Lab Notes

Bubbly Breakdowns: Bubbles add festive fizz to champagne, but when microscopic froth forms in metallic glass it signals a brittle breakdown. Materials scientist Michael Falk studied how bubbles form and expand when metallic glass is pulled outward by negative pressure, such as suction produced by a vacuum. His team's findings—published in *Physical Review Letters*—reveal that bubbles emerge in a way predicted by classical theories. But bubbles also compete with glass reshuffling its atoms to release stress applied to particular locations in a process called "shear transformation."

Light Beats: Researchers are investigating whether light, rather than electric jolts, can be used to treat irregular, life-threatening heart rhythms. In a paper published in *Nature Communications*, five biomedical engineers from Johns Hopkins and Stony Brook universities have proposed using biological lab data and an intricate computer model to test whether light-responsive proteins called opsins hold the promise of treating heart ailments. Researchers would test the idea on highly detailed computer models of the heart (developed by Professor Natalia Trayanova, Murray B. Sachs Professor) that simulate cardiac behavior from the molecular and cellular levels, all the way up to the behavior of the whole heart.

Sea Sentinels Signal Ocean Changes

Sea Butterfly (L. helicina)

Ethereal and remarkably beautiful, sea butterflies *(L. helicina)* are curious marine creatures that have evolved to have a unique—and somewhat bizarre—approach to swimming.

They use wing-like lobes called parapodia to "fly" vertically through the water column to reach nutrient-rich waters, escape predators, and find mates. Their snail-like shells create a weight imbalance that gives sea butterflies a distinctive "wobble" as they swim. They then throw a mucous web—several times the size of their bodies—that acts like a parachute, allowing them to float suspended until they release the web and sink freely back down.

It is this unique swimming behavior that first intrigued Rajat Mittal, a professor of mechanical engineering at the Whiting School, who has long had an interest in computational fluid mechanics and bioinspired engineering. Mittal recently teamed up with oceanographer Jeannette Yen, director of the Center for Biologically Inspired Design at Georgia Tech, to study the kinematics of sea butterfly movement in connection with ocean acidification. The project is supported by a three-year $245,000 grant from the National Science Foundation's Polar Programs.

Sea butterflies are minuscule creatures—measuring 1 to 3 mm—but they play an enormous role in polar ecology, serving as a food source for sea birds, marine mammals, and commercially important fish including salmon.

They are also extremely vulnerable to ocean acidification—the ongoing decrease in the pH of the Earth's oceans caused by the uptake of carbon dioxide from the atmosphere. Over the past century, the pH of the ocean has decreased from 8.2 to 8.1—faster than it has in the last 300 million years.

As ocean pH falls, the sea butterfly's aragonite shell thins, changing its body-to-shell ratio, which in turn impacts the creature's propulsion and swimming abilities—an unfortunate effect that Mittal and Yen hope to investigate as an early-warning indicator of ocean acidification.

The two are developing a bioassay that uses high-speed, high-resolution videography and 3-D tomographic particle velocimetry to examine the hydrodynamics and body trajectory of freely swimming sea butterflies. This is a novel approach to locomotive studies of planktonic organisms; traditionally, data has been captured in just two dimensions using methods that tethered the organism within the field-of-view of the camera.

Mittal will use the data collected with the new, state-of-the-art tomography system to develop computational models to unravel the creature's unique propulsion mechanisms—and to help scientists quantify the ecological impact of ocean acidification.

In addition to the ecological questions, Mittal asks: "What are the advantages to the sea butterfly's solution to underwater locomotion? Are there design solutions that can be transferred to bioinspired underwater microrobots?"

In April, Mittal and Yen will travel to the Antarctica Palmer Station on Anvers Island to collect the preliminary data that Mittal will use as a basis for his first computer models of sea butterflies swimming through the water.

—Mara Low