OPTOMECHANICAL PHYSICS

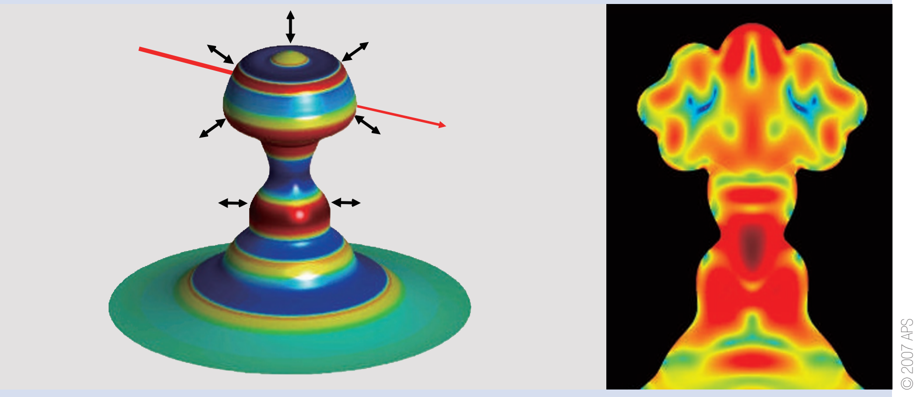
Good vibrations

Light can be used to make objects vibrate mechanically. So-called optomechanical oscillations have been demonstrated before at radio frequencies using toroidal-shaped resonators. Now Tal Carmon and Kerry Vahala from the California Institute of Technology have used light to excite vibrations in a micrometre-sized sphere at frequencies greater than 1 GHz for the first time.

Microspheres are particularly interesting because they are able to tightly confine light while dissipating small amounts of optical energy. Strong coupling between the mechanical and optical modes of the sphere could offer new insights in physics and possibly lead to applications of quantum optomechanical effects.

Carmon and Vahala build a micrometre-sized silica sphere onto a silicon chip (*Phys. Rev. Lett.* **98**, 123901; 2007). The spherical shape of the resonant structure boosts its mechanical resonant frequencies into the microwave-frequency regime, while fixing the structure onto a chip increases the stiffness of the structure, which also pushes the vibrational eigenfrequencies to higher values.

Continuous-wave light is evanescently coupled into the structure through a tapered fibre attached to the sphere. When the energy of the input light is tuned to one of the optical resonances of the sphere, optical energy builds up in the microcavity, creating radiation pressure. This pressure leads to an instability whereby the walls of the sphere inflate, which takes the sphere out of its optical resonance. In turn, light leaks out of the fibre and the structure physically 'deflates'. The flow of optical power to and from the sphere can be used to provide information about the mechanical eigenfrequencies, oscillation amplitudes and input power needed to induce the effect.



© 2007 APS

The first light-excited natural vibration oscillates at 157 MHz. Through numerical simulations, the researchers are able to map the change in shape of the microsphere as it vibrates from an oblate to a prolate shape. To select higher natural frequencies of the structure, Carmon and Vahala shorten the lifetime of the photons inside the spherical cavity by tuning the coupling gap between the sphere and the fibre. A narrower coupling gap improves the field coupling and reduces the photon lifetime. With suitable tuning of the gap, vibrational modes with a 1.08 GHz frequency were achieved.

Experimental improvements will allow higher mechanical oscillation frequencies to be reached. And with others studying optomechanical effects in systems such as photonic crystals, these sorts of optoexcited vibrations could be put to use elsewhere.

Amber Jenkins

TERAHERTZ APPLICATIONS

A source of fresh hope

Is the terahertz spectral range finally about to be opened up for broad application across the physical and biological sciences? Researchers propose a new source of terahertz waves that could do just this.

Edmund Linfield

is a professor in the School of Electronic and Electrical Engineering at the University of Leeds, Leeds, LS2 9JT, UK.

e-mail: e.h.linfield@leeds.ac.uk

Over the past decade, there has been a staggering increase in the number of research groups worldwide seeking to develop and exploit the terahertz frequency range (which spans from approximately 100 GHz to 10 THz). This has been fuelled, at least in part, by the promise of applications across the physical and biological sciences. These applications include (but are by no means limited to) the spectroscopic studies of pharmaceutical products (for example, distinguishing different forms of a given drug[1] or reconstructing chemical distributions inside tablets), the detection of explosives[2] and illegal drugs (useful for security screening at airports), the determination of disease (such as cancers) in skin tissue[3] and industrial-process monitoring. These applications sit alongside the traditional needs for terahertz sources, detectors and systems for current and future astronomical programmes, as well as for studies of condensed-matter physics and nanoscale structures, for which key energy scales and timescales lie in the terahertz spectral range.

Given all of these promising avenues, why is it that researchers are still only discussing

©2007 Nature Publishing Group