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Dynamics of Isolated Columnar Vortex in Tube with Sinusoidal Cross-section

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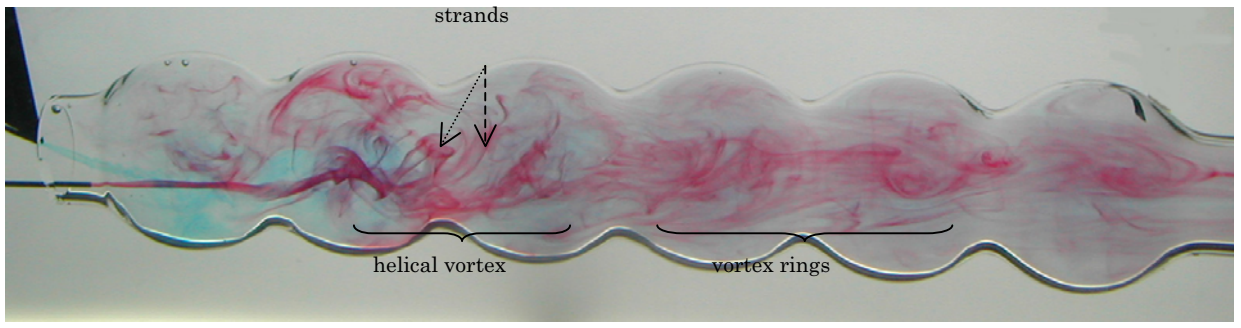
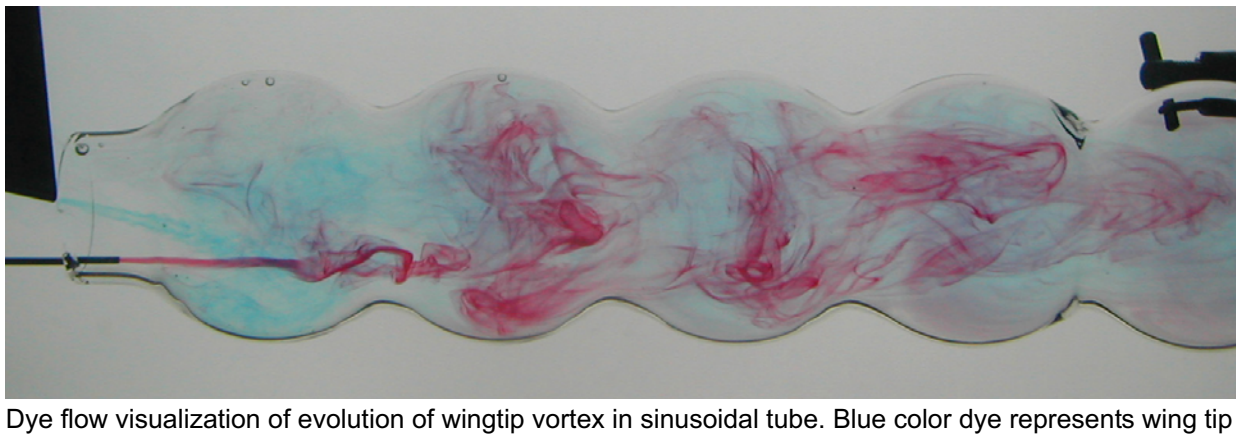
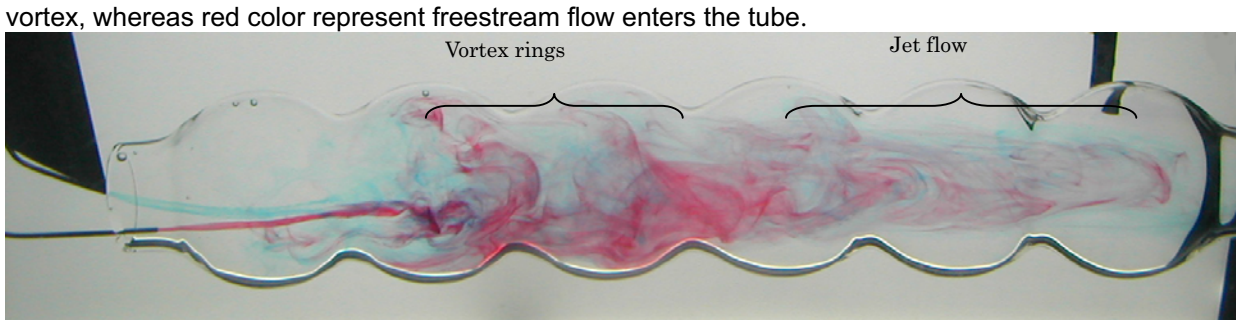




Dye flow visualization of evolution of wingtip vortex in sinusoidal tube. Blue color dye represents wing tip vortex, whereas red color represent freestream flow enters the tube.



Evolution of vortex in sinusoidal tube. The jet flow patterns downstream after the fourth lobe is clearly visible.

The dynamics of the isolated columnar vortex in tube with axially sinusoidal cross-section, under pulsatile freestream flow, due to the tube geometry was studied. There is the redistribution of the axial vorticity at the starting point into the azimuthal vorticity downstream $\left(\omega_z \vec{e}_z \rightarrow \omega_\theta \vec{e}_\theta\right)$. Theoretical analysis, based on inviscid model, has shown that the axial vorticity decreases exponentially, whereas the azimuthal vorticity increases likewise. The isolated columnar vortex was the wing tip vortex created by the NACA0012 wing section of 8 cm chord placed in water at freestream of 5 cm/s and at 20 degree and angle of attack. This vortex was made visible means of food-coloring dye flow visualization. The sinusoidal tube had its minimum diameter of 3 cm, and the sinusoidal wave length of 8 cm. The columnar vortex gradually changed to helical vortex or series of vortex-rings-like structure. The flow downstream became simply a jet flow.