Rotation and Flow in a Ring Trap
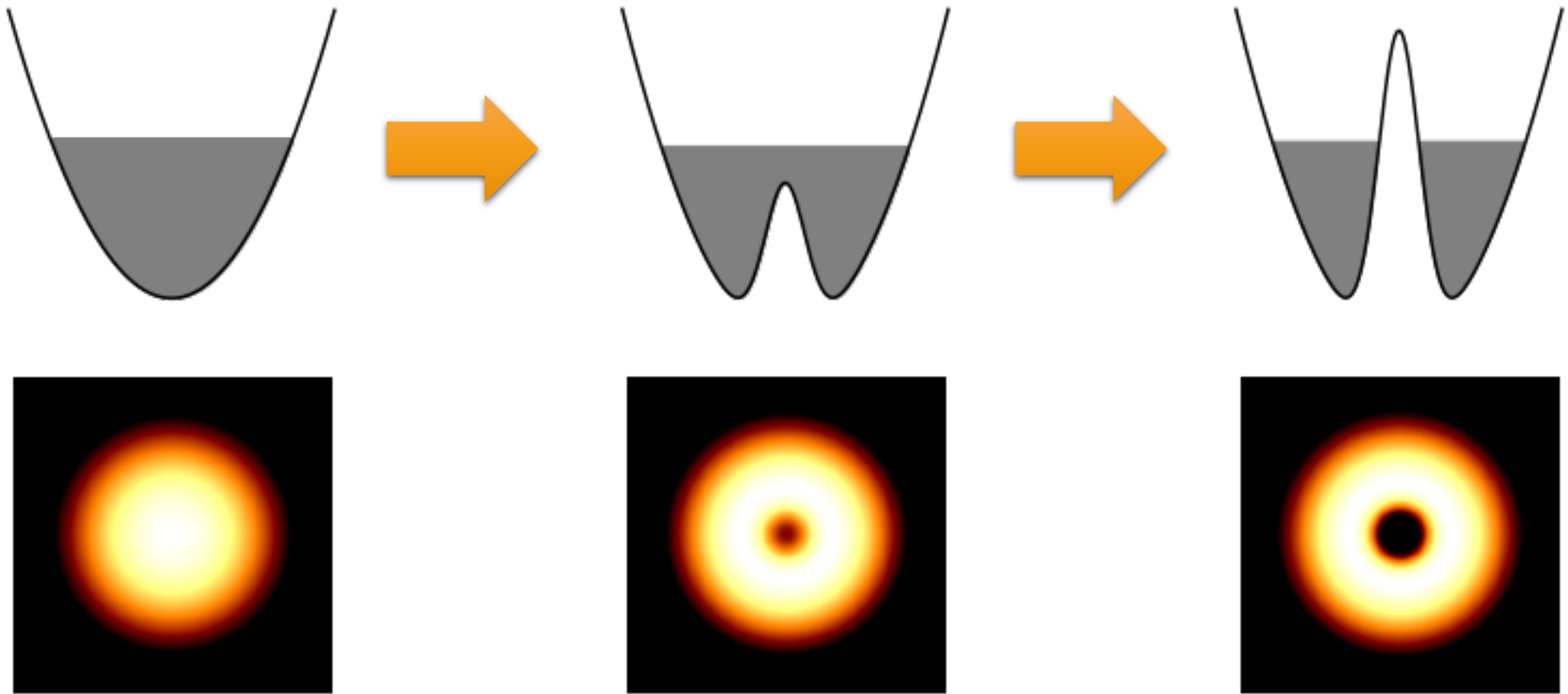
A273 Programming Exercise

