The vortex-in-cell method for the study of three-dimensional vortex structures

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Abstract The vortex particle method for numerical simulation of the 3D vortex structure evolution was used. Validation of the method was tested for the study of a single vortex ring by comparing the computed translation velocity with the theoretical formula and for the leap-frogging phenomenon for two rings with the same circulation.

Our paper is clear as a bell
On the method of vortex-in-cell;
For vortical strings
And leap-frogging rings
The method works plausibly well.

1. Introduction

Vorticity plays a fundamental role in all real fluid dynamic phenomena and for this reason the vortex method in the study of the fluid dynamics cannot be overestimated. In computation the "vortex particle" permits direct tracing for the evolution of the vorticity. Now it seems that the 2D vortex particle method is well grounded in that many numerical and theoretical results have been obtained (Ould Salihi & at al 2000, Kudela 1999). On the other hand, the 3D vortex method must still be developed. Generally the vortex method can be divided on the direct, free grid method based on the Biot-Savart law (Leonard 1985, Knio & Ghoniem 1990, Winckelmans & Leonard 1993) and vortex-in-cell methods where a grid is used for the velocity calculation but particles are used to track the vorticity (Christiansen 1973, Zawadzki & Aref 1991, Cottet 2000). The vortex-in-cell method is much faster then the free grid vortex method. Despite the fact that vorticity is divergence free, we introduced to the computation a vector particle that carries the "mass" of the vorticity. We are going to build a 3D program for the simulation of the viscous fluid flow using the vortex-in-cell method. Components that must be