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This study addresses the flow mechanisms over an accelerating rotating wing using a combined experimentalnumerical approach. The results correlate between the vorticity production and the spanwise velocity component and characterize the lift evolution time scales involved. These flow mechanisms reflect a more realistic characterization of the aerodynamic performance of flapping wings compared to the revolving wing representation.

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17:30–202A+B

Aerodynamics of hovering flight in bat

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In this paper, we study numerically the aerodynamics in the hovering of a small-sized bat Glossophaga soricina. We developed a three-dimensional Navier–Stokes solver which can handle large deformation of the bat's membraneous wing in flapping motion. The kinematics of the wing is constructed using the data measured in experiment. Our prediction shows that the lift generated is almost sufficient to support the weight of the bat. We also provide the first evidence from simulation that the upstroke in bat's hovering is inactive in lift generation. The near-filed vortex structures is also discussed.

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17:50–202A+B

Unsteady swimming of small organisms

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Planktonic organisms ubiquitously show unsteady, impulsive, or erratic behavior to attack a prey or escape a predator in natural environments. Despite this, the role of unsteady forces such as history and added mass forces on their swimming motion is poorly understood. In this paper, we derive the fundamental equation of motion for a spherical organism swimming in a nonuniform flow at low Reynolds number regime. We show that history and added mass forces are important for finite $Sl \cdot Re$ where Reynolds number, Re, is the ratio of inertial to viscous forces and Strouhal number, Sl, is the ratio of the time scale of unsteadiness to the convective time scale. This is particularly important since many organisms such as Paramecium and copepod live in this range.

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FM10: Low Reynolds number flow
09:20–10:40, Tuesday, 21 August
Dominique Barthes-Biesel, France, Chair
John Brady, USA, Chair
Room: 203A+B

09:20–203A+B

Reaction-induced motion: chemical swimming, sailing and surfing

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Recent experiments demonstrated the ability to power the motion of micro- and nano-scale objects by using surface catalytic reactions - so-called catalytic nanomotors. The chemical reaction creates local concentration gradients of the reactant (the fuel) and product species and their resulting diffusion entrains the motor, a process we call "chemical swimming". For slow reactions the reaction velocity determines the speed. For fast reactions the motor velocity can not exceed the diffusive speed of the reactants. Motor speeds for different reactant concentrations and motor sizes are discussed and the theoretical predictions are compared with Brownian Dynamics simulations. It is also shown that directed reaction-induced motion can be realized by controlling the shape of the motor - "chemical sailing". Finally, motors confined to an interface can "surf" the reaction-induced concentration gradient. Through these mechanisms the motor is able to harness the ever-present random thermal motion via a chemical reaction to achieve directed autonomous motion.

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09:40–203A+B

Passage of a DDS nano-particle through the cleft of capillary wall with glyco-chains

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A novel drug delivery system (DDS) such as using a biomimetic carrier is awaited the practical use. In particular, the transportation of DDS nano-particles through the cleft of blood capillary wall is of crucial importance in understanding its fundamental aspects and in developing the application technique. In this paper, we shall present numerical calculations in the following two cases: (i) the particle is deformable but the wall is rigid, and (ii) the particle is rigid but the wall is covered by deformable glycocalyx.

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