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The HVBK model

$$\rho_s \frac{D\mathbf{v}_s}{Dt} = -\nabla p_s - \mathbf{F} + \mathbf{f}_{ext}$$

$$\rho_n \frac{D\mathbf{v}_n}{Dt} = -\nabla p_n + \mathbf{F} + \mu \nabla^2 \mathbf{v}_n$$

- Coarse-grained vortex tangle

  Pros: - simulation of high Re possible

  - accounts for mutual coupling in a consistent fashion

  Cons: - energy cascade continuously beyond the intervortex cut-off scale

A **Truncated** HVBK model

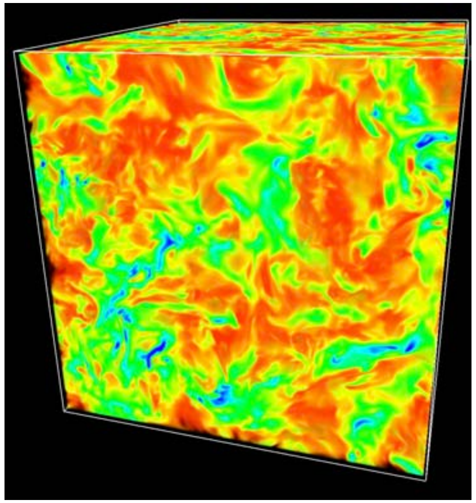
- Phase space is restricted to scales larger than intervortex spacing
- Intervortex spacing is estimated self-consistently from the superfluid vorticity field

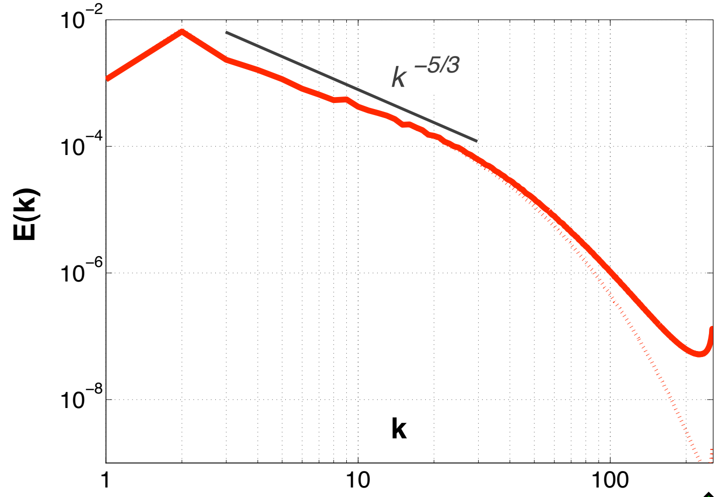
$$\text{intervortex} \simeq \frac{1}{\sqrt{VLD}}$$

$$\text{with } VLD \simeq \frac{\langle {\boldsymbol{\omega}_s}^2 \rangle^{1/2}}{\kappa}$$

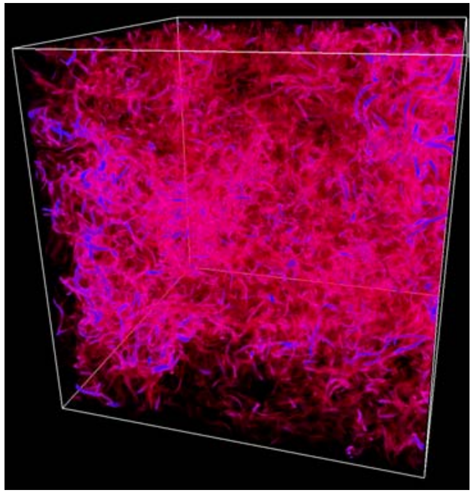
High Temperature $(\rho_s/\rho_n = 0.1\ ,\ T \sim 2.1565\ \text{K})$

