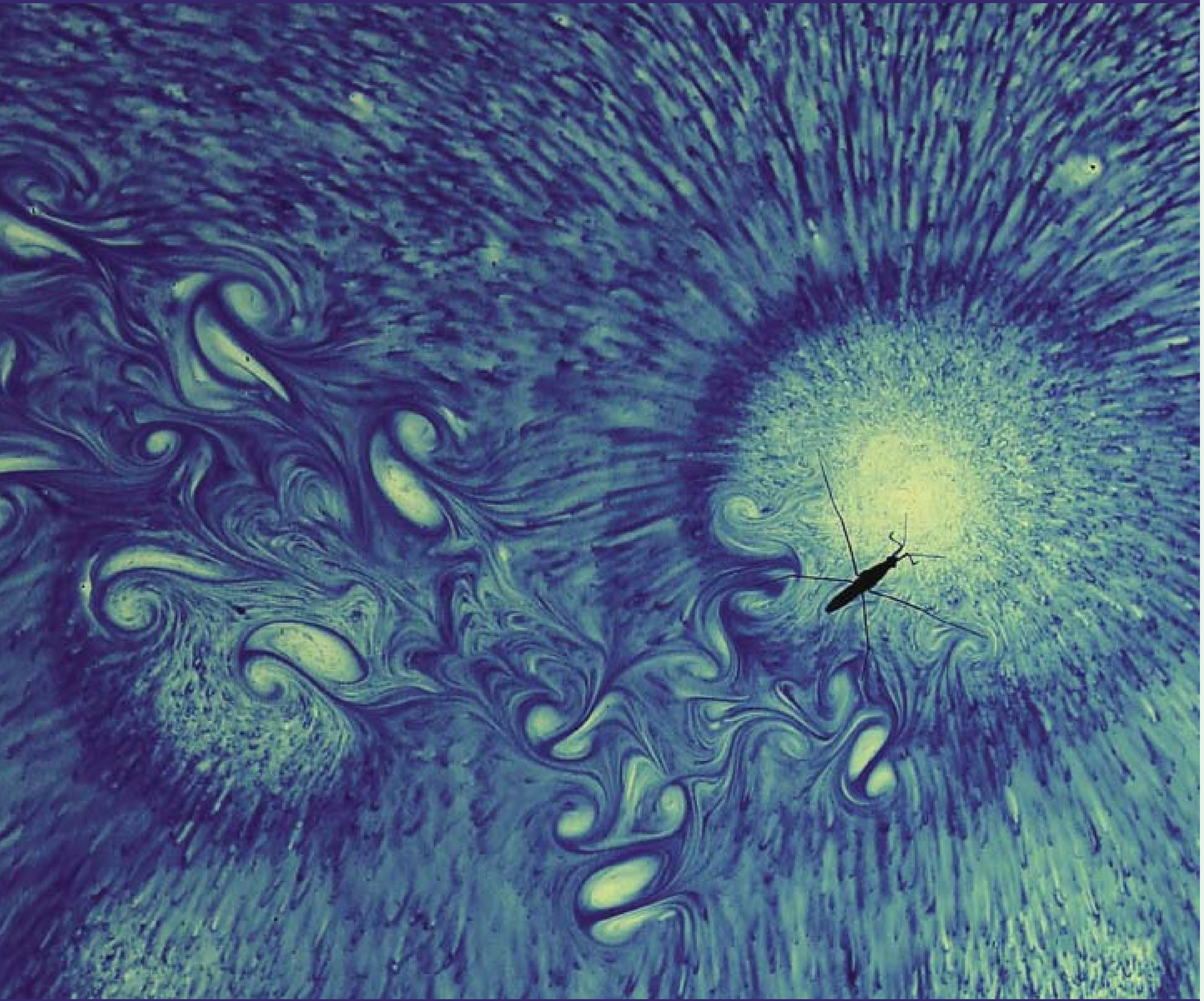

Vortices left by a light-seeking water strider are highlighted in a photograph taken after the sodium salt thymol blue has been sprinkled on the water surface, prompting convection that creates texture. In the center of the starburst a chunk of thymol blue has reduced the local surface tension, causing the dyed surface layer to be swept clear. When the fluid is illuminated from below, the water strider heads for the starburst. (Reprinted by permission from *Nature* 424:663–666 (2003) copyright 2003 Macmillan Publishers Ltd.)

Felice Frankel

John Bush is associate professor of applied mathematics at the Massachusetts Institute of Technology. In his research, he uses experimental and theoretical techniques to elucidate fundamental problems in fluid dynamics. I first saw some of John's still photographs of water responding to various forces and since then have paid close attention to his stunning images. I am always delighted to be reminded that research can be presented with both mathematical and visual beauty.

F. F. Can you tell us what brought you to investigating the motion of water striders?

J. B. Much of my recent work in fluid mechanics has been focused on flows dominated by the influence of surface tension. I have long been looking for outstanding problems in the biological sciences in which surface tension is important. When I learned of Denny's paradox—the assertion that infant water striders should be unable to move—I realized that the dynamics of water-walking insects was just such a problem.

F. F. "Denny's paradox?"

J. B. It was generally believed that water striders relied on waves to transfer momentum to the underlying fluid. A standard result from hydrodynamic theory indicates that, in order to generate waves, an object moving at the surface must exceed the minimum wave speed (about 23 centimeters per second at an air-water interface). Infant water striders' peak leg speeds may be less than this critical value. It was thus thought that they would be unable to generate waves, unable to transfer momentum to the underlying fluid, and so unable to move. The fact that infant water striders *can* move resulted in the conundrum known as Denny's paradox.

F. F. How did you capture this particular still image?

J. B. It was shot by my students (David Hu and Brian Chan) with our standard digital Sony still camera. The 2-centimeter-deep fluid layer was contained within a shallow plexiglass tank placed on a light table, which gave the fluid its apparent luminescence. We were hoping for the strider to follow a straight line, and so leave a linear trail of vortices. The pattern of the thymol blue, the path taken by the strider, and the resulting lines were simply fortuitous. Needless to say, many such photos were taken, but this was our favorite.

F. F. What kind of information do you get from measuring the shape and size of the vortices?

J. B. The form of the vortices, in addition to their speed, indicates the magnitude of the momentum that they transfer. In order for water striders to move, they must transfer momentum to the underlying fluid; it was previously thought that they did so through waves. The point of our study was to show that vortices rather than waves are responsible for the dominant momentum transfer in the wake of the strider.

F. F. Much of your other work captures phenomena through photography. Would you say that you are engaged both visually and mathematically as you first approach a question ... or does the math come later?

J. B. All of my research has its origins in our laboratory, and is focused on elucidating new physical (specifically, fluid mechanical) phenomena. Photography is the simplest means by which to clearly present the flow of interest to the reader. The mathematical modeling is both motivated and constrained by our experimental observations, and the two typically evolve in tandem. However, in my work the mathematical modeling is rarely if ever as elegant as the phenomenon of interest.

Felice Frankel is a science photographer and research scientist at the Massachusetts Institute of Technology. She is now at work organizing Image and Meaning 2, an MIT conference to be held in Los Angeles in June 2005 (http://web.mit.edu/i-m). Address: c/o American Scientist, *P. O. Box 13975, Research Triangle Park, NC 27709-3975. Internet: felicef@mit.edu*