

# Critical review of vortex dynamics in supermedia and cautious discussion of unsolved problems

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## Abstract

At late 1980's there were two fundamental and outstanding problems in vortex dynamics in supermedia: The theoretical problem of the apparent contradiction between the theory of Bardeen-Stephen at one end and the Nozieres-Vinen-de Gennes theory at other end; and the experimental problem of the Hall anomaly in superconductors and its cousin of mutual friction in superfluids. The origin of theoretical problem apparently dated back to L. Landau in 1940's. There have been many serious efforts to solve those problems during past two decades.

In my talk salient features of vortex dynamics in super media will be summarized and critically reviewed. Emphasis will be placed on the efforts which bridge the microscopic theories and constraints and the vortex dynamics with its experimental consequences. Pure phenomenological type approaches will not be considered, because there are plenty of other reviews of this type of approaches; and any experimental data could be explained by an *ad hoc* set of parameters.

Recent examples are: the demonstration of prominent role of topology in vortex dynamics; the solution to the Hall anomaly which once bothered Bardeen, de Gennes and many others; the unified microscopic treatment of both transverse and frictional forces on moving vortex. The fundamental dynamical equation of vortex matter can now be cast into the elegant form of quantum dissipative dynamics of Leggett with Berry phase. Together with the Kosterlitz-Thouless transition, we have finally reached a coherent picture on both thermodynamic and dynamical roles played by vortices. The key historical progresses are discussed with a broader perspective, with the post-high  $T_c$  superconductor era, the quantum era, in mind. A few outstanding open problems may provide a reader a useful guidance and an interesting perspective.

## Sample references

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