

SUPPRESSED INVERSE CASCADE AND VORTEX CRYSTALS IN INSTABILITY-DRIVEN 2D TURBULENCE

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2D Navier-Stokes

$$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \cdot \nabla \mathbf{u} = -\nabla p + \nu \nabla^2 \mathbf{u} + \mathbf{f}$$

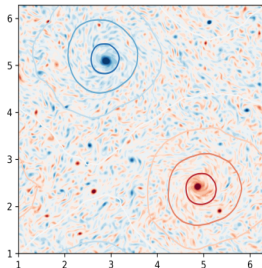
- The forcing has two components

$$\mathbf{f} = (1 - \gamma) \mathbf{f}_{\text{random}} + \gamma \mathcal{L}(\mathbf{u}) \quad \text{with} \quad \gamma \in [0, 1]$$

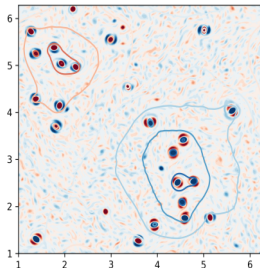
- $\mathbf{f}_{\text{random}}$ white noise injecting constant power in $|\mathbf{k}| \in [k_1, k_2]$
- $\widehat{\mathcal{L}\mathbf{u}}(\mathbf{k}) = \sigma \hat{\mathbf{u}}(\mathbf{k})$ if $|\mathbf{k}| \in [k_1, k_2]$ and 0 otherwise

From "gas" to "liquid" to vortex "crystals"

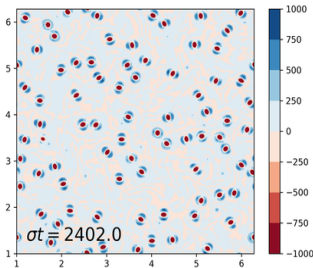
$\gamma = 0$ (Stochastic)



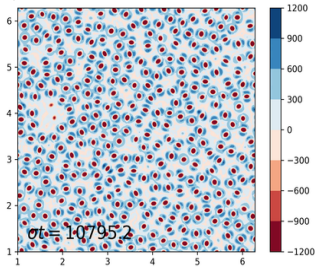
$\gamma = 0.35$



$\gamma = 1$ (Instability)



$\gamma = 1$ (abrupt transition)



$\gamma = 0.1$ (continued from $\gamma = 1$)

