Collapse of vortex lines in hydrodynamics and its sequences

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Abstract

A new mechanism of collapse in hydrodynamics for incompressible fluids is suggested. Connected with breaking of vortex lines, collapse results in formation of point singularities of vorticity. At the collapse point the vorticity value $|\mathbf{\Omega}|$ blows up as $(t_0 - t)^{-1}$ where t_0 is a collapse time, and its spatial distribution at $t \to t_0$ tends to quasi two-dimensional: along "soft" direction collapsing area compresses according to the law $l_1 \sim (t_0 - t)^{3/2}$, and along two other "hard" directions like $l_2 \sim (t_0 - t)^{1/2}$. It is shown that a given scenario of collapse takes place in the general situation for integrable hydrodynamics with the Hamiltonian $\mathcal{H} = \int |\mathbf{\Omega}| d\mathbf{r}$. The conclusion about collapse made is based on usage of the vortex line representation [2] according to which each vortex line is labeled by two-dimensional Lagrangian marker and another coordinate coincides with a curve parameter given the line. Sequences of such type of collapse are discussed for high-Reynolds number turbulence.

References

[1] E.A.Kuznetsov and V.P.Ruban, JETP, **91**, 775 (2000).

[2] E.A.Kuznetsov and V.P.Ruban, JETP Letters, **67**, 1076 (1998).