Photon-transistors for the supercomputers of the future

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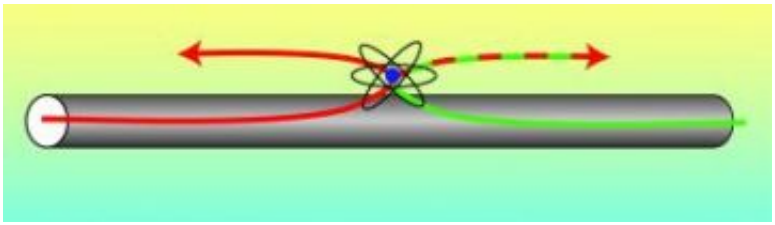

Two photons are sent through a nanowire towards an atom, where they collide, such that one photon (red) transfers its information to the other photon. Credit: Anders Søndberg Sørensen, associate professor, University of Copenhagen

Scientist from the Niels Bohr Institute at University of Copenhagen and from Harvard University have worked out a new theory which describe how the necessary transistors for the quantum computers of the future may be created. The research has just been published in the scientific journal *Nature Physics*.

Researchers dream of quantum computers. Incredibly fast super computers which can solve such extremely complicated tasks that it will revolutionise the application possibilities. But there are some serious difficulties. One of them is the transistors, which are the systems that process the signals.

Today the signal is an electrical current. For a quantum computer the signal can be an optical one, and it works using a single photon which is

the smallest component of light.

“To work, the photons have to meet and “talk”, and the photons very rarely interact together” says Anders Søndberg Sørensen who is a Quantum Physicist at the Niels Bohr Institute at Copenhagen University. He explains that light does not function like in Star Wars, where the people fight with light sabres and can cross swords with the light. That is pure fiction and can’t happen. When two rays of light meet and cross, the two lights go right through each other. That is called linear optics.

What he wants to do with the light is non-linear optics. That means that the photons in the light collide with each other and can affect each other. This is very difficult to do in practice. Photons are so small that one could never hit one with the other. Unless one can control them – and it is this Anders Sørensen has developed a theory about.

Light collisions at the quantum level

Instead of shooting two photons at each other from different directions and trying to get them to hit each other, he wants to use an atom as an intermediary. The atom can only absorb one photon (such are the laws of physics). If you now direct two photons towards the atom it happens that they will collide on the atom. It is exactly what he wants.

The atom is however very small and difficult to hit. So the photons have to be focussed very precisely. In a previous experiment researchers had discovered that microwaves could be focussed on an atom via a superconducting nano-wire. They got the idea that the same could happen with visible light.

The theoretical model shows that it works. The atom is brought close to the nanowire. Two photons are sent towards the atom and when they hit it an interaction occurs between them, where one imparts information to

the other. The information is sent in bits which are either a one or zero digit, and the order of digits produces the message. (Today we can send information via an optic cable and each bit is made up of millions of photons.) In quantum optics each bit is just one photon. The photon has now received its message and the signal continues on its way. It is a step on the way to building a photon-transistor for a quantum computer.

Source: University of Copenhagen