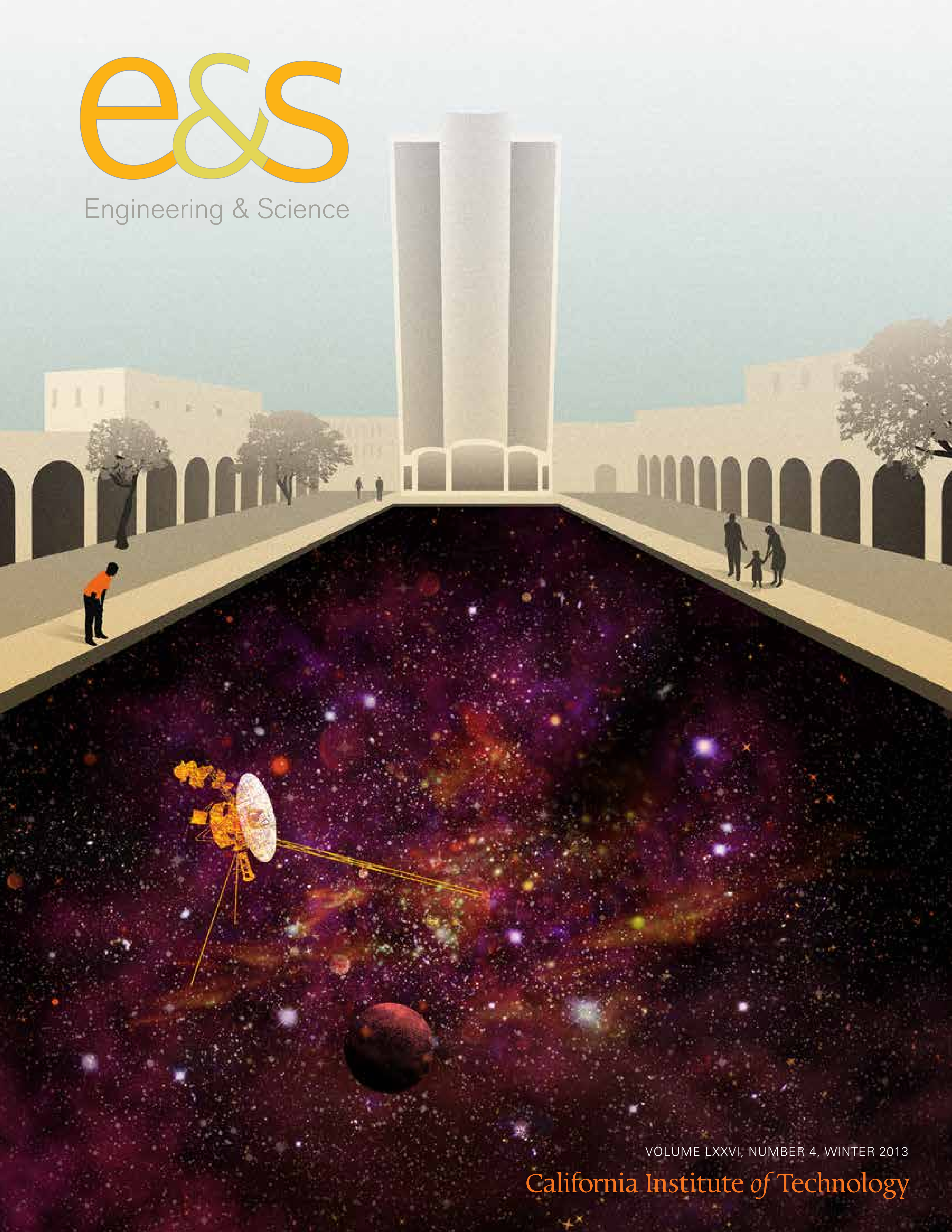

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LAB SPACES

BY JESSICA STOLLER-CONRAD

When asked to envision a typical workspace, most of us imagine neutral colors, generic cubicles, and fluorescent lights. The work done in Caltech's offices and laboratories, however, is anything but typical—and that uniqueness is often reflected in the design of the spaces within which the Institute's researchers do their most creative work. Some labs were designed to include artistic elements that reflect a specific research interest; in others, sophisticated instruments are themselves objects of beauty. Here are some examples of Caltech's uniqueness and creativity at work—literally.