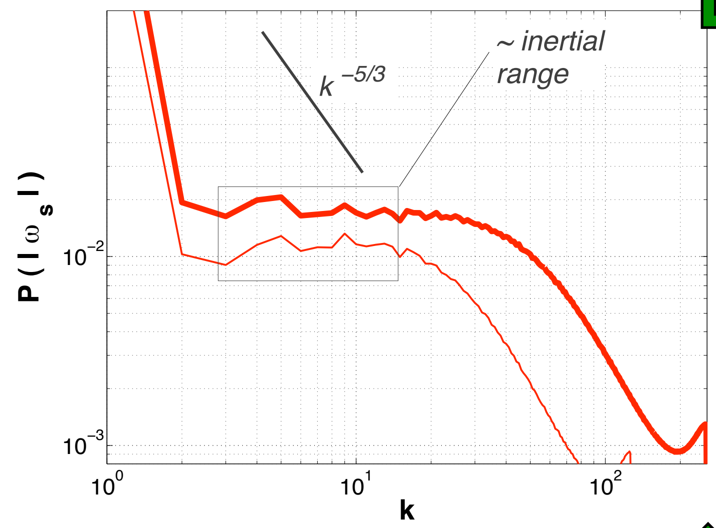
Velocity





Vorticity $|\omega_s|$





- Consistent with He-II experiments
- Similar to Navier-Stokes fluids
- Provides some validation of the model

Inter-vortex spacing

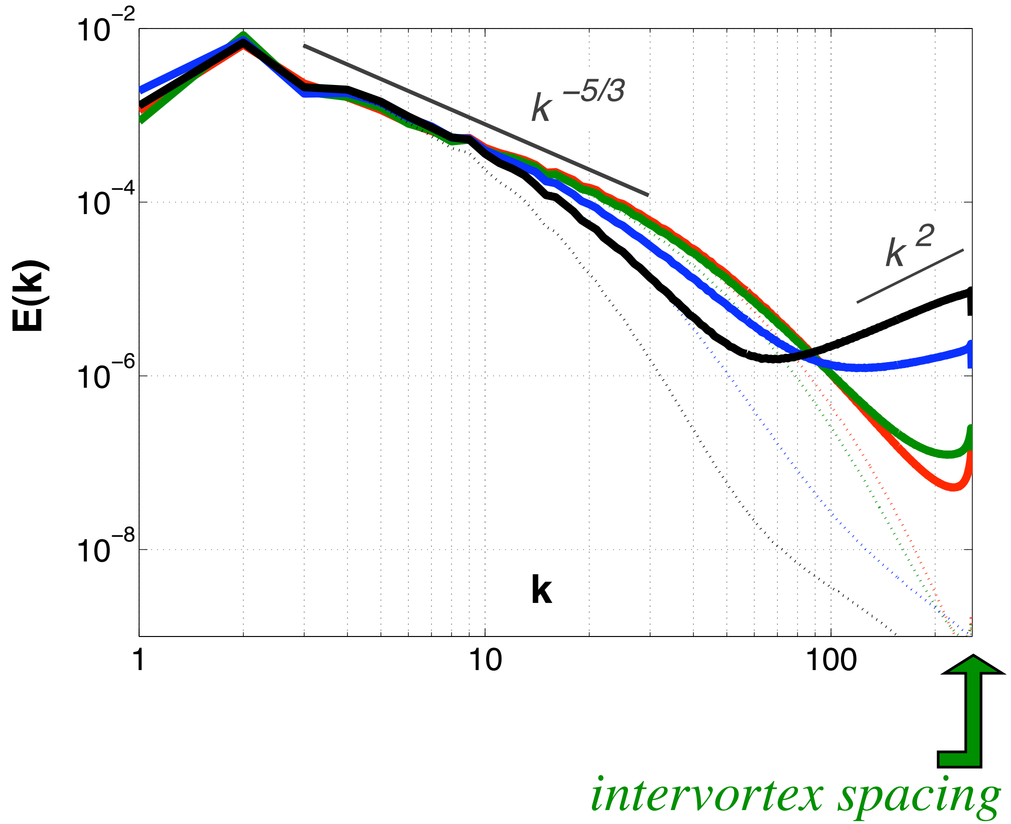
Velocity spectra versus Temperature

VERY LOW ($\rho_s/\rho_n = 40$, $T \sim 1.15$ K)

