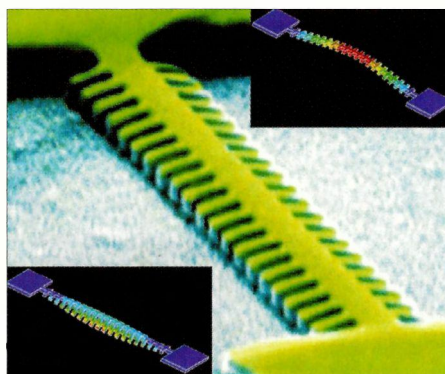


Displacement joins the quantum club

Under the right circumstances almost anything can be quantized, and many such quantities have been observed directly in experiments. Now it seems that a new quantity may have joined the list: displacement. Researchers at Boston University used silicon to construct a comb-like structure with “teeth” some 500 nm long and 200 nm wide. They then equipped it with a current-carrying gold strip so that it could be made to oscillate in a magnetic field.

What they have observed is quite remarkable. At millikelvin temperatures, where quantum effects dominate over thermal ones, they have seen preferences for distinct amplitudes of the displacement, just as one would expect for a quantum simple harmonic oscillator. The actual displacements due to the driving force are only femtometres, but the mechanical structure amplifies them up to the level where they become observable. The displacements reach frequencies up to 1 GHz, which makes this the highest frequency bulk mechanical oscillator to date.



Scanning electron micrograph of a suspended antenna oscillator. The device consists of a silicon beam measuring $10.7 \mu\text{m} \times 400 \text{ nm}$ with “paddles” on both sides. Inset are simulations of the fundamental resonance mode (top) and the high-order collective mode (bottom).

Further reading

Alexei Gaidarzhy *et al.* 2005 *Phys. Rev. Lett.* **94** 030402.

Silicon dot pushes boundary of single-photon detectors

While solid-state detectors, such as avalanche photodiodes, are starting to put the squeeze on photomultiplier tubes and other older single-photon detectors, still newer technology is making progress. Physicists at Toshiba Research Europe and the University of Cambridge have developed a novel single-photon detector based on a quantum dot – a tiny silicon disc measuring only $30 \times 8 \text{ nm}^2$.

The dot’s size makes it like an artificial atom (albeit with a very non-Coulomb potential) with the usual quantized electron energy states. The quantum dot is encased within a resonant tunnelling diode designed so that under normal circumstances no current can flow through it. If, however, the dot absorbs a photon, tunnelling becomes allowed and a current flows. The measured quantum efficiency is around 12% but is expected to reach 65%.

Further reading

J C Blakesley *et al.* 2005 *Phys. Rev. Lett.* **94** 067401.

Study challenges claims about grammar versus mathematics

An open question about the nature of human intelligence is the degree to which language is linked to other cognitive functions. Numerous claims have been made, for example, that the ability to do mathematics should be linked to the ability to handle grammar, and indeed such an idea does seem quite natural. Now, however, it looks

as though this idea must be discarded.

Rosemary Varley and colleagues at the University of Sheffield studied three men with brain damage, which affected their ability to handle grammar. To the surprise of the researchers, the men retained full ability to do computations, including recursion, and also to deal with structure-dependent concepts

such as expressions with brackets. This is the first time it has been shown that if mathematics is a language, it is certainly not like language as we know it from linguistics.

Further reading

Rosemary A Varley *et al.* 2005 *Proc. Nat. Acad. Sci.* **102** 3519.

Transitions viewed on the atomic scale

Phase transitions are often thought of macroscopically, as arising from big changes in the structure of a material, such as when ice melts, or water turns to steam, but of course these changes must be linked to events that happen atom by atom. Now a

team at the Universidad Autonoma de Madrid in Spain has managed not only to see the structure of two phases, atom by atom, but to film the transition between them.

The team used a special scanning-tunnelling electron microscope stabilized so that it can track the same set of atoms in a sample, even as the temperature of the sample changes. Looking at a film of lead deposited on germanium, the researchers could watch a small array of atoms as the film

switched between a smooth phase at temperatures above 86 K and a corrugated one below. They also observed similar behaviour for lead on silicon, and obtained results that agree with theories that assume that point-like defects do not play critical roles in such phase transitions.

Further reading

I Brihuega *et al.* 2005 *Phys. Rev. Lett.* **94** 046101.