Evolution of the anizotropy of the quantuum vortex tangle

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The variety of the dynamic phenomena exhibited by the superfluid ^{4}He involved the appearance and motion of quantized vortices. Due to the existence of these singularities the superfluid component is coupled dissipatively with the normal one. At low velocities, He II (superfluid ^{4}He) flows in the frictionless, presumably laminar manner consistent with the ideal fluid description. When the counterflow (the relative velocity of the components) $\mathbf{V_{ns}} = \mathbf{V_n} - \mathbf{V_s}$ becomes sufficiently large, the superfluid laminar flow develops into a superfluid turbulent flow in which the quantum vortices form a chaotic tangle. Evolution of the quantized vortex tangle is determined by its line-length density but also by various geometrical measures of vortex lines forming the tangle. The microscopic dynamics of vortex tangle is studied to derive evolution equation for average binormal to the vortex lines - the important vector measure which control the growth of vortex tangle. The binormal anizotropy vector is found to be sensitive to changes of both magnitude and direction of the counterflow. The obtained equation is to supplement the Vinen equation for line-length density. The proposed system of equations is then examined both analytically and numerically. It is shown that the system is applicable in analysis of the transients in which the counterflow changes its direction. It allows also the analysis of the processes in which the counterflow is periodic with various frequencies. The tangle response to the counterflow orthogonal signal in which the counterflow changes periodically from $\mathbf{V_{ns}}$ to $-\mathbf{V_{ns}}$, can be used to validate the proposed system of equations. According to the Vinen description such signal sustains the steady tangle (the generation term in the Vinen equation depends on the absolute value of the counterflow), while in the proposed approach the tangle evolution is much more complex and depends on the signal frequency. As one may expect, above some critical frequency (determined by the initial tangle density and the value of counterflow) the line-length density tends to zero.