And finally... Beyond ultracold (pp 500-503; N&V)

A method for cooling quantum gases to even colder temperatures, by reducing their entropy, is presented in this weeks Nature. The technique relies on a new form of 'blockade' effect between neutral atoms, which may also enable the implementation of controlled quantum gates in a scalable computing architecture.

Ultracold quantum gases, comprising neutral atoms confined in an 'optical lattice', hold great potential for simulating the physics of solid materials. Although quantum gases are now routinely cooled to nanokelvin temperatures, still further cooling will be necessary to simulate strongly correlated electron systems, such as quantum magnets and high-temperature superconductors. At such low temperatures, with the atoms already in their lowest-energy state, further cooling requires a way of removing entropy from the system.

Markus Greiner and colleagues report a new phenomenon, called 'orbital excitation blockade' that makes such cooling possible. The authors show that, when two atoms occupy the same lattice site, the excitation of one of them to a higher energy level (orbital) suppresses the excitation of the other. Excited atoms can then be removed from the system, taking entropy with them.

This ability to control the number of atoms occupying each lattice site is also of interest for quantum computing, as it should allow the creation of quantum registers with thousands of lattice-trapped atoms, and, in principle, the implementation of two-quantum-bit gates for generalized computing.

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