The Domm System: Vortex Dynamics of wakes

VASILEIOS VLACHAKIS, Department of Engineering Science and Mechanics, Virginia Tech, Blacksburg, VA 24061, HASSAN AREF\(^1\), Fluid DTU, Technical University of Denmark, Lyngby, DK-2800, Denmark — A significant number of engineering applications involve the dynamics of wakes behind bluff bodies. The dynamical system of four vortices in a periodic strip, all of the same absolute magnitude, two of either sign, is considered here. We refer to this as the Domm system since Domm was the first to consider it in 1956. To study the stability and understand the nonlinear behavior in the vicinity of the vortex street configurations we expose the vortices to perturbations that preserve momentum and energy. The variables that Domm used in his analysis provide a canonical transformation from the original vortex coordinates, as is evident from later work by Eckhardt and Aref. In effect, a canonical reduction of the four-vortex system from four degrees of freedom to two is achieved. The reduced system still has the Hamiltonian as an integral. Hence, it “lives” in a three-dimensional space. Our analysis aims to understand the global dynamics of the system and to relate it to finite-amplitude perturbations of vortex streets and their dynamics.

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