Light pulled out of empty space

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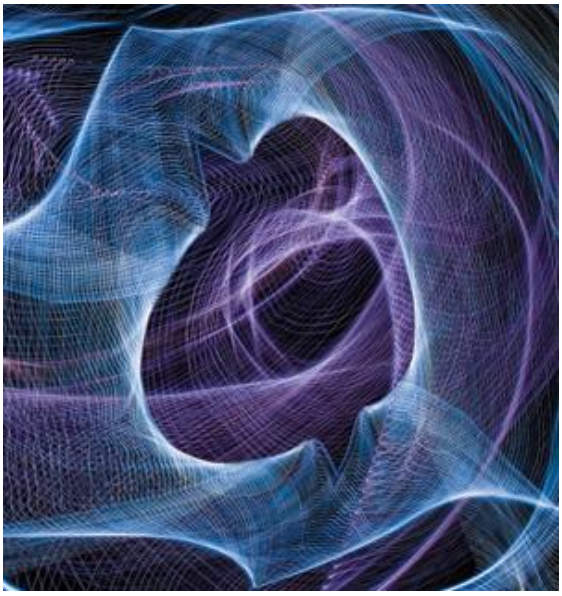
YOU can get something from nothing - as long as you are moving close to the speed of light. The discovery confirms a 41-year-old prediction on how to pull energy from empty space and produce light.



Getting something from nothing *(Image: John Lund/Riser/Getty)*

The phenomenon relies on the long-established fact that empty space is not at all empty, but fizzing with particles that pop in and out of existence (see "Out of the ether: the changing face of the vacuum"). This is down to the laws of quantum mechanics, which say that even a vaccum cannot have exactly zero energy but must exhibit small fluctuations of energy. These fluctuations show themselves as pairs of short-lived particles.

The presence of these "virtual" particles, usually photons, has long been proved in experiments demonstrating the standard Casimir effect, in which two parallel mirrors set close together will feel a pull towards each other. This happens because the small space between the mirrors limits the number of virtual photons that can appear in this region. Since there are more photons outside this space, the radiation pressure on the mirrors from the outside is larger than the pressure between them, which pushes the mirrors together.

Now Chris Wilson at Chalmers University of Technology in Gothenburg, Sweden, and his colleagues have gone a step further, pulling photons out of the void in a process called the dynamical Casimir effect. "It was a difficult technical experiment," says Wilson. "We were very happy when it worked."

The effect needs only a single metal mirror, but it must move at close to the speed of light through the sea of virtual photons in empty space. Because the mirror is a conductor, the photons - which are electromagnetic particles - will absorb some of its kinetic energy. They then radiate this extra energy by producing pairs of real photons.

Clearly, moving a mirror at close to light speed is impractical. So the researchers used a superconducting electrical circuit with an oscillator that rapidly alters the distance an electron must travel through the circuit.

The electron's movement is determined by the location at which the circuit's electric field falls to zero. To control the circuit's characteristics, the team used a superconducting quantum interference device. With this SQUID they were able to change the distance from the electron to the zero-field location so quickly that the electron appeared to move at a quarter of the speed of light. This was fast enough for the circuit to emit real photons (*Nature*, DOI: 10.1038/nature10561). "Particles were produced in pairs, coming right out of the vacuum," Wilson says.

"This is a significant breakthrough," says Diego Dalvit, a physicist at the Los Alamos National Laboratory in New Mexico. The energy of virtual photons is cosmologists' best guess of what lies behind the dark energy that is causing the universe's expansion to accelerate. The experiment will "open possibilities for doing table-top experiments of cosmology", Dalvit says.

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