ABSTRACT: In this presentation, we shall briefly summarize some of the ongoing research projects in the Fluid Dynamics Research Laboratories at Cornell, and thereafter launch into the main topic, concerning recent discoveries and research in vortex-induced vibration (VIV). We pay special attention to the vortex dynamics and energy transfer that give rise to modes of vibration. We present new vortex wake modes, often in the framework of the Williamson-Roshko (1988) map of vortex modes compiled from forced (controlled) vibration studies. New modes include the periodic formation of vortex triplets, co-rotating vortices and vortex rings. We shall present some new ultra high-resolution controlled cylinder vibration experiments, which are able to predict catastrophic jumps and several other characteristics of free vibration response, and to help understand the origin of hysteretic and intermittent switching mode transitions.

We study the effect of the Reynolds number (Re) on the dynamics and vortex formation modes of spheres rising or falling freely through a fluid (where \( Re = 100-15,000 \)). Since sphere oscillation was first reported by Newton (1726), the fundamental question of whether a free sphere vibrates has been the subject of a number of investigations. Mass ratio is clearly an important parameter. We find that falling spheres always move without vibration. However, in contrast with previous studies, we discover that a whole regime of buoyant spheres also rise through a fluid without vibration! It is only when one passes below a critical value of the mass ratio, that the sphere suddenly begins to vibrate periodically in a zigzag trajectory. We do not observe helical or spiral trajectories unless the experiments are conducted in disturbed background fluid. We find that these wakes comprise periodic sequences of vortex rings, which we define as the ’R’ and ’2R’ and ’4R’ modes. We present a new regime map of dynamics and vortex wake modes as a function of the mass ratio and Reynolds number \((m^*, Re)\).

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Refreshments will be served before the seminar. Reception after the lecture in room 5-314 by invitation. Please contact Maggie Sullivan sullmag@mit.edu or maria@mit.edu with any questions.