Diamond center defect helps scientists measure electrical fields

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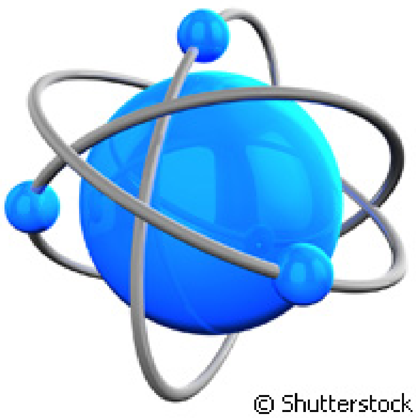

Scientists recognize how important a role electrical fields play in nature and technical areas. By adjusting these fields, the transmission of nerve impulses becomes possible and the operation of modern data storage is fulfilled by saving electrical charges (so-called Flash Memories). What researchers have not been able to do is get an ultra-precise reading of electrical fields by using physical measurement techniques. Until now, that is. With the help of one single defect centre in diamond, scientists at the University of Stuttgart in Germany successfully measured electrical fields. Presented in the journal *Nature Physics*, the study was funded in part by the EU.

Electrical charges use varied ways to control almost 100 % of all physical, chemical or biological processes. A case in point is deoxyribonucleic acid (DNA) and the exact distribution of electrons on it. This distribution is critical for the precise transmission of genetic information, and modern electric circuits trigger electric currents up to single electrons.

Experts say that measuring minor electronic fields linked to the charge is no easy task. Enter the Stuttgart team that devised a new sensor consisting of just one single atom. This nitrogen atom is an impurity captured in diamond, they say.

The team points out that the diamond lattice 'fixes' the atom and enables a laser to address the nuclear vacancy center. "The interaction of the atom with the measured field can be determined by the light emitted by the impurity and, therefore, electrical fields can be measured which are just a fracture of the electrical field of an elementary charge in 0.1 um distance," the scientists explain.

Because the sensor is about the size of an atom, scientists can measure electrical fields with the same spatial precision. The sensor-generated optical readout enables it to be placed in any geometry. The process also attains its sensitivity and resolution at room temperature and ambient conditions.

While researchers have succeeded in demonstrating the existence of small magnetic fields, this latest finding of combining both measurement techniques permits the measurement of electrical and magnetic fields in a single place without changing the sensor, the team points out.

Thanks to this latest development, novel applications can and will emerge. Measuring the magnetic moments' distribution of the chemical compounds' nuclei at the same time is an example, they say, adding that the structure of a substance and its chemical reactivity can be measured simultaneously.

"The ability to sensitively detect individual charges under ambient conditions would benefit a wide range of applications across disciplines," the authors write. "However, most current techniques are limited to low-temperature methods such as single-electron transistors, single-electron electrostatic force microscopy and scanning tunnelling microscopy. Here we introduce a quantum-metrology technique demonstrating precision three-dimensional electric-field measurement using a single nitrogen-vacancy defect centre spin in diamond."

More information: Dolde, F., et al. (2011) Electric-field sensing using single diamond spins. N*ature Physics*, published online 17 April. DOI: 10.1038/nphys1969

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