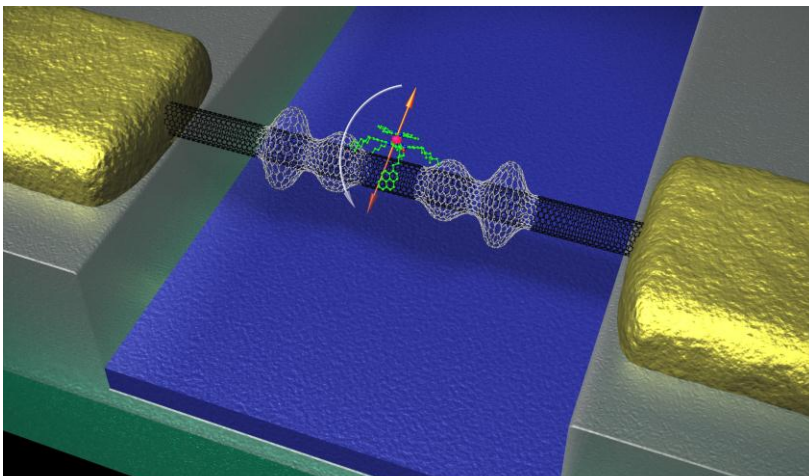


## Nature: Smallest Vibration Sensor in the Quantum World

**Magnetic Spin of a Molecule Excites Vibrations in an Adjacent Carbon Nanotube/  
Basis of Sensors and Quantum Computers/ Video shows deformation wave on Carbon nanotube**



The spin of a molecule (orange) changes and deforms the nanotube (black) mounted between two electrodes (gold). (Figure: C. Grupe/KIT)

**Carbon nanotubes and magnetic molecules are considered building blocks of future nanoelectronic systems. Their electric and mechanical properties play an important role. Researchers of Karlsruhe Institute of Technology and French colleagues from Grenoble and Strasbourg have now found a way to combine both components on the atomic level and to build a quantum mechanical system with novel properties. It is reported now in the print version of *nature nanotechnology* journal (DOI: 10.1038/nnano.2012.258).**

In their experiment the researchers used a carbon nanotube that was mounted between two metal electrodes, spanned a distance of about 1  $\mu\text{m}$ , and could vibrate mechanically. Then, they applied an organic molecule with a magnetic spin due to an incorporated metal atom. This spin was oriented in an external magnetic field.

“In this setup, we demonstrated that the vibrations of the tube are influenced directly when the spin flips parallel or antiparallel to the magnetic field,” explains Mario Ruben, head of the working group at KIT. When the spin changes, the resulting recoil is transferred to the

**Monika Landgraf**  
Chief Press Officer

Kaiserstraße 12  
76131 Karlsruhe, Germany  
Phone: +49 721 608-47414  
Fax: +49 721 608-43658  
E-mail: presse@kit.edu

**For further information,  
please contact:**

Kosta Schinarakis  
PKM – Science Scout  
Phone: +49 721 608 41956  
Fax: +49 721 608 43658  
E-mail: schinarakis@kit.edu

carbon nanotube and the latter starts to vibrate. Vibration changes the atomic distances of the tube and, hence, its conductance that is used as a measure of motion.

The strong interaction between a magnetic spin and mechanical vibration opens up interesting applications apart from determining the states of motion of the carbon nanotube. It is proposed to determine the masses of individual molecules and to measure magnetic forces within the nano-regime. Use as a quantum bit in a quantum computer might also be feasible.

According to the supplementary information published in the same issue of *nature nanotechnology* such interactions are of high importance in the quantum world, i.e. in the range of discrete energies and tunnel effects, for the future use of nanoscopic effects in macroscopic applications. Combination of spin, vibration, and rotation on the nanoscale in particular may result in entirely new applications and technologies.

[Videoanimation shows wave on Carbon nanotube.](#)

The online version of the print paper:

<http://www.nature.com/nnano/journal/v8/n3/full/nnano.2012.258.html>

The supplementary information:

<http://www.nature.com/nnano/journal/v8/n3/pdf/nnano.2013.27.pdf>

The homepage of the research group at KIT can be found at:

<http://www.ruben-group.de/>

**Karlsruhe Institute of Technology (KIT) is a public corporation according to the legislation of the state of Baden-Württemberg. It fulfills the mission of a university and the mission of a national research center of the Helmholtz Association. KIT focuses on a knowledge triangle that links the tasks of research, teaching, and innovation.**

This press release is available on the internet at [www.kit.edu](http://www.kit.edu).

The photo of printing quality may be downloaded under [www.kit.edu](http://www.kit.edu) or requested by mail to [presse@kit.edu](mailto:presse@kit.edu) or phone +49 721 608-4 7414. The photo may be used in the context given above exclusively.