US scientists develop world's fastest oscillating nanomachine

Scientists at Boston University said Wednesday that they have developed an antenna-like sliver of silicon one-tenth the width of a human hair that can oscillate at gigahertz speed.

This device, pushing nanotechnology forward into the realm of quantum mechanics, can help further miniaturize wireless communication devices like cell phones, the researchers said.

With two sets of protrusions, much like the teeth from a two-sided comb or the paddles from a rowing shell, the antenna not only exhibits the first quantum nanomechanical motion but is also the world's fastest moving nanostructure.

The Boston team led by assistant professor Pritiraj Mohanty developed the device, which is called nanomechanical oscillator.

This device is also the fastest of its kind, oscillating at 1.

49 gigahertz, or 1.49 billion times a second, breaking the previous record of 1.02 gigahertz achieved by a nanomachine produced by another group, according to a paper in the latest issue of journal Physical Review Letters.

More important to the researchers, the oscillator lies at the cusp of classic physics, what people experience everyday, and quantum physics, the behavior of the molecular world. Comprised of 50 billion atoms, the antenna built by Mohanty's team is so far the largest structure to display quantum mechanical movements.

According to Alexei Gaidarzhy, the paper's lead author, during the past several decades engineers have made phenomenal advances in information technology by shrinking electronic circuitry and devices to fit onto semiconductor chips.

Shrinking electronic or mechanical systems further will inevitably require new paradigms involving quantum theory. For example, these mechanical/quantum mechanical hybrids could be used for quantum computing.

Because Mohanty's nanomechanical oscillator is "large," the research team was able to attach electrical wiring to its surface in order to monitor tiny discrete quantum motion, behavior that exists in the realm of atoms and molecules.

At a certain frequency, the paddles begin to vibrate in concert, causing the central beam to move at that same high frequency, but at an increased and easily measured amplitude.

Where each paddle moves only about a femtometer, roughly the diameter of an atom's nucleus, the antenna moves over a distance

of one-tenth of a picometer, a tiny distance that still translates to a 100-fold increase in amplitude.

The group carries out the experiments under extremely cold conditions, at a temperature of 110 millikelvin, which is only a tenth of a degree above the absolute zero. When cooled to such a low temperature, the nanomechanical oscillator starts to jump between two discrete positions without occupying the physical space in between, a telltale sign of quantum behavior.

When fabricating and testing the nanomechanical device, the researchers placed the entire apparatus, including the cryostat and monitoring devices, in a copper-walled, copper-floored room.

This setup shielded the experiment from unwanted vibration noise and electromagnetic radiation that could generate from outside electrical devices, such as cell phone signals, or even the movement of subway trains outside the building.

Source: Xinhua

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