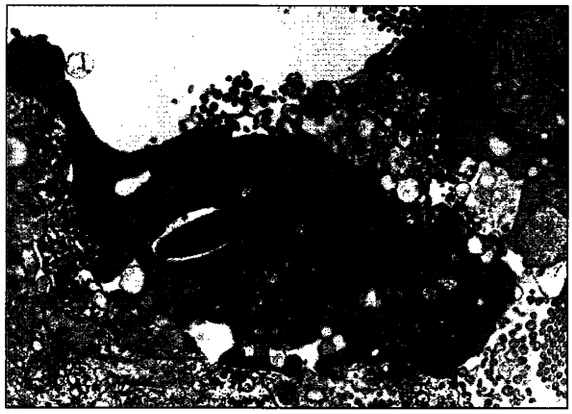
virulence: At least one species can create an intracellular traffic jam within certain of the host's immune cells.

Once inside those immune cells, *Salmonella enterica*, the bacterium that causes food poisoning in humans and a typhoid fever–like illness in mice, shoots a protein called SpiC into the host cell's cytoplasm. Somehow that protein clogs an intracellular transport system that would normally dump the organism into a toxic cellular chamber called the lysosome. The blockage is so far-reaching that it also prevents other deliveries to the lysosome and other cellular locations, according to work in the 15 July *EMBO Journal* by Eduardo Groisman, a microbiologist at Washington University School of Medicine in St. Louis, and colleagues.



Safe at home. *Salmonella* inside a vesicle can avoid being shuttled to the cell's death chamber.

"This [finding] opens up a new area of research," says Jorge Galán, a microbiologist at Yale University. Researchers already knew that *Salmonellae* have a specialized protein export machinery that they use only within host cells and that helps them replicate, but SpiC is the first secreted protein of this system to be identified. Galán adds that "there has to be a target for that protein in the host cell." SpiC may lead scientists to that target, illuminating both normal intracellular traffic patterns as well as how *Salmonella* jams them.

Immune cells such as macrophages normally kill bacteria by first engulfing them—encircling them with the cell membrane and thus forming a vesicle. The vesicle then moves through the cell, stopping in a regular itinerary to fuse with other vesicles and transfer its contents. Eventually it docks with the lysosome—a death chamber where toxic chemicals and enzymes chew up the cargo. Some research suggests that *Salmonella* survives in vesicles that have lysosome-like characteristics. But other experiments indicate that the organism manages to avoid this fate.

Seeking a clue to *Salmonella*'s activity once inside a macrophage, the researchers focused on an apparently unique gene, *spiC*, that they had previously sequenced from the bacterium. The team created a mutant strain that doesn't produce SpiC and found that it grows poorly in macrophages and is much less virulent in mice than are wild-type bacteria. This suggested that the protein is central to *Salmonella*'s harmful effects.

The team labeled cells with gold particles, which collect in the lysosome and highlight it, then infected the cells with wild-type *Salmonella* or SpiC mutants. The researchers found that wild-type *Salmonella* were less likely to end up in the gold-labeled lysosomes than were SpiC mutants. In a separate experiment, they used radioactively labeled molecules to monitor vesicle traffic. Even for vesicles that didn't contain *Salmonella*, they found, transport seemed to be inhibited in cells infected with wild-type bacteria, while lysosomes received their usual deliveries in cells infected by SpiC mutants.

To find out whether SpiC alone could block vesicular transport, the team analyzed the protein's effect on the movement of transferrin, a protein that normally uses vesicular transport to ferry iron from outside the cell to compartments inside and then returns to the surface. The researchers found that cells infected with a genetically engineered virus that produces SpiC both brought less transferrin into the cell and recycled it to the surface less efficiently than did those carrying virus without SpiC. Similarly, in a system of cell extracts, the team found that purified SpiC prevented vesicles from fusing.

Other bacteria trapped in vesicles have evolved ways to prevent their compartment from fusing with the lysosome, but SpiC is the only known bacterial protein to tie up global vesicular traffic. "This is a totally new way of altering trafficking," says Galán. "It points at a mechanism that's very different from that of any other bug. ... It has to be interfering with some key regulator of the trafficking pathway."

The new work may open the way to resolving the long-standing controversy about whether *Salmonella*-bearing vesicles fuse with lysosomes, but it also raises questions. Vesicles normally fuse with lysosomes within 20 minutes of infection, but researchers can't detect SpiC until about an hour later. SpiC production may begin while the bacteria are in other cells, but before they enter the macrophages, suggests Samuel Miller, a microbiologist at the University of Washington, Seattle. And because macrophages rely on vesicle fusion to secrete factors that stimulate and attract other cells of the immune system, SpiC's blockage of vesicle fusion might also affect macrophage activity in unanticipated ways, hampering immune system function, says Ralph Isberg, a microbiologist at Tufts University School of Medicine in Boston.

Just as one crucial accident can slow activity throughout a city, SpiC's traffic snarl may have profound effects on its host cell.

–EVELYN STRAUSS

QUANTUM MECHANICS

Physicists Tame a Single Photon

"To catch a baseball without stopping it" may sound like a Confucian riddle, but that is the essence of a groundbreaking quantum manipulation experiment reported in this week's issue of *Nature*: A team of French physicists has managed to detect a single photon repeatedly without destroying it. "The basic idea is that we can trap a single photon in a box ... and monitor and make repeated measurements on it as though it were a particle in a box," says Serge Haroche, who led the team at the Ecole Normale Supérieure (ENS) in Paris. The experiment is a unique demonstration of a phenomenon known as quantum nondemolition —the repeated nondestructive measurement of a quantum state—that a few teams of physicists have managed to demonstrate before, but never with anything as delicate as a single photon. "I think it's marvelous," says Wojciech Zurek, a quantum measurement guru at the Los Alamos National Laboratory in New Mexico. "They have implemented one of the goals, one of the mileposts, which has defined the field of quantum measure-

ment for close to 20 years."

