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Axisymmetric interaction between a laminar vortex ring and a sphere – stationary sphere case.[1] PAULO FERREIRA DE SOUSA, JAMES ALLEN, New Mexico State University — The interaction between a vortex ring and a neutrally buoyant sphere centered in the axis of travel of the ring is one of the simplest fluid-structure interactions and was commented on by Lord Kelvin. A starting case in order to calculate this case is to have a laminar vortex ring interact with a stationary sphere. In order to calculate this interaction, a high-order 3D immersed boundary flow solver was used. The momentum equations are spatially discretized on a staggered mesh by finite differences and all derivatives are evaluated with implicit 10th order compact finite difference schemes. The fourth order accurate Runge-Kutta scheme was used for temporal discretization. The immersed boundary was implemented through a direct forcing procedure. It is shown that as the vortex approaches the sphere, significant secondary vorticity is generated on the surface of the sphere. As the interaction continues and the vortex ring diameter increases in response to the presence of the sphere, a secondary vorticity ring wraps around the front of the advancing vortex. This secondary ring separates from the surface and breaks up as it interacts with the primary ring. For Reynolds number around 1000, a three-dimensional azimuthal instability, which appears to be of centrifugal nature, grows on the secondary vorticity ring.

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