Harmonic Trap ⇢ Ring Trap

Equation: Integration and Issues

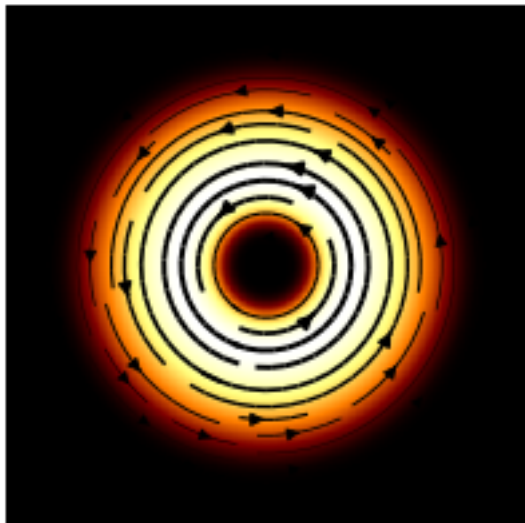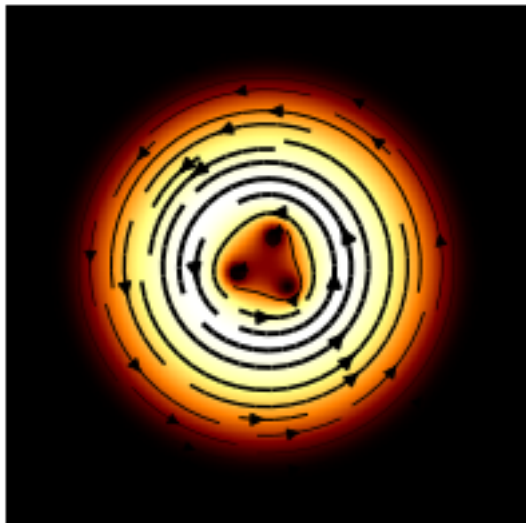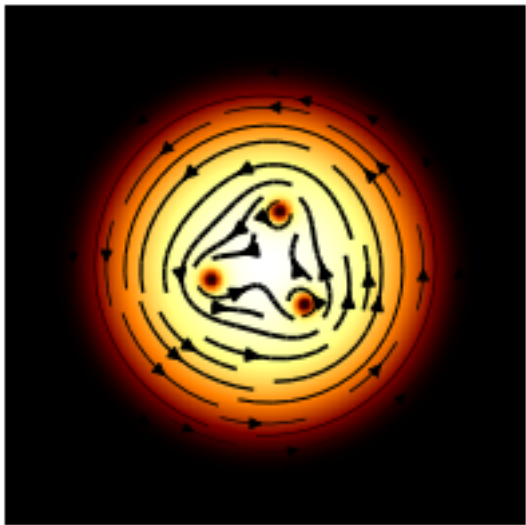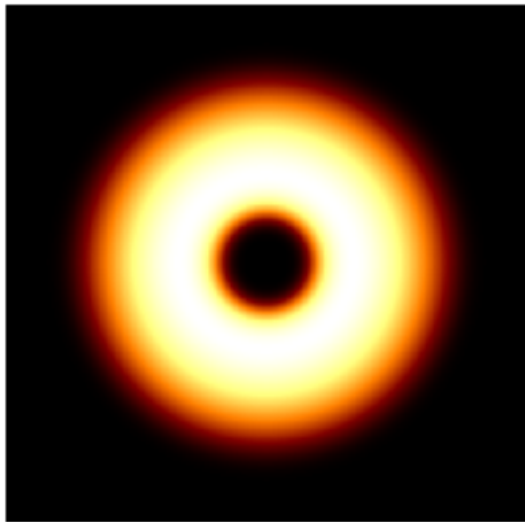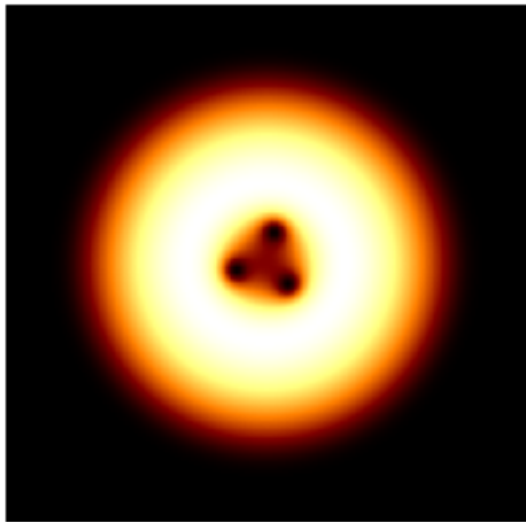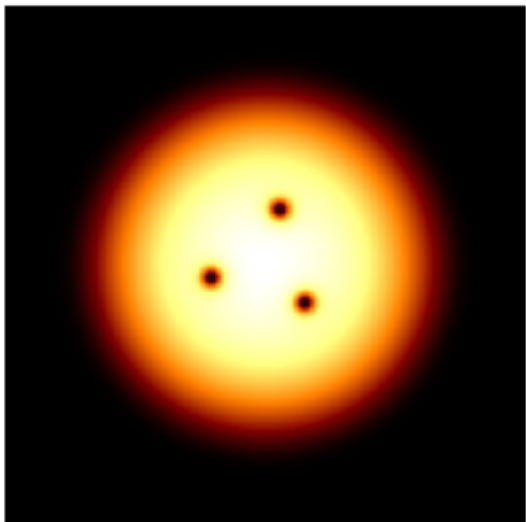$$\left(-\frac{\hbar^2}{2m}\nabla^2 + V(x) + U_0|\Psi(x)|^2 + \Omega L_z\right)\Psi(x) = \mu\Psi(x)$$

