that disorder (in the form of dislocations in single crystals, grain boundaries in polycrystals, and glassy regions in quenched samples) has an important role in supersolidity[3]. But what kind of disorder leads simultaneously to a stiffening and to a macroscopic mass flow through the solid matrix? And how? To behave collectively as in a superfluid, atoms need to be able to exchange their positions. Without vacancies in the crystal, exchange seems impossible[8]. Defects can be considered as regions where there are vacancies, and numerical studies have found mass superflow inside dislocations, grain boundaries and glassy regions[9–11]. For macroscopic flow to take place, these defects need to be connected together. Is it possible that, at low-enough temperature, impurities bind to dislocations and prevent them from moving? This would explain the stiffening. Could the binding of impurities promote the connection of dislocations that then form a three-dimensional network and allow superflow? Perhaps, but one needs a very large dislocation density to explain the amplitude of the flow and the temperature at which supersolidity appears. Could fluctuations enhance supersolidity? Are they modified by the binding of impurities? And why should a theory based on dislocations apply to polycrystals where grain boundaries are already connected, and to porous media where similar effects have been observed?

Evidence for glassy behaviour in quench-frozen samples was found recently[12]. In my opinion, the mechanism is not the same as in single crystals or in polycrystals. In other recent work, Phil Anderson[13] has reiterated that supersolidity does not necessarily need disorder to take place, because the ground state of solid helium-4 may contain vacancies. This statement is in absolute contradiction of numerical studies. To me, it now seems important to check experimentally whether disorder is really necessary for supersolidity, or if it only enhances it. I'm no longer so sure. ❐

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LUNAR SCIENCE

In the Moon's wake

In November 1998, when the annual Leonid meteor shower coincided with the New Moon, astronomers working in Texas noticed an unexpectedly high concentration of sodium atoms localized above the Earth. This 'Na spot' was identified as a stream of atoms escaping from the Moon. Now, a comprehensive study by Majd Matta and colleagues of the brightness of this spot over 31 consecutive lunar months has provided clues as to how sodium atoms escape the Moon's surface (*Icarus* http://dx.doi.org/10.1016/j.icarus.2009.06.017; 2009).

The Moon is known to have a thin and transient atmosphere made up of atoms that have been released from the lunar surface. One of the species detected so far is sodium, which can be picked up using Earth-based spectroscopic techniques. These measurements have shown that the sodium atmosphere extends to about 8,700 km — five times the lunar radius, R_M — on the side of the Moon closest to the Sun and to about 20 R_M on the dark side. This comet-like sodium tail is attributed to solar radiation pushing the sodium atoms away from the Sun.

All-sky observations made between 18–20 November 1998 at the McDonald Observatory in Fort Davies, Texas, revealed an intense spot of 589 nm light — the same wavelength as sodium D lines — in a 3° × 3° area of the night sky. This Na spot was seen near the antisolar point and only on the three nights of the New Moon, when the Earth is roughly aligned with the Sun and the Moon. The explanation was that the Moon's sodium tail was being focused by the Earth's gravitational field. It was also postulated that the spot was made particularly bright by an increase in the rate of sodium escape from the Moon's surface during the Leonid meteor shower, which had been at its most intense a couple of days earlier (it takes the sodium atoms roughly two days to travel the distance between the Moon and the Earth).


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Matta and colleagues, using the El Leoncito Observatory in Argentina, spent almost two and a half years (from April 2006 to September 2008) monitoring how the intensity of this spot varies. Their aim was to determine whether increases in intensity coincided with any other form of astronomical activity, and thereby provide a better understanding of the mechanism by which the sodium atoms escape from the lunar surface.

Contrary to what was first thought, the team found little correlation between meteoric activity at the Moon and the lunar-tail brightness. There was also little connection between the Na-spot intensity and the flux of either solar-wind protons, which are thought to sputter sodium atoms from the surface, or solar photons, which could lead to photon-stimulated desorption. Matta *et al.* suggest that no single mechanism drives sodium expulsion exclusively, but stress that the ambiguity may be due to the absence of any appreciable meteor storms in the period of the study.

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