PHYSICAL MATHEMATICS SEMINAR

TOPIC: BENDING LEAVES AND FLAPPING FLIGHT:
TRANSITIONS IN FLOW-BODY INTERACTION PROBLEMS

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ABSTRACT:

The coupled motion of fluids and solids in contact is common in the biological world, and leads to unexpected phenomena and new problems for theoretical mechanics. These phenomena can often be understood by identifying new length and time scales intrinsic to the fully-coupled system. I will discuss recent work on two problems in this area, both of which arose from experiments in the Applied Mathematics Lab at Courant.

The first study concerns the bending of a flexible 2-D body immersed in a steady planar flow, and is motivated by the flexibility of organic structures in fluid environments. In our model we find a transition from the quadratic growth of drag with flow speed typical of rigid bodies to a much-reduced 4/3-power law. We also find that the body and wake assume a unified, parabolic form. I present an asymptotic argument which explains the governing phenomenon: the formation of a "tip region" on the fiber, which gives rise to global self-similarity.

In the second problem, I study a fluid flow problem at the transition between low- to high-Reynolds-number locomotion. A 2-D rigid wing is flapped in the vertical direction and is free to move horizontally. Above a critical flapping speed, it has been shown experimentally and in my numerical study that the wing becomes unstable to horizontal motion. I will explore the intriguing coupled dynamics in the neighborhood of this critical speed, in which the nondimensional body mass plays an important role. This problem was originally inspired by the swimming strategies of small molluscs, but generally improves our understanding of the generation of thrust in flapping flight.

DATE: TUESDAY, FEBRUARY 10, 2004
TIME: 2:30 PM
LOCATION: Building 2, Room 338

Refreshments will be served at 3:30 PM in Room 2-349

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