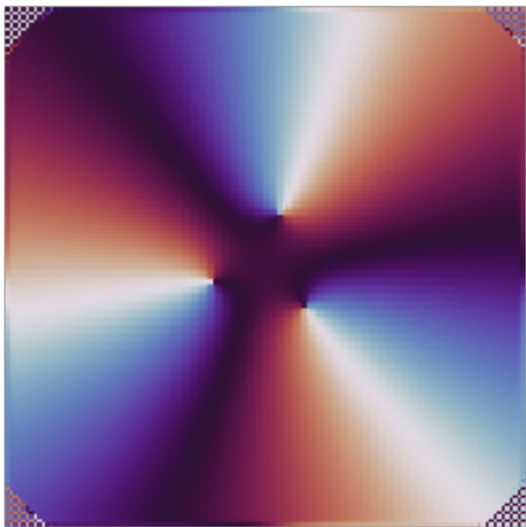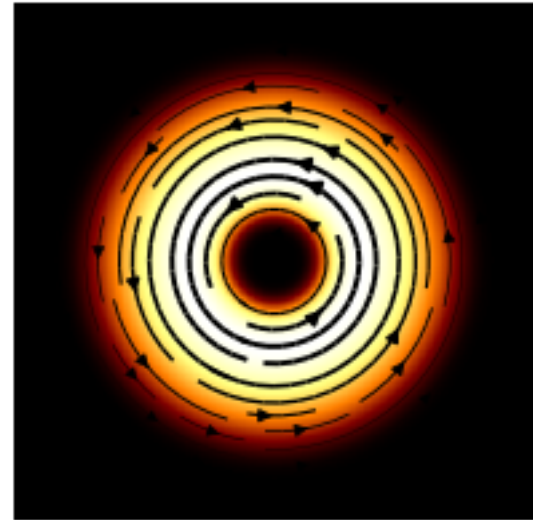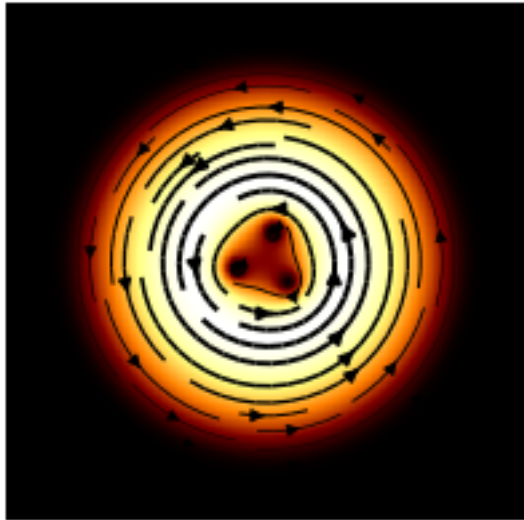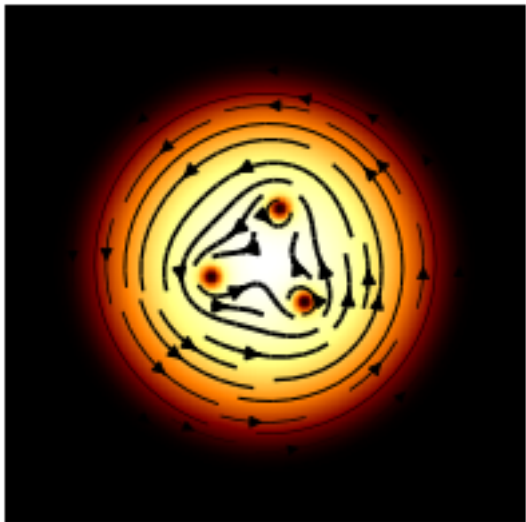$$V(x) = \frac{1}{2}x^2 + a\left(\exp\left(-\frac{1}{2}x^2\right) - 1\right), \qquad L_z = xp_y - yp_x$$

