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A quantum gas specialist learns about crystals from his own science.

Crystals can behave as electrical insulators or conductors. In a few and under right conditions, electrons flow perfectly—without dissipation. And in a subset of these "superconducting" crystals the minimum temperature for perfect conduction is bizarrely warm.

On the whole, physicists have tried to explain this phenomenon using models with a small number of parameters, such as the probability of an electron jumping between two crystal sites, and the interaction energy between two neighboring electrons. Extensive laboratory studies measuring every conceivable property of the curious crystals confirm several predictions of these models, but their general solution is still hotly debated.

Recently, a couple of research groups have been casting around for less obvious routes into their problem, and turned to the field that is my bread and butter: quantum gases. They have modeled electrons zooming through hot crystals as gases of cold potassium atoms moving around in a space demarcated by laser beams—a kind of egg-box made with light.

In December, one group led by Immanuel Bloch, detected its potassium gas switching to a state with exactly one atom per hole of the egg-box. In the context of solid-state physics, such an ordered state is considered as a key ingredient along the route to superconductivity. Bloch's team was not the very first group to see the switch, but their measurement of the size of the gas revealed a crucial property of this phase, its incompressibility (U. Schneider et al, Science 322, 1520; 2008).

This work is a crucial step in turning quantum gases into useful playthings for scientists studying superconducting crystals. Like crystals, quantum gases are now thought of as insulators as well as conductors, making the experimental analogy a more complete, and making them more useful playthings for scientists studying superconducting crystals.

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