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When Markus Meister, Lawrence A. Hanson, Jr. Professor of Biology, came to sunny California from Boston in the fall of 2012, he quickly noticed that his new laboratory, ironically, had very poor lighting. Even more ironic? Meister studies the neurobiology of the visual system, or how our eyes process images. When he met with architects to redesign the space, they proposed not only optimizing the flow of natural light but also adding another prominent light source in the form of the long, luminous wall seen at left. Though light from the wall isn't used in experiments, Meister considers it an important design feature, facing the laboratory's common area and inspiring the researchers in their adjacent glass-walled offices. But don't worry about Meister getting tired of a bright blue wall shining into his office. "My only contribution to the design was to require that the color be able to change to anything we want," he says. "Most of the time we use all colors of the rainbow in a slow rotation."

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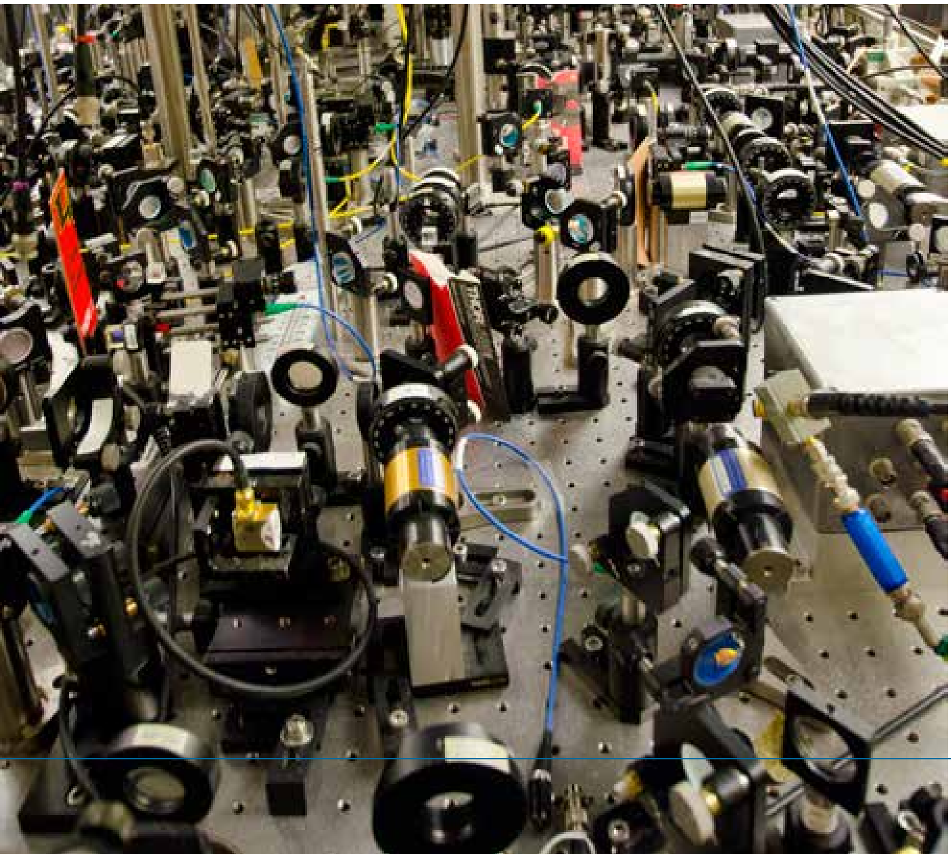
The cleanroom at the Kavli Nanoscience Institute—designed to be as free of dust and microbes as possible—is an important resource for Caltech's nanotechnology researchers, who design high-tech components 10 to 100 times smaller than any floating piece of dust. Right, Pawel Latawiec, a former undergraduate student in the laboratory of Axel Scherer, Bernard Neches Professor of Electrical Engineering, Applied Physics and Physics, uses a tool in the cleanroom to produce plasmonic chips—devices that increase the intensity of light—for use in the precise study of viruses and small biological systems. And that golden glow? It has a purpose, too: because the chips' photoreactive polymers are put into their functional patterns using ultraviolet (UV) light, those bluish-purple waves must be filtered out of white light in the room to prevent unwanted pattern changes. The resulting UV-less rays cast a yellow hue.