- Solve GPE using split-operator method

- Issues:
  - Bugs? → Hopefully resolved!
  - Converged? → Check with Hamiltonian
  - Ground state? → Not fully resolved
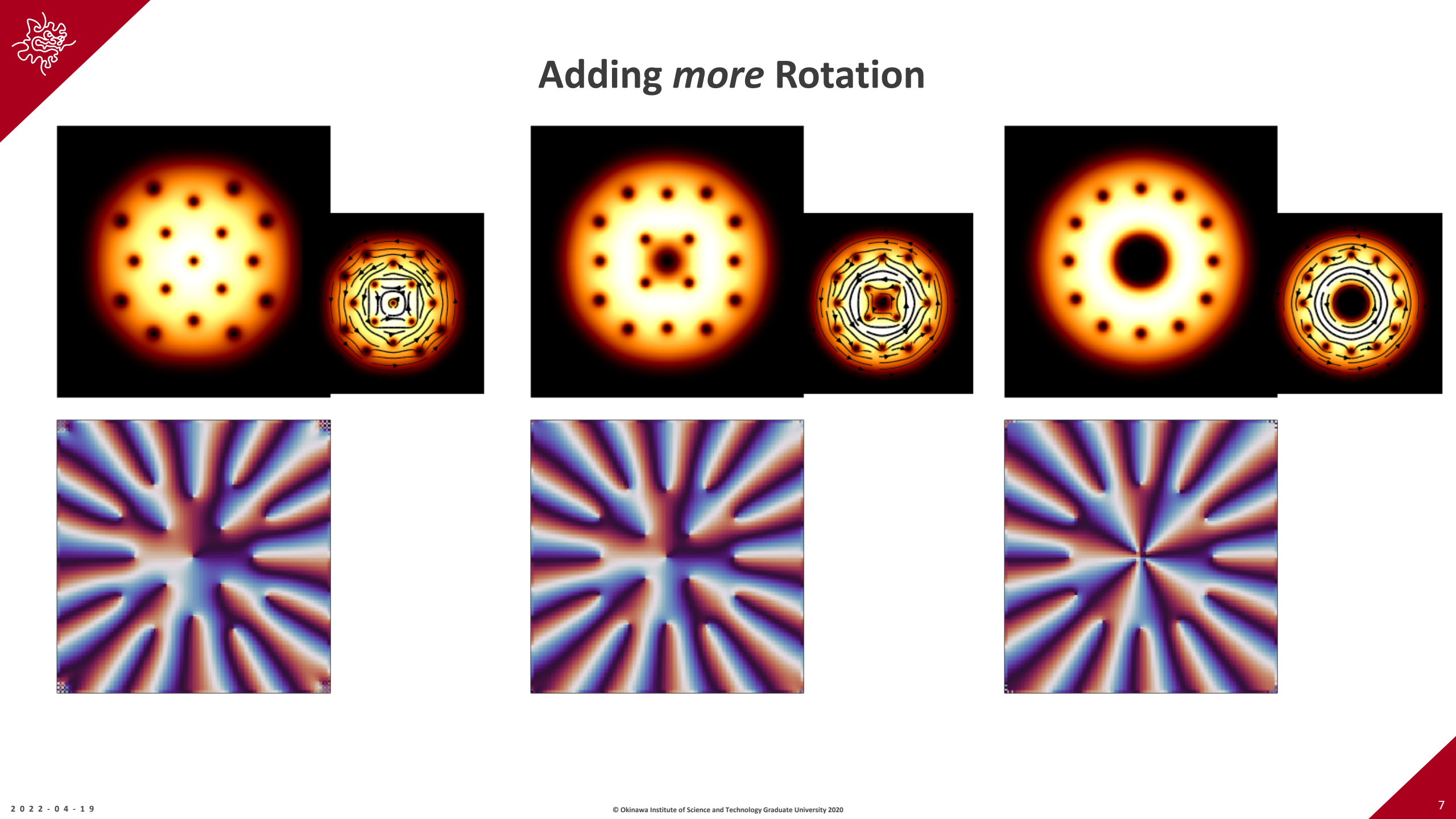