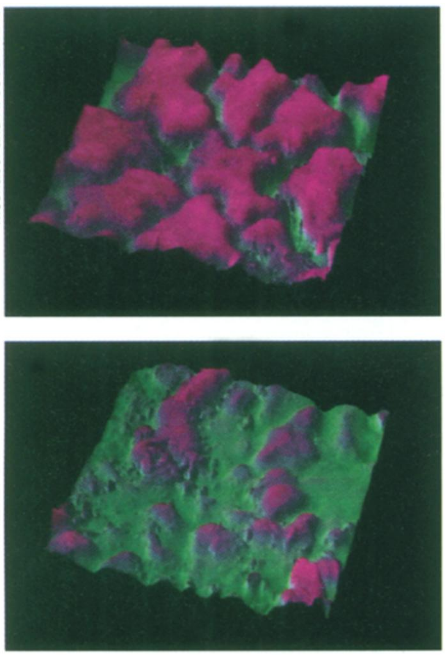
Mapping out a leaf's mountains and valleys

Cartographers have created topographical maps of much of the world, but they have overlooked at least one important area: the surfaces of leaves. Because a leaf's surface can make it more or less hospitable to microbes, insects, and insecticides, such maps would prove useful to a broad range of scientists, from biologists to agronomists.

Now, Wendy L. Mechaber of the University of Arizona in Tucson and her colleagues have remedied that oversight. Her team's maps "are an interesting development, and some will find [them] a very useful tool," says Sanford D. Eigenbrode of the University of Idaho in Moscow.

Surface features can determine how well water, agricultural sprays, or even beneficial microbes stay on a leaf, Mechaber notes. Moreover, the surface has a big effect on some of a leaf's residents, studies show. For example, to infect a plant, the bean rust fungus must distinguish minute variations in the topography of its leaves. When an insect sits on a leaf, the amount of its pheromones that escape into the air may depend on the thickness of the layer of fatty lipid molecules that coat most leaves and can absorb volatile compounds.

Mechaber and R. Jobe/ PNAS



Computer-generated, color-coded images of leaf surfaces, about 100 micrometers square. The largest mountain of lipids on the young leaf (above) is 6,327 nanometers high; on the older leaf (below), it is 4,374 nanometers.

Researchers have relied on scanning electron microscopes to create pictures of leaf surfaces. However, the pictures are distorted and provide inaccurate data on important features such as the height of the lipid layer, explains Mechaber.

Using atomic force microscopy, an imaging technique normally employed by physicists and materials scientists to measure much smaller objects, Mechaber and her colleagues magnified leaf sections from a perennial cranberry vine (*Vaccinium macrocarpon*) 1,600 times and determined their three-dimensional coordinates. When measuring height, they incorporated data only on the lipid layer and not, for example, data on surface hairs.

They then used a standard geologic mapping program to produce the topographical maps, they report in the May 14 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The scientists compared five leaves that grew during the current growing season with four older ones. The young leaves have more lipids, which formed "a regular pattern of broad expanses or plateaus," the team reports. The older leaves' surfaces lack both the broad, elevated areas and a clear pattern.

The wear and tear of exposure to organisms and the elements change leaves' topography over time, the group suspects, "much as geologic erosion preserves some land features while strongly changing others." — *T. Adler*

Schrödinger's cat: Two atoms in one?

Underlying the peculiar world of quantum mechanics is the notion that, under certain circumstances, matter can exist in more than one state or position at the same time.

Long held as an oddity of quantum mechanical theory, this property of matter has defied easy experimental realization. Even more exotic is the idea that the act of observation or measurement somehow determines which state exists at any given moment.

To illustrate quantum mechanics' strange nature, Austrian physicist Erwin Schrödinger proposed in 1926 a puzzling thought experiment. If a cat is placed in a sealed box and its fate—to live or die—is correlated with whether or not an atom radioactively decays, then the presence of the atom's decayed and undecayed quantum states translates into a cat that is simultaneously dead and alive—a highly counterintuitive idea.

Now, a team of physicists has managed to create a "Schrödinger-cat-like state of matter" in a single atom. By supercooling a beryllium atom with a laser, then prodding it with a rapid sequence of laser pulses, the physicists have managed to get the atom to oscillate in such a way that it exists "in the bizarre state of being in two well-separated positions at once."

"This situation defies our sense of reality," say Christopher Monroe, a physicist at the National Institute of Standards and Technology in Boulder, Colo., and his colleagues in the May 24 SCIENCE. "Schrödinger's cat paradox is a classic illustration of the conflict between the existence of quantum superpositions and our real-world experience of observation and measurement."

When we observe cats, they say, we don't expect our observations to influence whether the felines die or stay alive—or to see one cat both dead and alive.

In the recent atomic experiment, the researchers make one cold beryllium atom vibrate harmonically, producing what they call a superposition of two "coherent-state wave packets." The atom's electrons oscillate in a way that creates a dual presence, as if two atoms existed in distinct locations at the same time.

"Imagine a marble in a bowl, rolling back and forth," says Monroe. "At one point, the one marble appears as two marbles rolling back and forth in opposite directions, passing through each other and appearing simultaneously at each edge of the bowl."

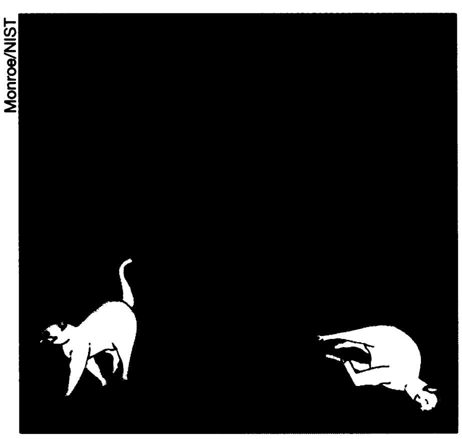
The atom's two states are separated by 80 nanometers. "For a brief period, the atom appears to exist in two places," Monroe says.

"This is a marvelous experiment," says Wojciech H. Zurek, a physicist at Los Alamos (N.M.) National Laboratory. "They're putting an ion into a trap and separating it into a very weird superposition. It's very clever."

Although this experiment involves only a single atom rather than a visible object, such as a cat, Zurek says it will open the door to deeper experimental probes into "the boundary between classical physics and quantum mechanics."

While this experiment ignores macroscopic effects on objects such as Schrödinger's cat, it may at least have demonstrated, says Zurek, "the paradox of Schrödinger's kitten." — *R. Lipkin*

Monroe/NIST



A single atom can appear in two places at the same time, shown here by paired probability curves.

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