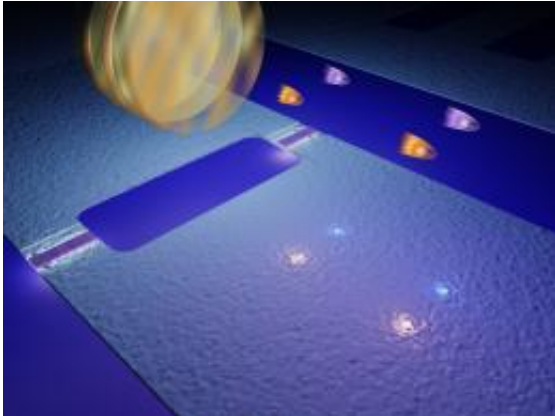


Scientists create light from vacuum

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In the Chalmers scientists' experiments, virtual photons bounce off a "mirror" that vibrates at a speed that is almost as high as the speed of light. The round mirror in the picture is a symbol, and under that is the quantum electronic component (referred to as a SQUID), which acts as a mirror. This makes real photons appear (in pairs) in vacuum. Credit: Philip Krantz, Chalmers

(PhysOrg.com) -- Scientists at Chalmers University of Technology have succeeded in creating light from vacuum - observing an effect first predicted over 40 years ago. The results will be published tomorrow (Wednesday) in the journal *Nature*. In an innovative experiment, the scientists have managed to capture some of the photons that are constantly appearing and disappearing in the vacuum.

The experiment is based on one of the most counterintuitive, yet, one of the most important principles in [quantum](#) mechanics: that [vacuum](#) is by no means empty nothingness. In fact, the vacuum is full of various particles that are continuously fluctuating in and out of existence. They appear, exist for a brief moment and then disappear again. Since their existence is so fleeting, they are usually referred to as virtual particles.

Chalmers scientist, Christopher Wilson and his co-workers have succeeded in getting [photons](#) to

leave their virtual state and become real photons, i.e. measurable light. The physicist Moore predicted way back in 1970 that this should happen if the virtual photons are allowed to bounce off a mirror that is moving at a speed that is almost as high as the speed of light. The phenomenon, known as the dynamical Casimir effect, has now been observed for the first time in a brilliant experiment conducted by the Chalmers scientists.

"Since it's not possible to get a mirror to move fast enough, we've developed another method for achieving the same effect," explains Per Delsing, Professor of Experimental Physics at Chalmers. "Instead of varying the physical distance to a mirror, we've varied the electrical distance to an electrical short circuit that acts as a mirror for microwaves.

The "mirror" consists of a quantum electronic component referred to as a SQUID (Superconducting quantum interference device), which is extremely sensitive to magnetic fields. By changing the direction of the magnetic field several billions of times a second the scientists were able to make the "mirror" vibrate at a speed of up to 25 percent of the speed of light.

"The result was that photons appeared in pairs from the vacuum, which we were able to measure in the form of microwave radiation," says Per Delsing. "We were also able to establish that the radiation had precisely the same properties that quantum theory says it should have when photons appear in pairs in this way."

What happens during the experiment is that the "mirror" transfers some of its kinetic energy to virtual photons, which helps them to materialise. According to quantum mechanics, there are many different types of virtual particles in vacuum, as mentioned earlier. Göran Johansson, Associate Professor of Theoretical Physics, explains that the reason why photons appear in the experiment is that they lack mass.

"Relatively little energy is therefore required in

order to excite them out of their virtual state. In principle, one could also create other particles from vacuum, such as electrons or protons, but that would require a lot more energy."

The scientists find the photons that appear in pairs in the experiment interesting to study in closer detail. They can perhaps be of use in the research field of quantum information, which includes the development of quantum computers.

However, the main value of the experiment is that it increases our understanding of basic physical concepts, such as vacuum fluctuations - the constant appearance and disappearance of virtual particles in vacuum. It is believed that vacuum fluctuations may have a connection with "dark energy" which drives the accelerated expansion of the universe. The discovery of this acceleration was recognised this year with the awarding of the Nobel Prize in Physics.

More information: "Observation of the dynamical Casimir effect in a superconducting circuit" C. M. Wilson, G. Johansson, A. Pourkabirian, M. Simoen, J. R. Johansson, T. Duty, F. Nori, & P. Delsing, *Nature* 479, 376 - 379 (17 November 2011), [doi:10.1038/nature10561](https://doi.org/10.1038/nature10561)

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Provided by Chalmers University of Technology

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