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News

Chilled light enters a new phase

First Bose–Einstein condensate of photons could help build solar cells and lasers.

Zeeya Merali

By forcing light particles to behave like atoms, scientists have created a super-photon. *Getty*

The fuzzy dividing line between light and atoms has been blurred even further. Quantum physicists have created the first Bose-Einstein condensate using photons — a feat until now suspected to be possible only for atoms. The technique could be used to increase the efficiency of solar cells and lasers.

Bose-Einstein condensates (BECs) are a bizarre quantum phase of matter. They were first proposed in the 1920s by Satyendra Nath Bose and Albert Einstein, who reasoned that if certain atoms are chilled to within a fraction of absolute zero, quantum effects should take over. As a result, all the atoms are squeezed into the same quantum state, so that they "march in step", behaving collectively as though they are a sort of super-atom, explains quantum physicist Martin Weitz at the University of Bonn in Germany.

In 1995, two experimental groups independently produced the first examples of BECs with rubidium and sodium atoms[1,2]. In theory, physicists knew that it should also be possible to form a BEC using particles of light, or photons. But in practice it seemed near impossible because, unlike atoms, the number of photons in an experiment is not conserved. That means that when you try to chill photons they vanish from the experiment, becoming absorbed by surrounding atoms in the apparatus, says Weitz. "If you try to cool down a light bulb, it goes off — the light just disappears — and that's the big problem," he explains.

Light trap

Now Weitz and his colleagues have found a way to get light to stick around long enough for a BEC of photons to be created — details of the technique are published in *Nature* today[3]. To prevent the usually massless photons from escaping, the team trapped them in a cavity between two curved mirrors. The mirrors restricted the way the photons could move and vibrate — forcing them to behave as though they were atoms with a mass about ten billion times smaller than a rubidium atom.

"It is a spectacular piece of physics, that removes one more distinction between atoms and light."

To build a standard BEC, atoms must usually collide with each other, to even out their temperature. But photons, even those with a slight 'mass', interact too weakly to do this. So the team added dye molecules to the cavity; these absorbed and re-emitted the photons, helping them to reach thermal equilibrium. "The magic of BEC formation happens when you pump more and more photons into the cavity until suddenly, no more can enter this thermal equilibrium, so they condense out," says Weitz. These extra

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