Communiqués de presse

Nanotechnologies : IBM Recherche passe une nouvelle étape au cœur de l’atome

Paris - 24 sept. 2010: La clé, pour parvenir à construire des iPods de plus en plus petits pouvant contenir toujours plus de chansons ou encore des superordinateurs ayant la capacité de « ressentir » leur environnement, dépend de la capacité des scientifiques à pousser la loi de Moore toujours plus loin. Des chercheurs explorent la possibilité de stocker des informations dans de simples atomes – ce qui transformerait de manière radicale les ordinateurs tels que nous les connaissons – mais ces atomes se déplacent à une vitesse si incroyable qu’il est impossible de collecter les données physiques nécessaires afin de faire de cela une réalité. Du moins jusqu’à présent.

Une équipe de chercheurs d’IBM dévoile aujourd’hui à la une du prestigieux journal *Science*, comment elle a utilisé le microscope à effet tunnel ainsi qu’une technique récemment développée pour parvenir à mesurer les changements incroyablement rapides d’orientation magnétique des atomes, à la façon dont une caméra vidéo à grande vitesse enregistre chaque battement d’aile d’un colibri ou une fleur lorsqu’elle éclot. Cette approche rend possible la mesure de processus à l’intérieur des atomes magnétiques, à une vitesse 100 000 fois supérieure qu’auparavant.

Cette innovation pourrait pousser plus loin le développement dans d’innombrables domaines, depuis le nombre de chansons que nos iPods peuvent contenir, jusqu’à étendre l’adoption de l’énergie solaire. Le travail régulier d’IBM dans le domaine des sciences fondamentales et l’investissement dans la recherche (environ 6% des revenus ces 8 dernières années), donnent à la société l’avantage unique de tirer parti de progrès de cette nature.

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IBM Scientists Capture High Speed Measurements of Individual Atoms

Highlights :

· IBM scientists have measured how long information can stay in an individual atom

· IBM breakthrough enables ability to record, study and visualize the magnetism of individual atoms at staggering speeds – one million times faster than previously possible

· Could be valuable tool to study solar cells, quantum computing and storage-class memory at the nanoscale

SAN JOSE, Calif., September 24, 2010 – Today IBM (NYSE: IBM) researchers published a breakthrough technique in *Science* that measured how long a single atom can hold information, and gives scientists the ability to record, study and "visualize" extremely fast phenomena inside these atoms.

Just as the first motion pictures conveyed movement through high-speed photography, scientists at IBM Research – Almaden are using the Scanning Tunneling Microscope like a high-speed camera to record the behavior of individual atoms at a speed about one million times faster than previously possible. The findings will appear in the September 24, 2010 issue of the peer-reviewed journal *Science*.

For more than two decades IBM scientists have been pushing the boundaries of science using the STM to understand the fundamental properties of matter at the atomic scale, with vast potential for game-changing innovation in information storage and computation.

The ability to measure nanosecond-fast phenomena opens a new realm of experiments for scientists, since they can now add the dimension of time to experiments in which extremely fast changes occur. To put this into perspective, the difference between one nanosecond and one second is about the same comparison as one second to 30 years. An immense amount of physics happens during that time that scientists previously could not see.

"*This technique developed by the IBM Research team is a very important new capability for characterizing small structures and understanding what is happening at fast time scales*," said **Michael Crommie, University of California, Berkeley**. "*I am particularly excited by the possibility of generalizing it to other systems, such as photovoltaics, where a combination of high spatial and time resolution will help us to better understand various nanoscale processes important for solar energy, including light absorption and separation of charge*."

In addition to allowing scientists to better understand the nanoscale phenomena in solar cells, this breakthrough could be used to study areas such as:

Quantum computing. Quantum computers are a radically different type of computer – not bound to the binary nature of traditional computers – with the potential to perform advanced computations that are not possible today. With today's breakthrough, scientists will have a powerful new way to explore the feasibility of a novel approach to quantum computing through atomic spins on surfaces.

Information storage technologies. As technology approaches the atomic scale, scientists have been exploring the limits of magnetic storage. This breakthrough allows scientists to “see” an atom’s electronic and magnetic properties and explore whether or not information can be reliably stored on a single atom.

How it Works

Since the magnetic spin of an atom changes too fast to measure directly using previously available STM techniques, time-dependent behavior is recorded stroboscopically, in a manner similar to the techniques first used in creating motion pictures, or like in time lapse photography today.

Using a “pump-probe” measurement technique, a fast voltage pulse (the pump pulse) excites the atom and a subsequent weaker voltage pulse (the probe pulse) then measures the orientation of the atom's magnetism at a certain time after excitation. In essence, the time delay between the pump and the probe sets the frame time of each measurement. This delay is then varied step-by-step and the average magnetic motion is recorded in small time increments. For each time increment, the scientists repeat the alternating voltage pulses about 100,000 times, which takes less than one second.

In the experiment, iron atoms were deposited onto an insulating layer only one atom thick and supported on a copper crystal. This surface was selected to allow the atoms to be probed electrically while retaining their magnetism. The iron atoms were then positioned with atomic precision next to non-magnetic copper atoms in order to control the interaction of the iron with the local environment of nearby atoms.

The resulting structures were then measured in the presence of different magnetic fields to reveal that the speed at which they change their magnetic orientation depends sensitively on the magnetic field. This showed that the atoms relax by means of quantum mechanical tunneling of the atom's magnetic moment, an intriguing process by which the atom's magnetism can reverse its direction without passing through intermediate orientations. This knowledge may allow scientists to engineer the magnetic lifetime of the atoms to make them longer (to retain their magnetic state) or shorter (to switch to a new magnetic state) as needed to create future spintronic devices.

"This breakthrough allows us – for the first time – to understand how long information can be stored in an individual atom. Beyond this, the technique has great potential because it is applicable to many types of physics happening on the nanoscale," said **Sebastian Loth, IBM Research**. "*IBM's continued investment in exploratory and fundamental science allows us to explore the great potential of nanotechnology for the future of the IT industry*."

About IBM and Nanotechnology

IBM is a pioneer in nanotechnology. Among the company's many nanotechnology milestones, its scientists won a Nobel Prize for inventing the scanning tunneling microscope (STM), devised methods to manipulate individual atoms for the first time – famously spelling the letters IBM with 35 Xenon atoms – developed logic circuits using carbon nanotubes and incorporated sub-nanometer material layers into commercially mass-produced hard disk drive recording heads and magnetic disk coatings. IBM's current nanotechnology research aims to devise new atom- and molecular-scale structures and methods for enhancing information technologies, as well as discovering and understanding their scientific foundations.

To see an animation and interview explaining the technique, visit IBM Research - Almaden on YouTube.

For high resolution images of the technique and atomic level structures, visit IBM Research - Almaden on Flickr.
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