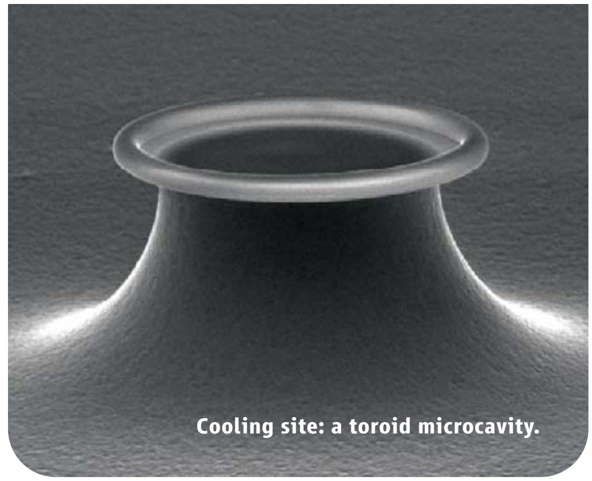
APPLIED PHYSICS

Cooling Rays of Light



Cooling site: a toroid microcavity.

Just as the vibrational frequency of a mechanical oscillator shifts in response to changes in its environment (e.g., changes in the pressure, temperature, or viscosity of the medium in which it sits), so it may be expected that the radiation pressure exerted by light on an object can also affect the vibrational modes of mechanical resonators. This phenomenon opens the possibility of either amplifying (heating) or damping (cooling) the motion of the resonator with light. Whereas laser cooling is now routine for microscopic objects such as atoms, translating the technique to larger objects presents more of a challenge, because the dynamical back-action between the photons and the resonator requires that photon lifetimes be long enough to interact with the mechanical modes of the resonator. Effectively, the photons must be confined in the cavity on a time scale comparable to the mechanical oscillation period of the resonator. Four recent studies, by Schliesser *et al.*, Gigan *et al*., Arcizet *et al*., and Kleckner and Bouwmeester, successfully access this regime for dynamical back-action and demonstrate efficient optical cooling of a mechanical oscillator mode to cryogenic temperatures. The ability to cool macroscopic objects with light not only has practical applications, as for mirror stabilization in large-scale interferometers, but also offers a means of probing quantum effects in mechanical systems. — ISO

Phys. Rev. Lett. **97**, 243905 (2006); *Nature* **444**, 67; 71; 75 (2006).

ASTROCHEMISTRY

Capturing Ferroelectric Ice

At low temperature and pressure, water crystallizes in two distinct morphologies, termed ice I and ice XI. Ice I exhibits the form of a hexagonal lattice of oxygen atoms, with attached protons distributed randomly around them. In ice XI, the protons become ordered and the resulting solid is ferroelectric. The inherent stability of ice XI is of particular interest because of its possible formation in space. However, researchers have accessed it only by doping of water samples with potassium hydroxide, and the influence of the dopant on long-range ordering was not well resolved.

Fukazawa *et al.* have succeeded in making large quantities of Ice XI in the laboratory by doping D_2O (deuterated to raise the neutron scattering efficiency) with very small amounts of KOD, and then carefully maintaining the samples in a 60 to 70 K temperature range over tens of hours. Neutron diffraction experiments confirmed an extended ordered structure. The existence of ice XI in cold space environments is therefore likely; the electronic properties of the bulk ice may affect the formation mechanism of icy planets. — JB

Astrophys. J. **652**, L57 (2006).

GENETICS

Pining for Understanding

The genes underlying complex (and industrially important) traits in pine have long been sought, but the paucity of genetic resources has made this an arduous search. González-Martínez *et al.* use a population genomic approach to examine the associations between phenotypic traits and single-nucleotide polymorphisms (SNPs) in known genes to identify specific allelic variants underlying solid wood production and wood biochemistry in loblolly pine. In spite of the large genome size in conifers, the high heterozygosity and rapid breakdown of linkage disequilibrium allowed them to identify 20 genes underlying complex polymorphic traits. Although the effects demonstrated for each SNP were relatively low, on the order of 5% (similar to that observed in previously identified quantitative trait loci), combining markers associated with the same trait accounted for 20% of the phenotypic variation and 40% of the additive genetic variance.

Besides its potential commercial use in tree breeding, this approach can also be applied to investigations of the evolution and ecological genetics of loblolly pine. — LMZ

Genetics 10.1534/genetics.106.061127 (2006).

DEVELOPMENT

Import Controls

The directed and controlled differentiation of cells is of critical importance for being able to use embryonic stem cells in a clinical setting. Yasuhara *et al.* have shown that a switch in a nuclear transport mechanism is involved in cell fate determination. For nuclear import, a protein with a nuclear localization signal (NLS) binds to the receptor importin-α, which in turn recruits importin-β to mediate translocation through the nuclear pore. They find that mouse embryonic stem (ES) cells express the subtype importin-α1, whereas cells that have differentiated into neurons express importin-α5. Experimental manipulation confirmed that neural differentiation can be enhanced by combining the down-regulation of importin-α1 with the overexpression of importin-α5. Hence, the switching of importin-α subtype triggers neural differentiation of ES cells. The authors propose a mechanism by which importin-α subtypes function in either the undifferentiated or differentiated state by controlling the selective import of transcription factors into the nucleus—Oct3/4 for the former and Brn2 with SOX2 in the latter—which adds yet another layer of regulation for cell

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