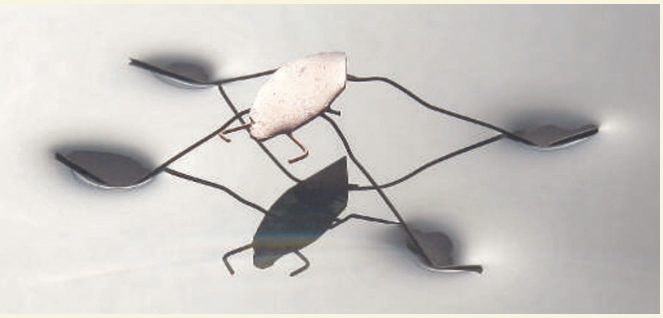
SURFACE CHEMISTRY

Repellent legs



The glossy, water-repellent leaves of lotus plants (*Nelumbo nucifera* and *N. lutea*) have inspired many synthetic superhydrophobic surfaces. But the best of these are difficult to make, and can be very fragile. Steven Bell and colleagues now describe a simple method to prepare robust superhydrophobic surfaces of high quality (I. A. Larmour *et al. Angew. Chem. Int. Edn* doi:10.1002/anie.200604596; 2007).

The secret of lotus leaves' water-repellency is the double roughness of their surfaces — caused by the presence of nanohairs on microbumps — coupled with a waxy coating. The authors recreate this double roughness by coating metal substrates with a textured layer of another metal, simply by immersing them in a metal-salt solution. Scanning electron microscopy shows that the deposited metal forms flower-like structures (0.20 to 1 μm across) that are made up of smaller crystallites (about 60 to 200 nm in size), simulating the complexity of lotus leaf surfaces.

Dipping the substrates in a solution of a chemical surface-modifier, HDFT, supplies a monolayer of hydrophobic molecules. These molecules are highly fluorinated, just like the Teflon lining of non-stick frying-pans. The resulting surfaces show almost perfect super-hydrophobicity: a drop of water on a perfectly water-repellent surface forms a contact angle θ of 180°, and the surfaces produced by this method have θ values consistently greater than 170°.

The approach is so simple that it can be applied to metal objects of any reasonable size or shape. The authors again turned to nature for inspiration. Pond skaters (*Gerridae*) use superhydrophobic legs to walk on water. Bell and colleagues made a model pond skater from copper (pictured), with legs that had been treated with silver and HDFT. Despite having ten times the mass of a real pond skater, the metallic insect was able to rest comfortably on the surface of water.

The authors suggest that their method will aid research into superhydrophobic surfaces. This should hasten the arrival of practical applications, such as reducing turbulent flow in water-bearing pipes.

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ultimate goal is to measure the pair correlations, or perhaps higher-order correlations between more than two particles, for various strongly correlated, interacting quantum systems. Such measurements are technically demanding, but the authors show how a significant step can be made towards that goal by using an atomic lens. This is a laser that forces atoms away from its axis, 'defocusing' the atomic clouds, spreading them out in space and so significantly increasing the resolution for detecting the position of individual atoms.

The atomic-lensing method should allow the observation of, for instance, the antibunching that a one-dimensional gas of bosons undergoes because of 'fermionization' as a result of increased atom–atom repulsion in a confined space. Analysing the raw data obtained from atom detectors, one should also be able to extract the full atomic counting distribution. For non-interacting bosonic atoms in thermal equilibrium, this distribution should be broader than a Poisson distribution (Fig. 1); for non-interacting fermions, it should be narrower.

Direct counting of atoms at high resolution is so far possible only with metastable helium atoms, which limits the application of the method. Alternatives are in development. The pair correlations of a Bose–Einstein condensate that was split into two interfering parts was measured a few years ago[5]. The detection of single atoms passing through a high-quality optical cavity is possible, and was also used[6] to measure bosonic counting statistics and the bosonic HBT effect.

Another powerful method for measuring pair-correlation functions is noise interferometry. This is particularly useful for ultracold gases in an optical lattice[7], a perfect periodic potential made by interfering laser beams. When this optical potential is strong, bosonic atoms cannot tunnel from lattice site to lattice site. They form instead a 'Mott insulator' state with a fixed number of bosons per site. The images obtained when these bosons are released from the lattice are noisy and blurred, indicating a lack of phase correlation. Analysing the noise correlations in a sequence of such images has been used to assess, for example, the pair-correlation functions of the Mott-insulator state of bosonic rubidium-87 atoms[8]. A band insulator of polarized fermionic potassium-40 atoms in a lattice has also been constructed[9]. This is a state in which atoms completely fill the lowest energy band; as in the Mott insulator, there is no possibility of tunnelling, and no site-to-site phase coherence. Whereas noise interferometry in a bosonic Mott-insulator system produces a periodic sequence of peaks (Fig. 2) indicative of bunching, here it leads to a series of dips, equivalent to fermionic antibunching.

These noise interferometry investigations and atom-counting experiments such as those of Jeltes and colleagues[2] will continue to supply fascinating information on the physics of strongly correlated quantum many-body systems and their constituents. As our methods develop, so our prying into the private and social lives of particles will become ever more pervasive. ■

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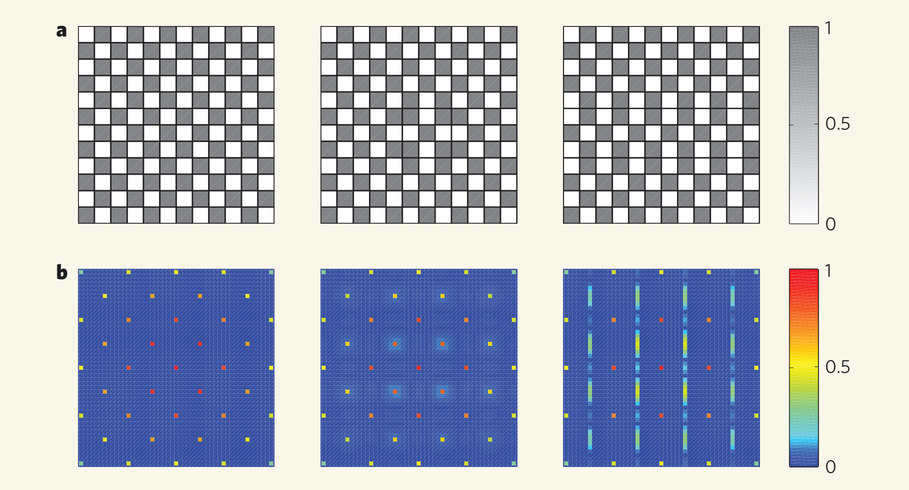

Figure 2 | Noise assessment. 'Noise interferometry' is a particularly efficient way of assessing spatial structures. **a**, A two-dimensional, dipolar Bose-gas Mott-insulator state held in an optical lattice, for example, ideally forms a chequer-board state of alternating filled and vacant sites at low temperatures and half filling[10] (left diagram; dark sites indicate presence of an atom). In practice, various kinds of defects occur (adjacent squares filled or unfilled; middle and right diagrams). **b**, Noise interferometry converts this spatial pattern into an easily identifiable interference signal, a characteristic series of peaks equivalent to a bunching behaviour.