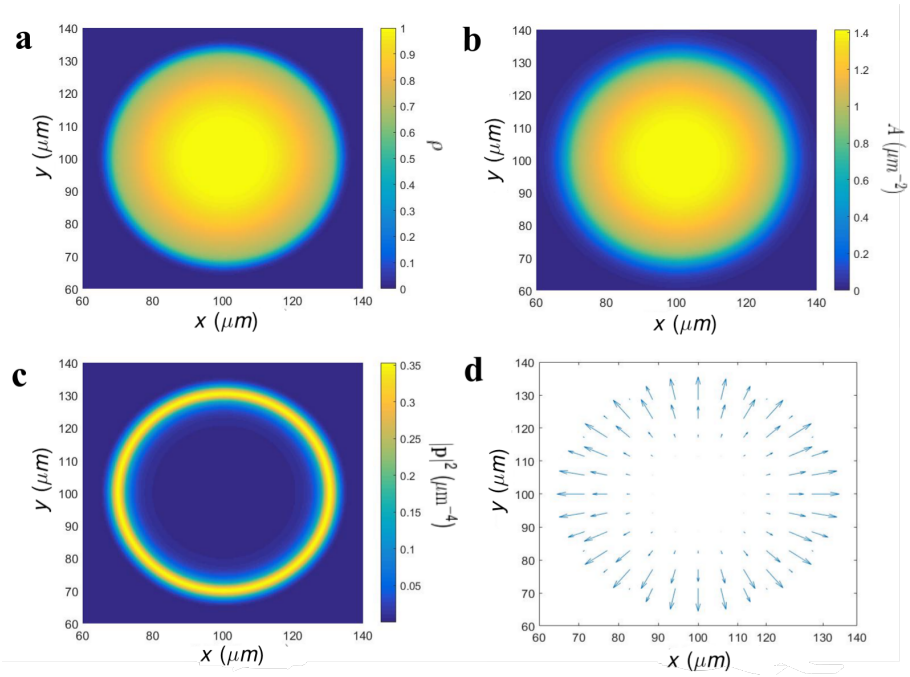
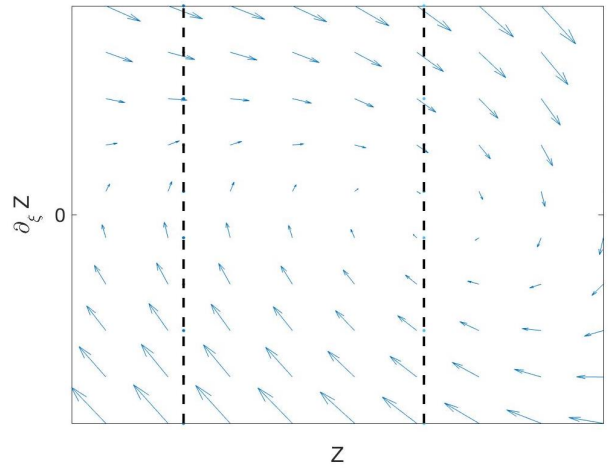


Supplementary Figure 1: Plots of the numerical values for a stationary cell: (a) ρ, (b) A, (c) $|\mathbf{p}|^2$, and (d) $\mathbf{p}$ for $\alpha = 3.4\ \mu m^5 s^{-1}$. The stationary approximations, see Formation of Rotational Waves, predicted $\rho = 1$, $A = 1.5\ \mu m^{-2}$, $|\mathbf{p}|^2 = 0\ \mu m^{-4}$ inside the cell, $\rho = 0$, $A = 0\ \mu m^{-2}$, $|\mathbf{p}|^2 = 0\ \mu m^{-4}$ outside the cell, and $\rho = 0.5$, $A = 0.75\ \mu m^{-2}$, $|\mathbf{p}|^2 = 0.56\ \mu m^{-4}$ near the membrane. The width of the interface is determined by the diffusion term in the phase equation, as seen in equation 2 in the main article.



Supplementary Figure 2: The phase plane for equation 31 in the main article. For simplicity this figure assumes $\partial\tilde{V} \approx 0$. The left vertical dashed line corresponds to $\delta r_o = 0\ \mu m$ and the right vertical dashed line corresponds to $\delta r_o = R_o$.

Parameter	Value
α	2.5-4.5 $\mu m^5\ s^{-1}$
β	$\alpha/2\ \mu m^{-1}\ s^{-1}$
σ	0.5 μm^{-4}
μ	0.1
D_ρ	1.0 $\mu m^2\ s^{-1}$
D_p	0.2 $\mu m^2\ s^{-1}$
D_A	1.0 $\mu m^2\ s^{-1}$
τ_1	10.0 s
τ_2	2.5 s
γ	0.5 $\mu m^3\ s^{-1}$
a_0	0.1 $\mu m^2 s^{-1}$

Parameter	Value
a_{nl}	1.5 $\mu m^2 s^{-1}$
d_0	1.0 s^{-1}
s	1.0 $\mu m^4 s^{-1}$
b	5.0 μm^{-2}
u_c	0.45 μm
G	0.01-0.1 $mg\mu m^{-1}s^{-2}$
η	3.3 $mg\mu m^{-1}s^{-1}$
H	0.3-1.0 μm
T_1	5.0-20.0 μm
L	200.0 μm
R_0	30.0 μm

Supplementary Table 1: Typical model parameter values. If not mentioned otherwise, these values are used for all simulations.