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Physics Breakthrough Reveals New Kind of Light

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By Clara Moskowitz,This story originally appeared on LiveScience.com

Physicists have created a new kind of light by chilling photons into a blob state.

Just like solids, liquids and gases, this recently discovered condition represents a state of matter. Called a Bose-Einstein condensate, it was created in 1995 with super-cold atoms of a gas, but scientists had thought it could not be done with photons, which are basic units of light. However, physicists Jan Klärs, Julian Schmitt, Frank Vewinger and Martin Weitz of the University of Bonn in Germany reported accomplishing it. They have dubbed the new particles "super photons."

An illustration of a "super-photon" created when physicists turned photons of light into a state of matter called a Bose-Einstein condensate

(Credit: Jan Klaers, University of Bonn)

Particles in a traditional Bose-Einstein condensate are cooled down close to absolute zero, until they glom onto each other and become indistinguishable, acting as one giant particle. Experts thought photons (packets of light) would be unable to achieve this state because it seemed impossible to cool light while concentrating it at the same time. Because photons are massless particles, they can simply be absorbed into their surroundings and disappear, which usually happens when they are cooled down.

The scientists needed to find a way to cool the photons without decreasing their numbers.

"Many scientists believed that it would not be possible, but I was pretty sure that it would work," Weitz told LiveScience.

To trap the photons, the researchers devised a container made of mirrors placed very, very close together - about a millionth of a meter (1 micron) apart. Between the mirrors, the researchers placed dye molecules - basically, little bits of color pigment. When the photons hit these molecules, they were absorbed and then re-emitted.

The mirrors trapped the photons by keeping them bouncing back and forth in a confined state. In the process, the light packets exchanged thermal energy every time they hit a dye molecule, and they eventually cooled down to about room temperature

While room temperature is nowhere near absolute zero, it was cold enough for photons to coalesce into a Bose-Einstein condensate.

"Whether a temperature is cold enough to start the condensation depends on the density of the particles," Klärs wrote in an e-mail. "Ultra-cold atomic gases are very dilute and they therefore have very low condensation temperatures. Our photon gas has a billion times higher density and we can achieve the condensation already at room temperature."

The researchers detail their findings in the Nov. 25 issue of the journal Nature.

Physicist James Anglin of Germany's Technical University Kaiserslautern, who was not involved in the project, called the experiment "a landmark achievement" in an accompanying essay in the same issue of Nature.

In effect, getting the photons to condense into this state caused them to behave more like regular matter particles. It also showcased the ability of photons, and indeed all particles, to behave as both a point-like particle and a wave - one of the most perplexing revelations of modern quantum physics.

"The physics behind the Bose-Einstein condensation is the transition from a particle-like behavior at high temperatures to a wave-like behavior at cold temperatures," Klärs wrote. "This is true for both atomic and photonic gases."

The researchers said the work could have applications down the line for creating new kinds of lasers that generate very-short-wave light in the UV or X-ray bands.

"That definitely will take some years," Weitz said.

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