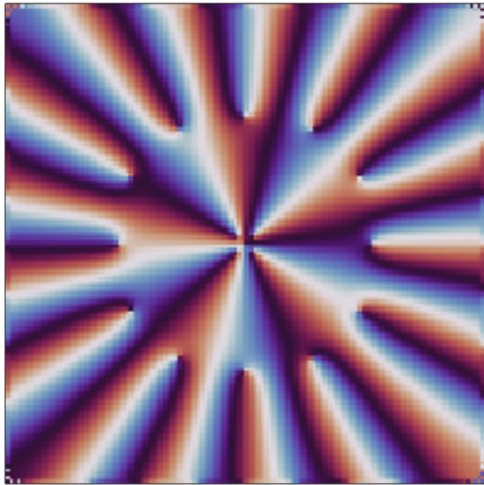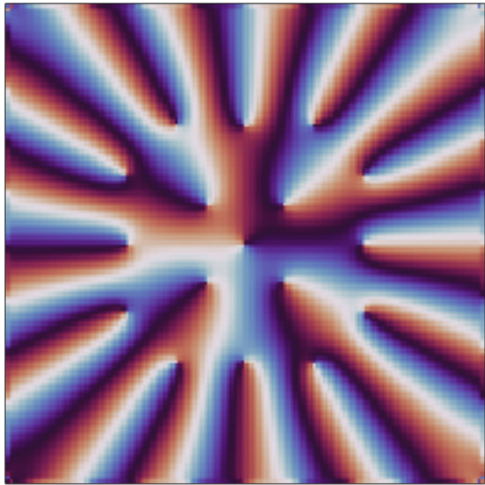
Adding Rotation
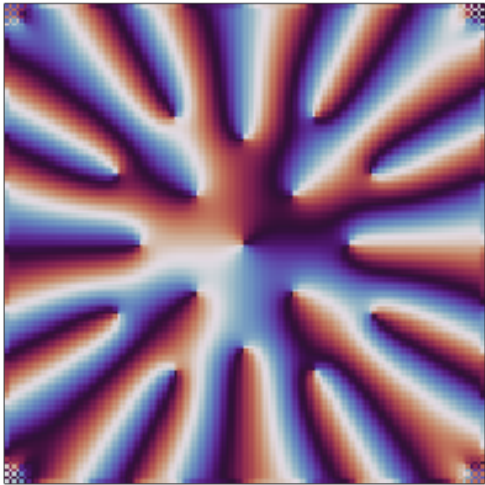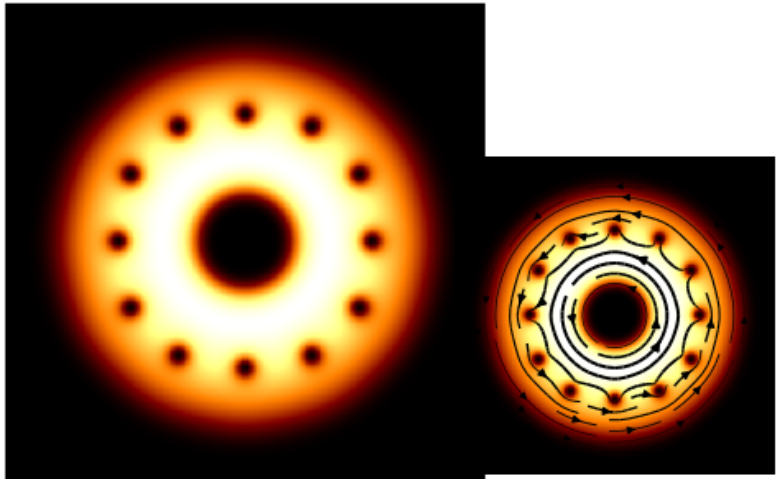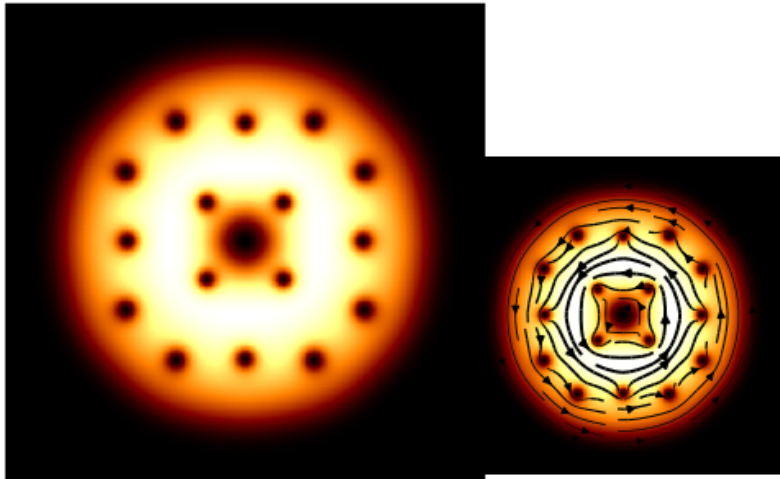