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Dynamics and wake patterns of freely rising and falling spheres at Re = 500 M. HOROWITZ, C.H.K. WILLIAMSON, Cornell University — We study the dynamics of spheres rising or falling freely at $Re = 500$. All falling spheres, whose mass ratio (or relative density) $m*$, exceeds 1, descended rectilinearly. For rising spheres, there exists a critical value of the mass ratio below which the sphere undergoes large-amplitude oscillations, $m*_{crit}= 0.36$. This motion occurs in a vertical plane; no helical trajectories are observed. Initial wake visualizations showed that rather than the two alternately signed vortex loops found in the flow past stationary spheres, the wake of a vibrating freely rising sphere comprised four vortex structures per cycle of oscillation. However, due to the small size and high oscillation frequency of the freely rising spheres, the exact nature and formation of these structures remained unclear. Further studies were performed in a towing tank, prescribing the motion of the sphere based on the measured displacement of the rising spheres. We are able to use much larger, slower-moving bodies while matching the Reynolds numbers of the rising spheres. These experiments result in the same vortex pattern, and reveal that the four structures found in the wake of the rising sphere are vortex rings. What previously appeared to be unusually sharp bends in the counter-rotating vortex pairs are very weak loop-shaped structures, delivering a total of six vortical structures per cycle. Immediately preceding these structures, the two vortices in the pair cross over one another, providing a mechanism for the change in sign of the streamwise vortex pair as the body moves from one half cycle to the next.

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