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NUMERICAL INVESTIGATION OF FREELY FALLING OBJECTS USING DIRECT-FORCING IMMERSED BOUNDARY METHOD

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The dynamic behavior of fluid-structure interactions in a Newtonian fluid flow is investigated numerically. A direct forcing immersed boundary method is validated and demonstrated through a number of examples, which include (1) sedimentation of a freely falling circular cylinder (as shown in Fig. 1), (2) the drafting, kissing, and tumbling of two tandem falling circular cylinders (as shown in Fig. 2), and (3) a freely dropping ellipse (as shown in Fig. 3). The computational results of sedimentation of a freely falling cylinder agree well with [1-3], and those of free-falling two tandem circular cylinders agree well with [4,5]. For the freely dropping ellipse, the patterns of falling trajectories depend on initial angle of attack and aspect ratio of ellipse. At the considered aspect ratio of 0.25 and initial angle of attack of zero degree, the trajectories follow a fluttering and tumbling pattern. The motion of the ellipse appears to be very sensitive to perturbations resulting from the vortex shedding on its trail, which causes its trajectory to be chaotic.

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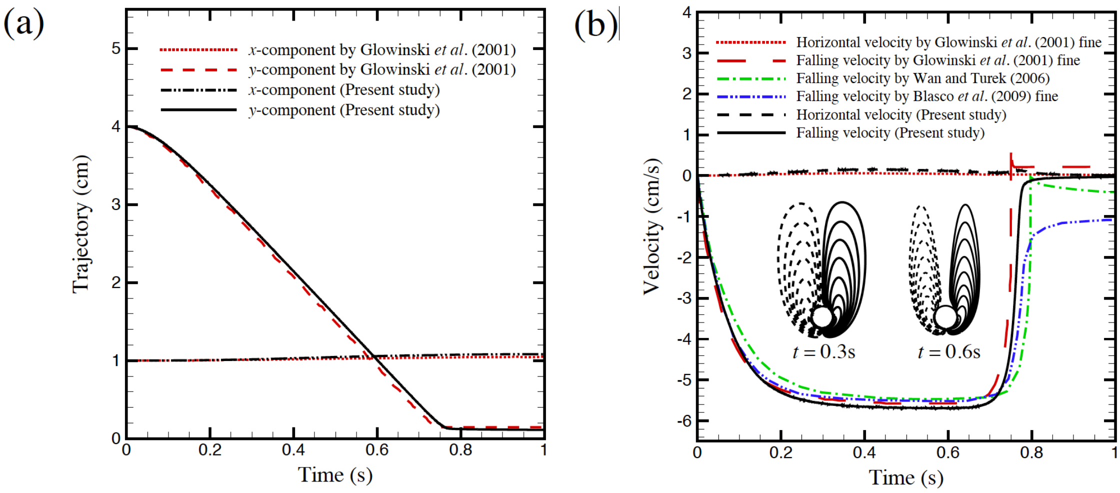

Figure 1.

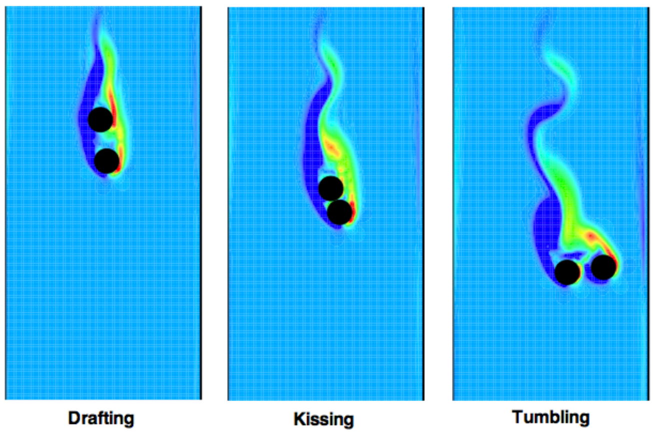

Figure 2.

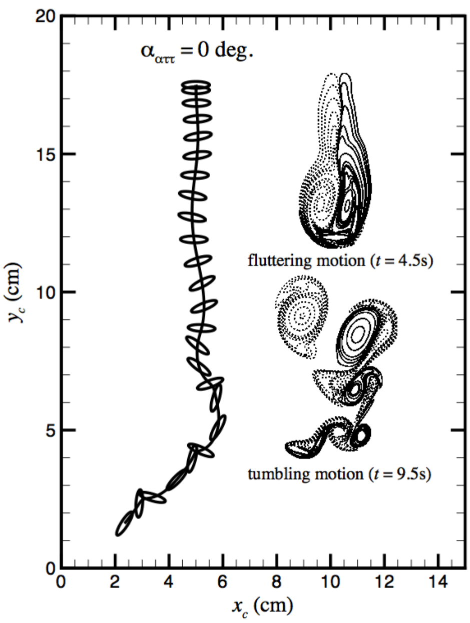

Figure 3.