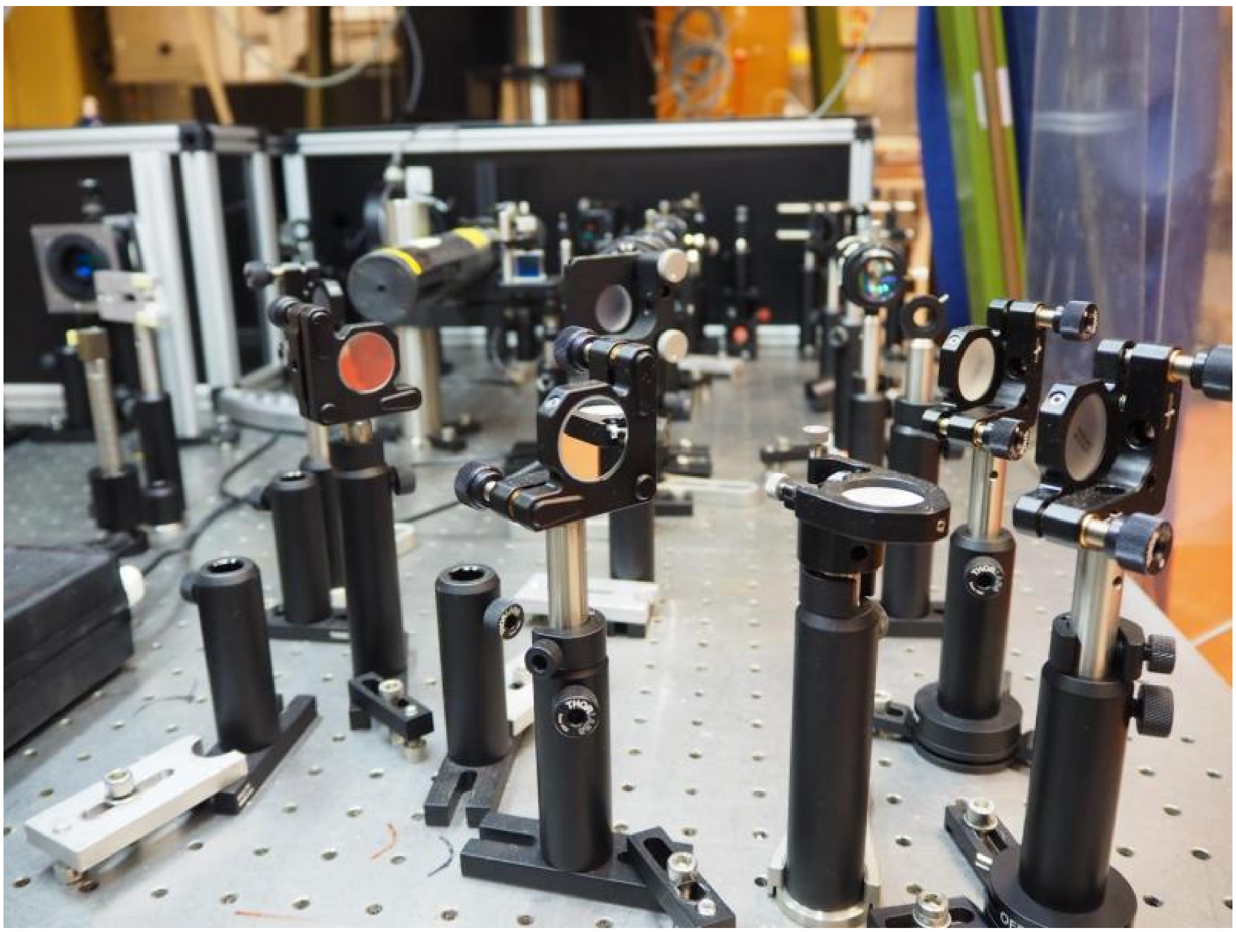
Single molecule detected for use in quantum network

April 4 2016, by Erik Arends



Credit: Leiden Institute of Physics

Leiden physicists have detected a single molecule called dibenzoterrylene in a new crystal and found that it is a candidate component for a quantum network. Future quantum computers will need such a network to work together while maintaining their advantages.The physicists have published their results in the journal *ChemPhysChem*.

Quantum computers hold big promise for the future. With exponentially faster calculations, they should be able to solve scientific problems and crack codes that are currently untouchable for modern computers. And realizing the full potential of quantum computers requires connection through a quantum network. In regular networks, the so-called qubits must transform into ordinary bits in order for a classical wire to carry them. Thus, the speed advantage of the quantum computer would be completely lost.

Individual molecule

Leiden physicist Michel Orrit studies single molecules as candidate building blocks for the necessary quantum network using a technique that he developed in the early '90s with which he observed an individual molecule with the use of fluorescence for the first time. Orrit's invention laid the groundwork for a follow-up technique that earned the 2015 Nobel Prize in Chemistry. And to this date, his original technique still proves to be valuable in modern research. Apart from bringing him the 2016 Physica Prize, it enabled Orrit to detect an individual dibenzoterrylene molecule, together with Ph.D. student Nico Verhart, and check its properties for use in quantum networks.

Radio channel

The researchers shine a laser beam on their sample, which is extremely diluted—100 nanomole per liter—leaving only a few molecules in focus for the laser. Needless to say, temperatures are just above absolute zero, so the particles stay neatly in place. Slowly changing the laser's color, they test many frequencies to which a molecule might tune, similar to tuning a radio. Every molecule is programmed to interact only with light of a very specific frequency, like an old radio that is stuck to one channel. When hit by light of exactly the right color, it fluoresces, absorbing and emitting those light particles.

Stable

Once the physicists find a matching color, they study the stability of the fluorescence signal. The more stable the signal, the better equipped the molecule is to serve as a building block of a quantum network. The frequency of an unstable molecule drifts away over time, for example, or the molecule could enter a dark state in which it doesn't fluoresce at all. It turns out that dibenzoterrylene molecules present neither of these instabilities and are a good candidate for quantum network components.

More information: Michel Orrit et al. Spectroscopy of single dibenzoterrylene molecules in para-dichlorobenzene, *ChemPhysChem* (2016). DOI: 10.1002/cphc.201501087

Provided by Leiden Institute of Physics

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