LOW TEMP ($\rho_s/\rho_n = 10$, $T \sim 1.44$ K)

INTERMED. ($\rho_s/\rho_n = 1$, $T \sim 1.96$ K)

HIGH TEMP ($\rho_s/\rho_n = 0.1$, $T \sim 2.1565$ K)



- Consistent with experiments (Maurer *et al*. , Salort *et al*.)
- <u>Equipartition of energy</u> : inertial cascade < <u>meso-scales</u> < quantum scales

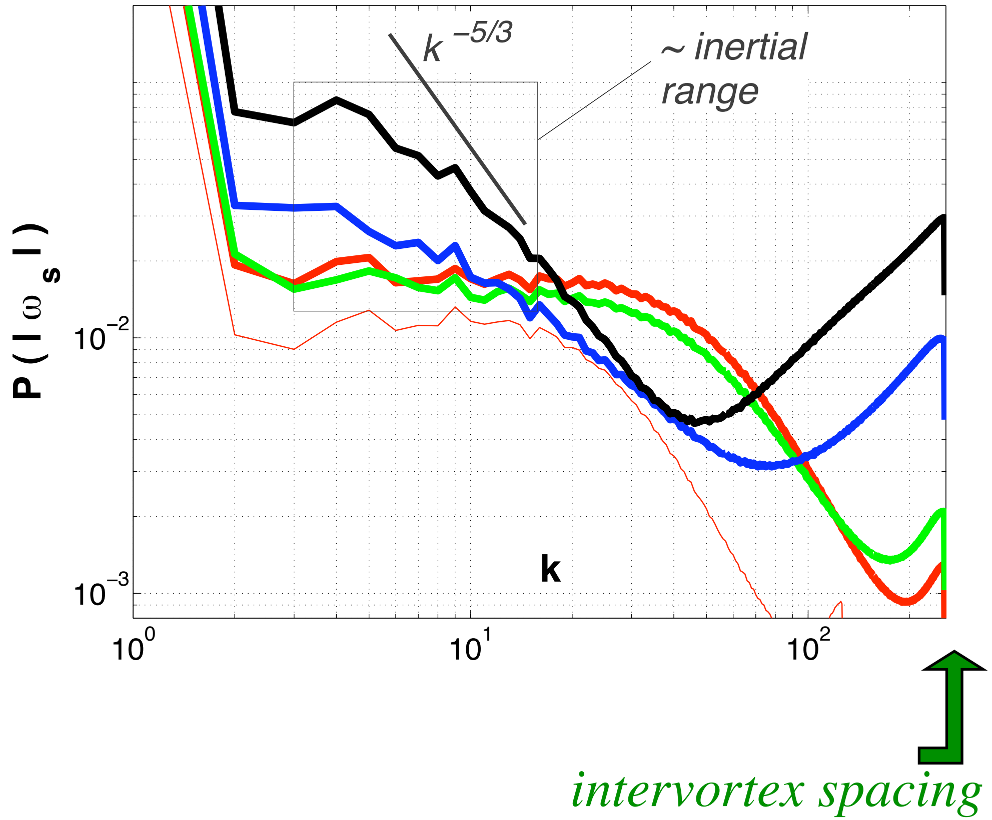
| Superfluid Vorticity | spectra versus Temperature

