

Superconductors have already found applications outside the laboratory in technologies such as Magnetic Resonance Imaging (MRI). MRI machines use superconductors to generate a large magnetic field that gives doctors a non-invasive way to image the inside of a patient's body. Superconducting magnets also made possible the recent detection of the Higgs Boson at CERN, by bending and focusing beams of colliding particles.

One interesting and potentially useful property of superconductors arises when they are placed near a strong magnet. The magnetic field causes electrical currents to spontaneously flow on the surface of a superconductor, which then give rise to their own, counteracting, magnetic field. The effect is that the superconductor dramatically levitates above the magnet, suspended in the air by an invisible magnetic force.

What prevents more widespread use of these materials is the fact that the superconductors we know about operate only at very low temperatures. In the simple elements for instance, superconductivity dies out at just

10 Kelvin, or  $-263^{\circ}\text{C}$ . In more complicated compounds, such as yttrium barium copper oxide ( $\text{YBa}_2\text{Cu}_3\text{O}_7$ ), superconductivity may persist to higher temperatures, up to 100 Kelvin ( $-173^{\circ}\text{C}$ ). While this is an improvement on the simple elements, it is still much colder than the coldest winter night in Antarctica.

Scientists dream of finding a material where superconductive properties can be used at room temperature, but it's a challenging task. Turning up the temperature tends to destroy the glue that binds the electrons into superconducting pairs, which then returns a material back to its boring metallic state. One of the great challenges in the field arises from the fact that we don't yet understand very much about this glue, except in a few limited cases.

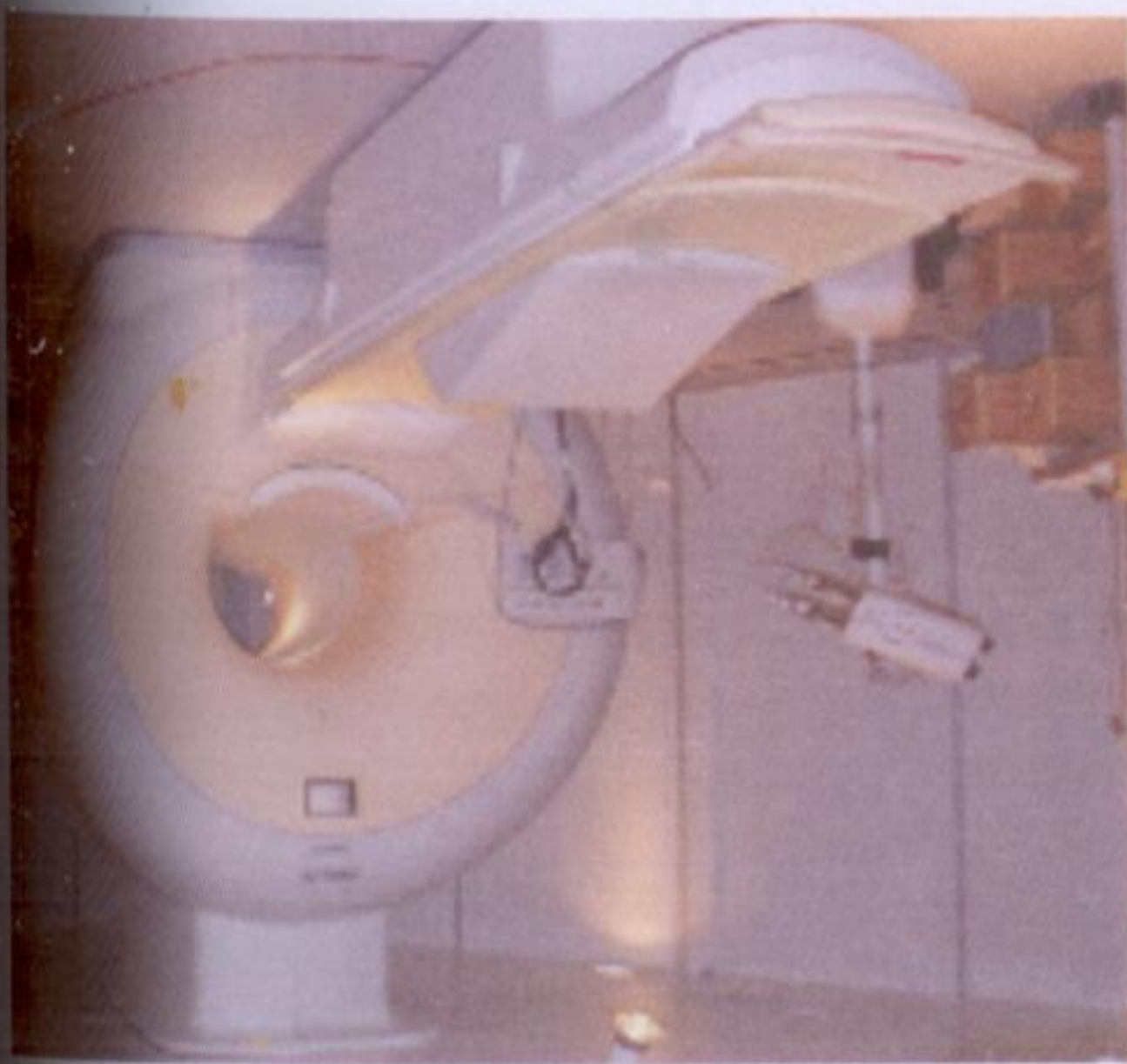
### From superatom to superconductor

New research from the University of Southern California has taken a novel step towards improving our understanding of how superconductivity arises. Rather than study superconductivity in bulk materials like wires, Vitaly Kresin and his coworkers have managed to isolate and examine small clumps of a few dozen aluminium atoms at a time. These tiny clusters of atoms can act like a "superatom", sharing electrons in a way that mimics a single, giant atom.

What is surprising is that measurements of these clusters reveal what may be the signature of electron pairing persisting all the way up to 100 kelvin ( $-173^{\circ}\text{C}$ ). This is still a frosty temperature of course but it is 100 times higher than the superconducting temperature of a piece of aluminium wire. Why does a small handful of atoms superconduct at a much higher temperature than the millions of atoms that form a wire? Physicists have some ideas but the effect is largely unexplored, and it might prove an interesting way forward in the quest for superconductivity at higher temperatures.

### Hoverboards anyone?

If physicists were able to achieve the goal of room temperature superconductivity in a material that was easy to fashion into wires, important new technologies would soon follow. For starters, devices which use electricity would become considerably more efficient and consume less power.



Superconductors are used in medical Magnetic Resonance Imaging. Jan Ainali, CC BY