It is a fact of life in quantum mechanics that an observation or measurement alters or destroys the object that is being observed. But theorists know it need not be so. In principle it should be possible to observe a quantum system without destroying it, and repeat the observation later and get the same result. Achieving nondemolition is extremely difficult, however, because of the fragile nature of quantum states. Over the past decade or so, several teams have managed it using interferometry, a technique that involves blending two light waves in such a way that minute changes in either of the two beams modify the recombined beam. Such a setup can reveal the impact of a "signal" light beam that disturbs the path of one of the other two beams before they are combined. The signal beam continues unperturbed, but the imprint of its passing is recorded in the altered interference pattern.

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>
> **—Wojciech Zurek**

This technique requires bright light beams. The ENS researchers wanted to see if they could achieve nondemolition with a single photon, much too feeble to disturb the path of a detection beam. Instead, they harnessed the sensitive quantum energy ladder of electrons around an atom. The first step is to trap a photon. The researchers built an open-sided cavity 3 centimeters long and 5 centimeters in diameter bounded at either end with spherical niobium mirrors, which reflect photons of the correct microwave wavelength. Then they cooled the trap to 1 degree above absolute zero, still warm enough to guarantee a single thermally induced microwave photon bouncing between the mirrors.

To detect the photon, the researchers shot a rubidium atom through the cavity. But before they sent it on its journey, the atom was pumped up with energy, so that its outermost electrons were not in their lowest energy states but in orbits far from the nucleus, a state known as a Rydberg atom (*Science*, 19 July 1996, p. 307). In this long-lived, bloated state, the atom is very sensitive to microwaves, guaranteeing the strongest possible interaction with any microwave photons lurking in the cavity.

The aim was to use the swollen Rydberg atom as a detector to see if a photon is resident, and if it is to leave it pinging around within the cavity in its original state. The cavity is just the right size, and the atom's speed carefully set, so that during its passage through the cavity there is just enough time for the atom to absorb the photon and reemit it before the atom reemerges.

At first sight, the exiting atom appeared unchanged from when it entered. "So you have the feeling that nothing has happened," says Haroche. But the cycle of absorption and emission does leave an imprint on the atom wave by altering its phase: The exiting atom was now out of step with its state on entry into the cavity. A separate system compared the phases before and after, revealing a half-wave phase shift—the signature of a cavity that contains a single photon. The researchers found that sending a second atom through the cavity produced the same result. "It shows that the first atom has made a measurement and left the photon behind for the second atom to read it," says Haroche.

Other physicists have lauded the technical skills of the ENS team. "It's an amazingly complex experiment, and there are several pieces of it, each of which is an amazingly complex experiment alone," says Zurek. "They have thought up some neat tricks to solve the experimental difficulties they're faced with," adds Oxford University's Andrew Steane. "It's a piece of work which probably no one else in the world could have done."

–ANDREW WATSON

Andrew Watson is a science writer in Norwich, U.K.

EUROPEAN UNION

Belgian Socialist Tapped To Head EU Research

Philippe Busquin, a Belgian Socialist Party official with a background in physics, has been selected to become the European Union's (EU's) new chief research executive. Romano Prodi, the European Commission's incoming president, last week presented his new team of commissioners, with Busquin as his candidate for research commissioner. After holding hearings, the European Parliament is scheduled to vote on Prodi's new team by mid-September.

In his new job, Busquin will lead the EU's research directorate—known up to now as DG-XII—and administer the 4-year, $17 billion Fifth Framework research program. The portfolio had previously included education, but—contending that research and technology "represent a full portfolio"—Prodi

ScienceScope

Mouse House West A leading purveyor of lab mice is going coast to coast. The Jackson Laboratory of Bar Harbor, Maine, announced this week that it will open a West Coast outpost in cooperation with the University of California (UC), Davis, in a bid to make genetically customized mice more easily available to researchers across the western United States. The new $10.6 million center, to be housed in several refurbished buildings, will raise up to 30,000 specially bred mice a year. The lab already ships about 2 million mice annually from its Maine headquarters, which stocks over 2300 varieties. The strains include "models" for many human diseases, from epilepsy to cancer.

Researchers at the host campus are looking forward to the rodent invasion. The school's medical and veterinary programs "will be greatly enhanced" by the ready supply of research subjects, says Stephen Barthold, director of the UC Davis Center for Comparative Medicine. The first colonies are scheduled to arrive early next year, once renovations—including the creation of special disease-free nurseries and air-cleaning systems—are complete.

Genomics Boom? France is poised to give a major boost to genome research. Government officials are hoping to give the nation's $46 million genome program about a 50% raise next year and launch at least four new gene research centers, or "genopoles," to complement an existing facility in the Paris suburb of Evry. The draft 2000 budget plan also calls for creating consortia teaming government agencies with private companies, especially biotech start-ups, which could ultimately hike total genome research spending to $150 million a year.

Gene jockeys won't know how much cash they will get until this fall, when Parliament votes on the 2000 budget. Still, "there is a lot of potential" for growth, says molecular biologist Pierre Chambon, president of the genome program's scientific advisory council. "The question is whether it is going to be supported at a proper level."

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