Dynamics of twisted vortex bundles and laminar propagation of vortex front

E. B. Sonin

Racah Institute of Physics, Hebrew University of Jerusalem, Jerusalem 91904, Israel

The interest to twisted vortex bundles arose in connection with experimental studies of the transient process of establishing of stable vorticity in rotating superfluid ^{3}He-B. The twisted vortex bundle appears in an originally vortex-free rotating container with a superfluid when vortex lines being injected at container's bottom expand into the rest part of the container. The focus of previous experimental and theoretical studies was possible turbulence of the vortex front and the transition from the laminar to the turbulent regime. Meanwhile a proper dynamical theory of the laminar regime of the propagating vortex front is still lacking aside from rough estimations of the dissipation rate and the velocity of the vortex front. However, without a satisfactory theory of the laminar regime it is impossible to have a reliable physical picture of the more complicated turbulent regime or of the transition between the laminar and the turbulent regime. The present work suggests the theory of twisted vortex bundles on the basis of the dynamical equations describing slow vortex motion taking into account Tkachenko rigidity.[1] The developed theory is applied to a twisted bundle terminated at the container lateral wall when the vortex front (the bundle segment diverging to the wall) propagates along the container axis. Special attention was devoted to the $T = 0$ zero limit, when mutual friction vanishes and the transition to the turbulent regime is expected as confirmed in experimental observations.

[1]E.B. Sonin, Rev. Mod. Phys. **59**, 87 (1987).