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Comment on "Vortex of Fluid Field as Viewed from Curvature" [Commun. Theor. Phys. 43 (2005) 604]

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Abstract *Here, we make comments to the conclusions of the paper: LIU Shi-Da, SHI Shao-Ying, LIU Shi-Kuo, et al., "Vortex of Fluid Field as Viewed from Curvature" [Commun. Theor. Phys.* **43** *(2005) 604].*

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1 Introduction

In a recent paper, Liu *et al.*[1] used local curvature of the streamlines to explain the vortices of the 2-dimensional fluid fields. Liu *et al.* said that the vortices "can be represented by curvature c, which varies with arc length s" of the streamlines; also they said that "the variance of point (x, y) with arc length in stream line satisfies a 2-order variable-coefficient linear ordinary differential equation" (hereafter referred to as Eq. (5)). Also, Liu *et al.* said that "the type vortex can be analyzed qualitatively by this ordinary differential equation". To arrive to the last affirmation, Liu *et al.* made in their paper the section 4 named "Qualitative Analysis of Vortex Structure". In conclusion, Liu *et al.* presented their ideas of the relation of curvature with the vortices as some important fact in the investigation of the vortex theory; however they did not compute the streamlines with Eq. (5) but they said that they used it to "analyze qualitatively the type vortex, from common circular vortex, spiral vortex to Karman vortex street etc. fluid field" and they said "We did not compute the stream line from curvature $c(s)$ but analyze qualitatively ordinary differential equation, which is relates to curvature $c(s)$ to derive the vortex type from physical view".

Part of our investigation is related on the phenomenon of the vortex in fluid fields; concretely in the concept of the vortex, the vortex boundary and the general boundary surfaces (Herrera,[2] Herrera *et al.*,[3] Herrera and Pallares,[4] Herrera,[5] Herrera and Pallares[6]). After read the article of Liu *et al.* we would want to make the following comment.

2 Comment

The concept of vortices is as old as the subject of fluid dynamics; yet, a universal accepted definition of a vortex is still lacking. The most important and influential work about the problem of give a definition of a vortex was the work of Jeong and Hussain.[7] Jeong and Hussain examined the deficiencies of the definitions related with de local minimum pressure, closed or spiral pahtlines (or streamlines), vorticity magnitude, and previous proposed definitions by Chong *et al.*[8] and Hunt *et al.*[9] After the work of Jeong and Hussain other scientific proposed new definitions based on local criteria or non local criteria in their works; some of the most recent and important works are (in chronological order): Grosjean *et al.*,[10] Michard *et al.*[11] Roth and Peikert,[12] Cucitore *et al.*,[13] Peikert and Roth,[14] Graftieux *et al.*,[15] Wu *et al.*,[16] Haller,[17] Chakraborty *et al.*,[18] Wu *et al.*[19]

Liu *et al.* said "vortex can be represented by curvature c"; but they did not say how was this representation. We agree with this statement; in fact, in Herrera and Pallares,[6] we will present a new method of define the vortical large-scale structure in three dimensional flows using the curvature, the torsion and the integration. However, Liu *et al.* did not make any method of definition or representation of a vortex.

Liu *et al.* have given a differential equation (Eq. (5)) that relates the curvature with the normalized velocity of the curves. But this Equation (5) does not give any new information about the stream lines. They tried to use Eq. (5), and they used it in the section 4 of their paper. The resume of this section 4 is that Liu *et al.* said that if a curve has constant curvature then the curve is a circle; and that if the curvature of a curve is s or $1/s$ then the curve is a spiral; and that if the curve has curvature $\sin s$ then the curve is a Karman street. However those statements are elementary and very well known without necessity of using Eq. (5).

With the actual definitions (see references) the concept of vortex are not defined using closed or spiral streamlines. But even if we look the globally closed or spiral streamlines, in fluid mechanics the function of curvature of the streamlines is always highly complicated. Also the curvature never is an initial data, normally is the velocity and Eq. (5) does not give any new information about the streamlines.

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