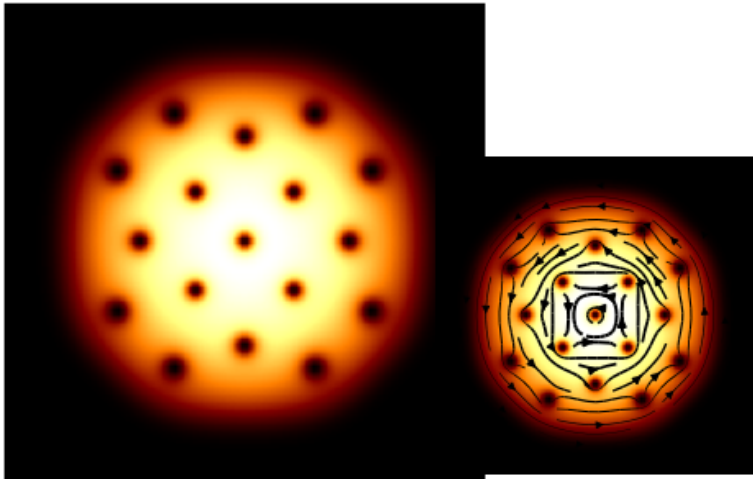
Adding Rotation: A Closer Look
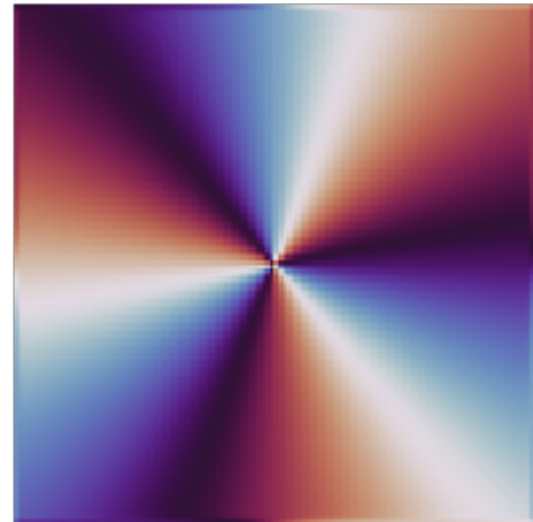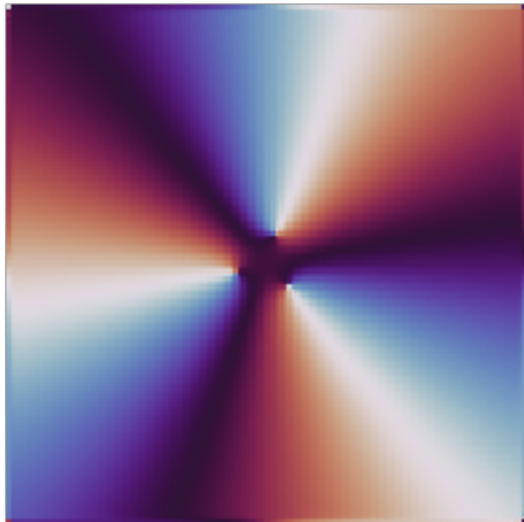
Higher Order Vortices: How?

