we have to keep probing the 'haystack' many times to convince it to give up its secrets. This begs the question: is it better to have a hundred noisy states than a handful of less noisy ones? The answer, at least in some cases, is yes. Suppose that each state contains a different unknown signal that we wish to measure and that, without amplification, the noise is just too great to be able to find the signal. In this case, we will always fail no matter how many states we have. However, if noiseless amplification allows us to detect the signal, then we will succeed at least sometimes. One area where this might be useful is quantum communications. Noiseless amplification could be used at a repeater station to restore the information in a quantum state that has been degraded in transit.

Intriguingly, the scheme of Usuga *et al.*[1] has more than an echo of a process that occurs in nature. Much like the present scheme, it is known that crickets make use of thermal noise to enhance the detection of weak signals in their wind-receptor cells[8]. The similarities are tantalizing and it would be interesting to investigate the links further. Although there are a few ideas for how the experiment reported here could be applied, a future challenge will be to find situations where it can be implemented to give a real practical advantage. That aside, it is an undeniably interesting result that gives some fundamental insight into quantum measurement and a beautiful demonstration of the maxim that sometimes in life you have to go backwards to go forwards. ❐

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LASER COOLING

From atoms to molecules

Even the simplest molecules are complex creatures. They can vibrate and rotate, and may have a permanent electric dipole moment that enables them to interact over relatively long distances. All these degrees of freedom are advantageous for a wide range of applications, from studying chemical reactions, to simulating the behaviour of condensed-matter systems and testing fundamental symmetries — provided that the internal and motional states of molecules can be controlled with a precision similar to that possible with atoms.

For atoms, the breakthrough towards almost full control came with the development of laser-based cooling methods. The use of optical forces for cooling and trapping looks equally attractive for molecules. But here their complex internal structure is a curse, and laser cooling has seemed less feasible. But there is new hope: Edward Shuman, John Barry and David DeMille report an experiment in which they laser-cooled the diatomic molecule strontium monofluoride, and they argue that there is a broader class of molecules whose properties make them amenable to laser cooling too (*Nature* doi:10.1038/nature09443; 2010).

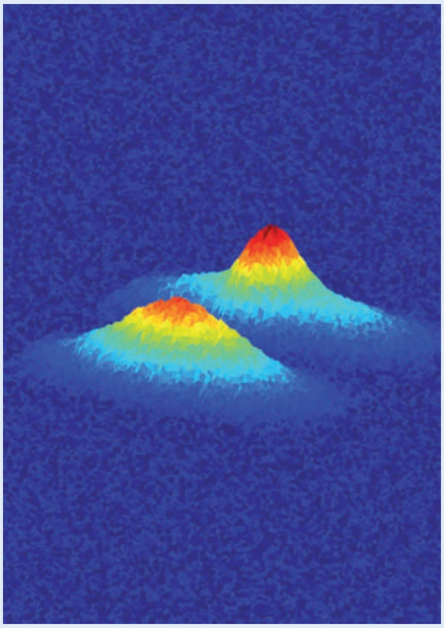

IMAGE COURTESY OF JOHN BARRY

The key to laser cooling is scattering a large number of photons from a laser beam. For example, the mechanism known as Doppler cooling works by letting atoms preferentially absorb photons with momenta opposite to their direction of flight (by choosing the laser frequency to be just below that of an electronic transition). To return to its original state, the excited atom emits a photon in a random direction, resulting in a tiny amount of net deceleration. After thousands of such cycles, atoms end up at submillikelvin temperatures.

Real systems, however, are never that simple and, unavoidably, other energy levels are populated through spontaneous decay. These leaks can be stopped using 'repump' lasers to bring stray energy back into the main cycle. In atoms, one or two repump lasers typically suffice, but in molecules, with their large number of low-lying states, repumping had seemed impractical.

But not necessarily. In previous work with David Glenn, Shuman, Barry and DeMille identified an optical cycling scheme for strontium monofluoride that suppresses vibrational and rotational decay channels by a careful choice of energy levels, such that laser cooling of this molecule requires only three lasers (*Phys. Rev. Lett.* **103,** 223001; 2009). Now they have successfully implemented the full scheme: in the image the lower peak shows the transverse velocity spread of the original (precooled) beam at 50 mK, whereas in the laser-cooled ensemble (top), the temperature is reduced to around 300 μK.

As well as Doppler cooling, a second mechanism called Sisyphus cooling has been found to be at work, but a complete description of the cooling forces is yet to be given. However, the authors expect that similar schemes will make it possible to manipulate a wider class of diatomic molecules, so that the laser cooling of molecules could eventually complement and extend other techniques for producing 'ultracold' molecules, such as the binding together of precooled alkali atoms or direct cooling.

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