VERY LOW $(\rho_s/\rho_n = 40 \ , \ T \sim 1.15 \text{ K})$

LOW TEMP $(\rho_s/\rho_n = 10 \ , \ T \sim 1.44 \text{ K})$

INTERMED. $(\rho_s/\rho_n = 1 \ , \ T \sim 1.96 \text{ K})$

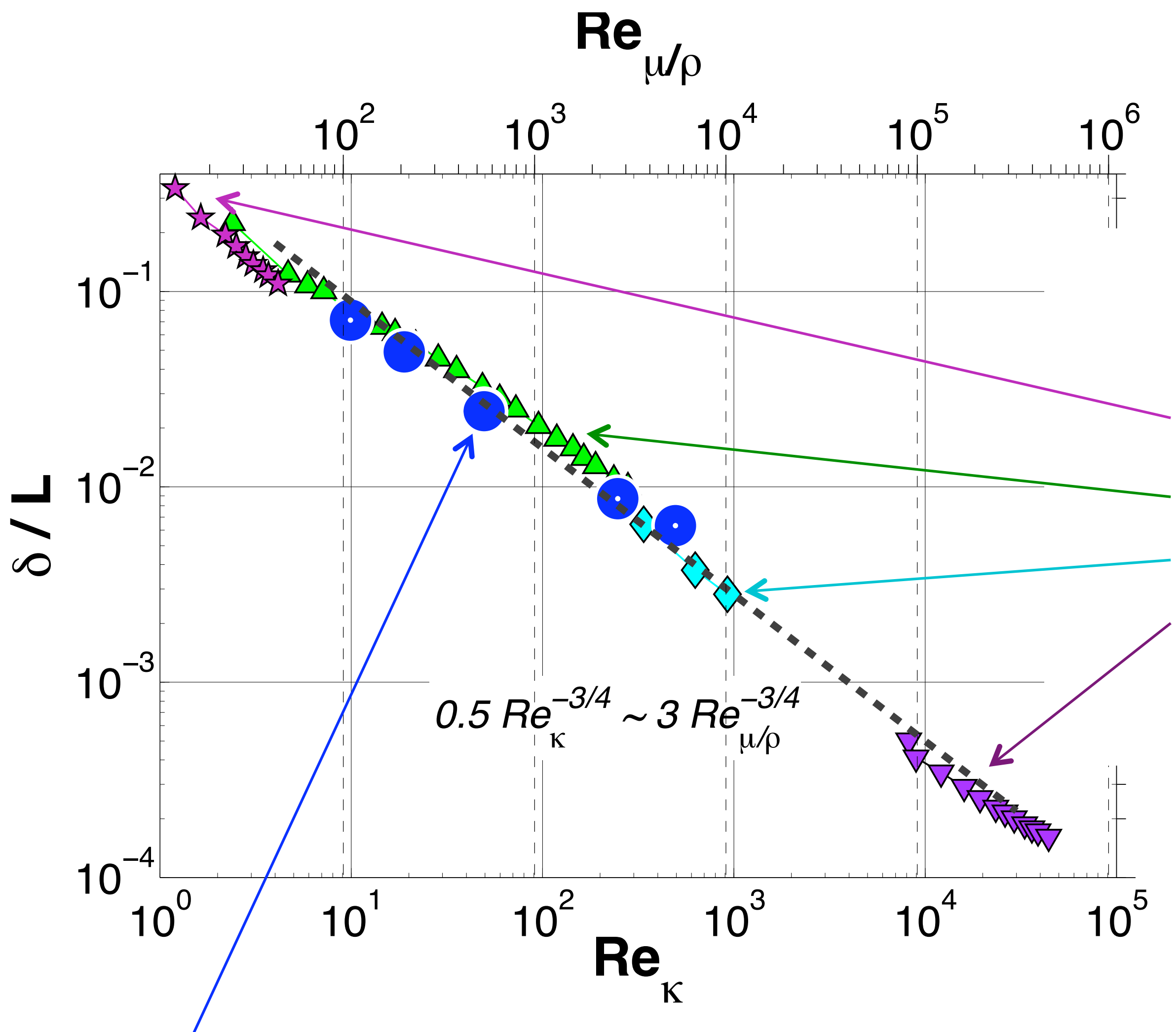
HIGH TEMP $(\rho_s/\rho_n = 0.1 \ , \ T \sim 2.1565 \text{ K})$



- Consistent with experiments (miniature second sound probe)
- At low (finite) temperature : <u>« vorticity » concentrates at low scales</u>

validation : Inter-vortex spacing

Simulations versus Experiments



***Experiments** (T≈1.5-1.6 K)*

Ijsselstein et al.

Holmes & Van Sciver

Walstrom

unpublished (Roche et al.)

***Present simulations** (T≈1.44 K , $\rho_s=10.\rho_n$)*