Atom laser demonstrated in chilled drips

Unlike an ordinary, incandescent bulb, a laser produces light of a single wavelength. Moreover, the emitted light waves are coherent, meaning that all of the energy peaks and troughs are precisely in step.

Now, a team at the Massachusetts Institute of Technology has demonstrated experimentally that a cloud consisting of millions of atoms can also be made coherent. Instead of flying about and colliding randomly, the atoms display coordinated behavior, acting as if the entire assemblage were a single entity.

According to quantum mechanics, atoms can behave like waves. Thus, two overlapping clouds made up of atoms in coherent states should produce a zebra-striped interference pattern of dark and light fringes, just like those generated when two beams of ordinary laser light overlap.

By detecting such a pattern, the researchers proved that the clouds' atoms are coherent and constitute an "atom laser," says physicist Wolfgang Ketterle, who heads the MIT group. These matter waves, in principle, can be focused just like light.

Ketterle and his coworkers describe their observations in the Jan. 31 SCIENCE.

The demonstration of coherence involving large numbers of atoms is the latest step in a series of studies of a remarkable state of matter called a Bose-Einstein condensate. Chilled to temperatures barely above absolute zero, theory predicted, the atoms would collectively enter the same quantum state and behave like a single unit, or superparticle, with a specific wavelength.

First created in the laboratory in 1995 by Eric A. Cornell and his collaborators at the University of Colorado and the National Institute of Standards and Technology, both in Boulder, Bose-Einstein condensates have been the subject of intense investigation ever since (SN: 7/15/95, p. 36; 5/25/96, p. 327).

MIT

A magnetic trap releases a sequence of clumps of coherent atoms (top). Pulled downward by gravity, each clump spreads out. Two overlapped clumps from neighboring drips produce an interference pattern (bottom).

At MIT, Ketterle and his colleagues cool sodium atoms to temperatures below 2 microkelvins. The frigid atoms are then confined in a special magnetic trap inside a vacuum chamber.

To determine whether the atoms in the resulting condensate are indeed as coherent as photons in a laser beam, the researchers developed a novel method of extracting a clump of atoms from the trap.

In effect, they manipulate the magnetic states of the atoms to expel an adjustable fraction of the original cloud; under the influence of gravity, the released clump falls. The method can produce a sequence of descending clumps, with each containing 100,000 to several million coherent atoms.

The apparatus acts like a dripping faucet, Ketterle says. He and his colleagues describe the technique in the Jan. 27 PHYSICAL REVIEW LETTERS.

To demonstrate interference, the MIT group created a double magnetic trap so that two pulses of coherent atoms could be released at the same time. As the two clumps fell, they started to spread and overlap. The researchers could then observe interference between the atomic waves of the droplets.

"The signal was almost too good to be true," Ketterle says. "We saw a high-contrast, very regular pattern."

"It's a beautiful result," Cornell remarks. "This work really shows that Bose-Einstein condensation is an atom laser."

From the pattern, the MIT researchers deduced that the condensate of sodium atoms has a wavelength of about 30 micrometers, considerably longer than the 0.04-nanometer wavelength typical of individual atoms at room temperature.

Ketterle and his colleagues are already planning several improvements to their primitive atom laser, including getting more atoms into the emitted pulses and going from pulses to a continuous beam.

Practical use of an atom laser for improving the precision of atomic clocks and for manipulating atoms is still distant, however, Cornell notes. — *I. Peterson*

FDA allows heart health claims for oats

Last week, the Food and Drug Administration announced that makers of low-fat, oat-rich cereals and other foods will be permitted to tout the ability of their products to lower serum cholesterol, a risk factor for heart disease.

Previously, the agency had allowed health claims for individual food components, such as calcium, or for natural food classes, such as "fruits and vegetables." The new ruling marks the first federally sanctioned health claim for a manufactured food.

In the gut, oat's soluble fiber—beta-glucan—forms a viscous gel that surrounds cholesterol-rich bile acids, limiting their reabsorption by the blood. The liver responds by making more bile acids and pulling more cholesterol from the blood. This explanation of oats' cholesterol-lowering ability, which has been documented in many studies (SN: 5/26/90, p. 330), spurred the Chicago-based Quaker Oats Co. to petition for the new health claim.

Yet even Quaker was surprised by the scope of FDA's ruling. Though studies by the company and others showed that foods rich in oats or oat bran can lower cholesterol—even in people on a low-fat diet—oat flour's ability to do that remains unproved, says Steven L. Ink, Quaker's nutrition director.

Because "we didn't have any data to specifically address the question," he says, FDA indicated last fall that it would not allow the health claim on products made with whole-oat flour. Yet when the ruling emerged last week, oat flour products, such as Cheerios by General Mills in Minneapolis, were included—apparently, Ink points out, in response to unpublished data submitted to the agency by researchers at the University of Minnesota some 8 months after the formal comment period. Ink says that Quaker will work to confirm oat flour's anticipated effects—"to make sure that all we've done thus far is not undermined by a question that was not thoroughly addressed."

Quaker Oats Co.

Banner and heart offer prototype health claim on a qualifying oat product.

In fact, data from David Jenkins of the University of Toronto have shown that beta-glucans are not all equal. Each fiber consists of a long chain of identical units; both the length of the chain and the number of cross-links it contains contribute to its viscosity—and to its biological effects. Because milling into flour, cooking, pressure extrusion, and other food-processing techniques may shorten the chain, Jenkins says he encouraged FDA to endorse health claims "only for materials shown to be effective."

Jur Strobos, a Washington, D.C.-based consultant and former policy director at FDA, believes "the health claim system will rise or fall on the success of this particular health claim." If consumers believe it and eat accordingly, he expects the next petition to seek a health claim for soy protein, "which also has a strong cholesterol-lowering effect." — *J. Raloff*