

Numerical and experimental study of the wake behind a NACA0012 airfoil and comparison with theoretical models at moderate Reynolds numbers

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Axial wing tip vortex characterization is a relevant issue not only from a theoretical point of view, but also due to its interest in control engineering applications. An experimental study has been performed displacing a NACA0012 wing model at moderate Reynolds numbers in a towing tank. We have measured the velocity field at every cross section in the axial direction using Particle Image Velocimetry (PIV). In addition, numerical simulations were carried out under the same conditions by means of OpenFOAM. These numerical and experimental results show, among other features, the vorticity evolution of the core center in the wing tip vortex, describing the vortex intensity decay when the small scale wing model moves downstream.

Both, experimental and numerical results were compared with the theoretical models proposed by Batchelor¹ and Moore and Saffman² in order to compute their parameters for the trailing vortex along the axial coordinate. These theoretical models have been modified by introducing a new parameter which represents a virtual origin in the axial coordinate, according to C. del Pino *et al.*³ It has been observed a precise agreement between numerical and experimental results, as shown in figure 1. It has been also studied the evolution of the theoretical parameters as function of Reynolds numbers, aiming to obtain a fit model, that allow us to analyze the vortex stability in a future research.

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¹ G. K. Batchelor. *Axial Flow in trailing line vortices*. J. Fluid Mech. 20,645 (1964).

² D. W. Moore and P. G. Saffman. *Axial flow in laminar trailing vortices*. Proc. R. Soc. London, Ser. A 333, 491 (1973).

³ C. del Pino, L. Parras, M. Felli y R. Fernández-Ferá. *Structure of trailing vortices: Comparison between particle image velocimetry measurements and theoretical models*. Physics of Fluids. 23, 013602 (2011).

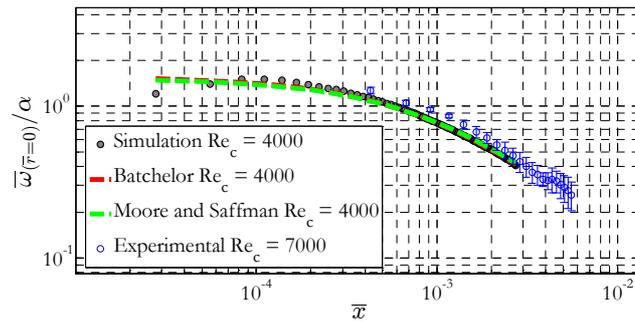


Figure 1: Axial evolution of the axial component of the vorticity at the vortex core.