$$E_{vortex} \approx \frac{\hbar^2}{m} \pi l^2 n \log \frac{D}{\xi}$$

- Energy of vortex $\sim l^2$
  $\Rightarrow l = 1$ energetically favorable

- However, for ring trap: $n \approx 0$
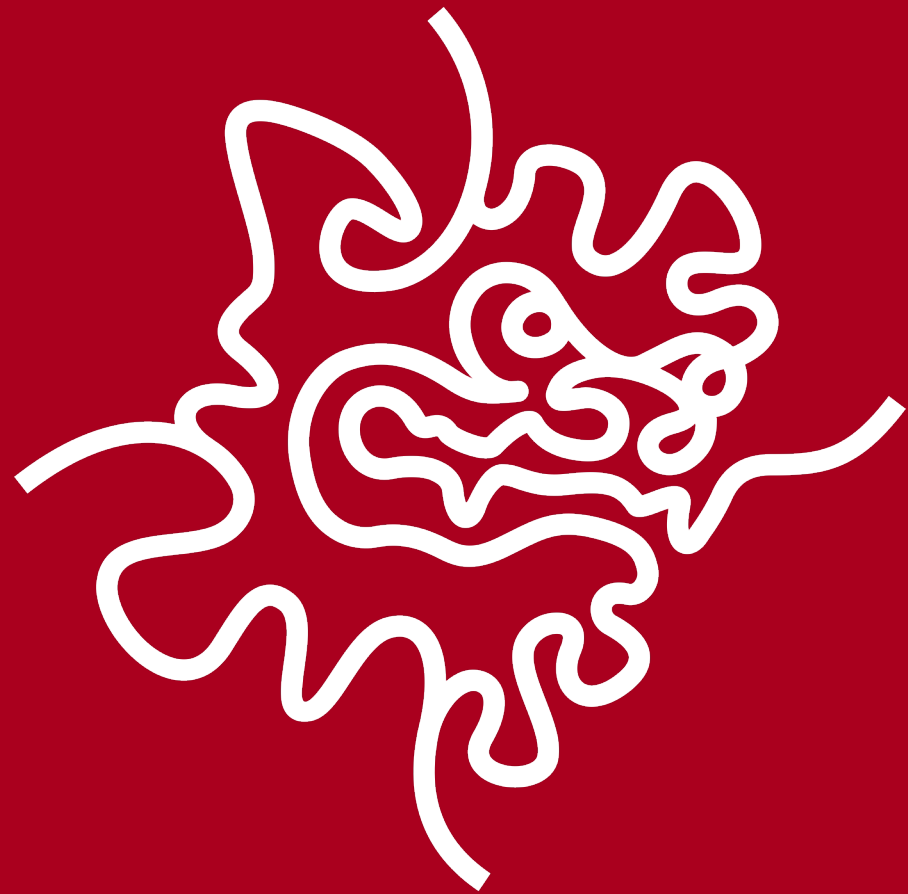 $\Rightarrow$ Vortices with $l \geq 1$ okay!

Adding *more* Rotation

What is still left to do?

- Figure out a consistent way to check if ground state

- Try improve convergence

- Implement in more efficient language

- Implement other methods to compare

- More complex trap shapes

Thank you!