New optical microcavity could lead to more efficient quantum computing

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Right now, there is no shortage of proposed architectures for quantum computers. Scientists are constantly looking for, and developing viable candidates for quantum information processing. And with the production of an open and scalable microcavity, the group of Ed Hinds at the Centre for Cold Matter at Imperial College, London thinks it might have found at least one possibility.

“If we can make a large number of these optical microcavities work on one chip,” Michael Trupke tells *PhysOrg.com*, “it would be very helpful in leading towards making a quantum computer.” The team at Imperial College published their findings regarding an open microcavity in “Atom Detection and Photon Production in a Scalable, Open, Optical Microcavity” in *Physical Review Letters*.

Trupke points out that there are many designs for quantum computers using optical cavities, but this one is unique due to the fact that it is a scalable version, easily fabricated. These qualities make the Imperial College microcavity a good candidate. “It is possible to make more of these on one chip, and use them to send photons into optical fibers.”

The microcavity in question resides on a silicon wafer. It consists of a curved mirror, and is closed by a plane mirror attached to the end of an optical fiber. Cold atoms were detected falling through the cavity be the effect they had on the reflection spectrum, as well as the way they influenced the noise in the reflected light. Trupke explains, via email, that “the Purcell effect, by which the spontaneous emission of atoms can be modified by tailoring the electromagnetic field of the vacuum, was used to produce protons in the mode of the cavity, which then couples directly to an optical fiber."

Trupke admits: "We don't know yet if this is the best way to make a quantum computer, we will need to continue in our research to see what we can do with it." He is quick to point out that he and his colleagues are already working on the next step. "We are improving the setup so as to guide the atoms and hold them inside the cavity," he says. The team also hopes to improve the atom detection time, as well as improve the signal/noise ratio.

"In principle, our design would allow for photon transport over long distances." He also points out that using the silicon makes it possible to integrate other components into the array. "We have begun to fabricate chips with both cavity mirrors and wires, which can be used to guide atoms into the cavities. We haven't done this yet, but theoretically we could also add other simple electronic components to the surface, integrating them with the cavities."

But the microcavity developed can be useful for more than quantum information processing. Such a setup can aid in the observation of cold atoms, as well as provide information about photon production and create a source of photons for use in other optical experiments.

"Ultimately," Trupke says, "a quantum computer is not the be-all and end-all of this work. We think this could lead to a quantum computer, but there are many other beautiful experiments that can be done with a device like this. We are only beginning now to understand how powerful such an optical cavity can be for atomic physics applications."