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This tangle of wire, glass, and metal is actually a carefully positioned network of optical instruments that Caltech scientists use to study the interactions between our macroscopic world and the realm of quantum mechanics—the set of physical principles that govern the behaviors of tiny subatomic particles. Researchers in the laboratory of Jeff Kimble, William L. Valentine Professor and professor of physics, use the blue fiber-optic cables in this setup to transport laser light through a series of optical instruments that can control and change the frequency, direction, intensity, and path of the light. The trip through the maze manipulates the light so that it can be used to cool atoms to less than 30 microkelvins—just shades away from absolute zero. The cold atoms resulting from this process can then be localized one by one within nanoscale structures fabricated at the Kavli Nanoscience Institute—allowing researchers to control the quantum interactions of single photons and atoms.

▼ *John Seinfeld, Louis E. Nohl Professor and professor of chemical engineering, studies where particles in the air come from and what they are made of. The atmosphere around us, he says, is a giant chemical reactor; the airborne particles that are the result of these atmospheric reactions generally contain a great deal of organic material that comes from the volatile organic compounds found in motor vehicle exhaust as well as in emissions from trees and vegetation. Seinfeld's research group simulates these organic reactions in the large transparent teflon chamber pictured below, which is surrounded by lights that mimic sunlight. The data gathered from these experiments at Caltech—which is a general source of much of the world's information on the formation of atmospheric aerosols—will help researchers understand where the constituents of smog come from and how they can be reduced.*

◀ *It would be difficult to walk into the lab space of Paul Sternberg, Thomas Hunt Morgan Professor of Biology, and not quickly realize that he's spent the last several decades at Caltech studying worms—specifically,* Caenorhabiditis elegans, *a tiny roundworm whose compact genome and easy-to-follow development have made it an excellent model for determining gene functions. Sternberg's laboratory features a wiggling worm design tiled into the floor, a worm-shaped desk (seen left, with Sternberg), and even a detailed representation of the worm's anatomy in a wall decal, a flattened computer rendering the worm's skin made transparent so that its organs are visible.*

▲ Jennifer Jackson's basement laboratory is underground, but her research digs even deeper to discover the properties of minerals that are nestled more than 600 kilometers below Earth's surface. Because researchers can't physically get down that deep—even the deepest drill hole only descends about 12 kilometers—Jackson, professor of mineral physics, has to simulate the high-pressure conditions of the interior of the planet. She does this using a tool called a diamond anvil cell—a schematic of which is represented in the floor tiles of her laboratory. In the photo above, the structures in blue represent the two diamond anvils. A mineral sample—represented by the red tile—is then compressed between the two anvils. Diamonds are used to compress the mineral sample because they are hard enough to stand up to the crushing pressures they themselves create, and transparent enough that Jackson and her team can shine a laser (represented in yellow) and X-rays through them—as well as through the sample—to measure physical changes in the sample.

▲ This fluorescent column of water is more than just an attractive design element in John Dabiri's lab space—it's also an experiment in progress. Dabiri, professor of aeronautics and bioengineering, uses this four-foot-tall water tank to study the effect that vertically migrating swarms of small organisms, such as brine shrimp, may have on the transport and mixing of nutrients in the ocean. Once the brine shrimp are released from a cage at the bottom of the tank, they are lured by the blue lights to try to reach the top, a process that involves a combination of passive floating and active swimming. This mimics their behavior in the wild, where various species of plankton migrate daily to the water's surface to eat, and swarm back down to avoid predators. The researchers then use a high-speed camera to measure the flow field and determine how much food and water from the bottom is dragged to the top by each swarm. While the effects of a single shrimp are, well, shrimpy, the millions of shrimps and other tiny swarming organisms that rise from the ocean floor each day may play a significant role in distributing the ocean's nutrients.