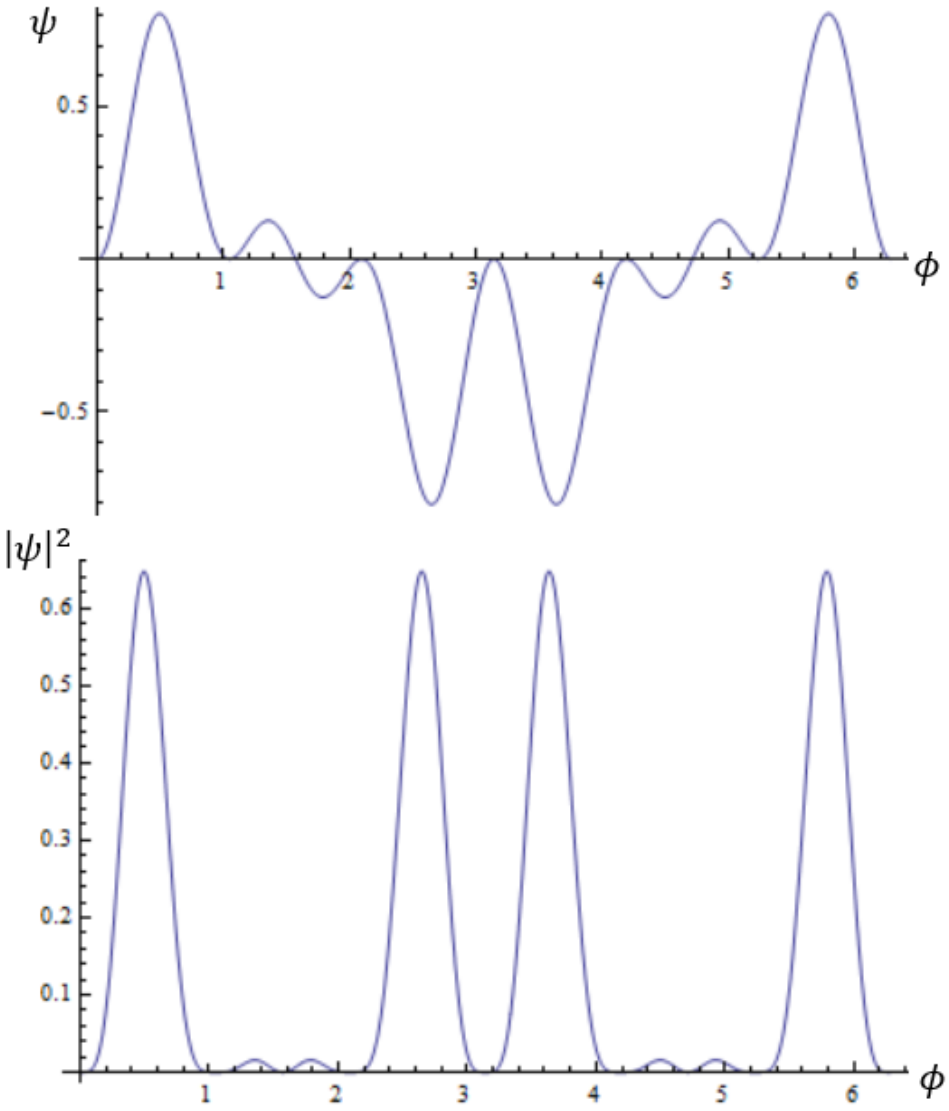
Consider the following normalized quantum state on a unit ring:

$$\Phi(\phi) = \sqrt{\frac{8}{3\pi r_0}} \sin^2(3\,\phi)\cos(\phi) \tag{1}$$

1. Translate this state into eigenfunction, bra/ket, and matrix representations. Remember that you can use any of these representations in the following calculations.
2. What is the expectation value of L_z in this state?
3. The wave function and it's probability density are plotted below. (I have set $r_0 = 1$ to make the plotting easier). What features of these graphs (if any) tell you the expectation value of L_z in this state?



4. What is the probability that the particle can be found in the region $0 < \phi < \frac{\pi}{4}$? Repeat your calculation in the region $\frac{\pi}{4} < \phi < \frac{3\pi}{4}$?