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1. Secondary Structures in a Corotating Vortex Pair

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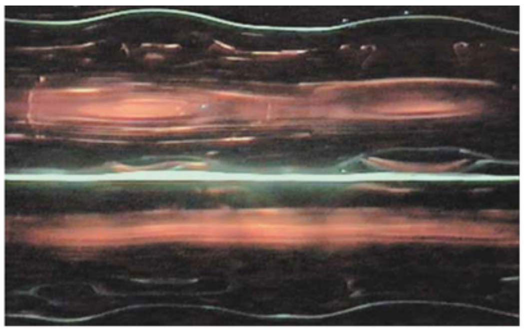
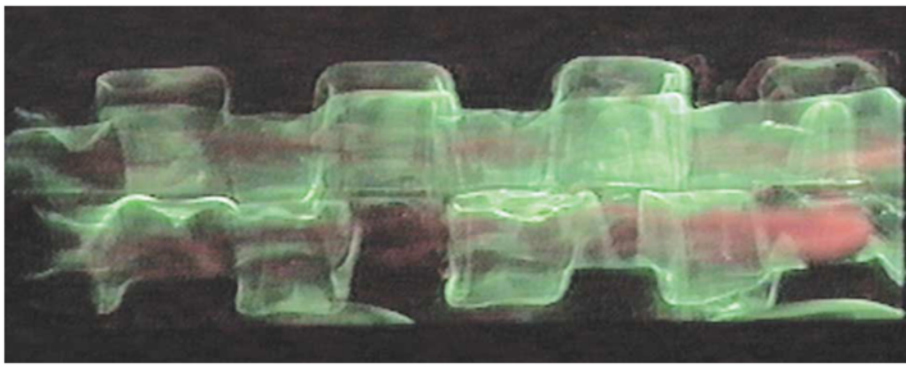
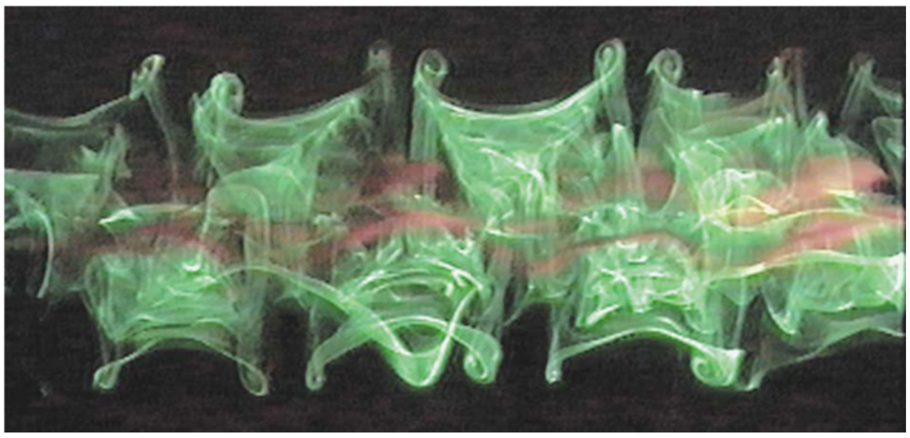
(1)



(2)



(3)



This sequence shows the evolution of two perturbed corotating vortices, generated in water using impulsively moved flat plates. The Reynolds number based on the circulation of one vortex is approximately 3000. The vortex cores are visualized using red dye (Rhodamin B), painted on the plate edges. In addition, a nylon thread coated with green fluorescent dye is placed in the middle between the two vortex centers (1). Illumination is achieved in a sheet (1) or in volume ((2) and (3)), using light from an Argon laser, and the flow is observed from the side, i.e. perpendicular to the vortex axes (the field of view is approx. 25 cm wide in (2) and (3)). The corotating vortices, which in their basic state rotate around each other, are perturbed by adding a sinusoidal deformation to the edge of the vortex-generating plates. This creates a periodic perturbation of vorticity between the vortices, near the dyed thread, where the basic flow exhibits a hyperbolic stagnation point. The corresponding strain stretches the vorticity perturbation into secondary vortex pairs, which are perpendicular to the primary vortices. At an early stage, this process leads to the peculiar square dye patterns in (2). In (3), taken about half a rotation period of the primary pair later, the secondary vortex pairs are clearly visible, as they now wrap around the outside of the corotating pair. The presence of the secondary structures amplifies the wavy deformation of the primary vortex cores, which are still visible in red. At a later stage, the two primary vortices merge into a single one, and the interaction with the perpendicular secondary vortices leads to a rapid breakdown of the flow into turbulent small-scale structures.