SUPERCONDUCTORS

The first challenge for today's researchers is "to develop materials that are superconductors at ambient conditions, because currently superconductivity only exists either at very low temperatures or at very high pressures," said Mehmet Dogan, a postdoctoral researcher at the University of California, Berkeley. The next challenge is to develop a theory that explains how the novel superconductors work and predict the properties of those materials, Dogan told Live Science in an email.

Superconductors are separated into two main categories: low-temperature superconductors (LTS), also known as conventional superconductors, and high-temperature superconductors (HTS), or unconventional superconductors. LTS can be described by the BCS theory to explain how the electrons form Cooper pairs, while HTS use other microscopic methods to achieve zero resistance. The origins of HTS are one of the major unsolved problems of modern-day physics.

Most of the historical research on superconductivity has been in the direction of LTS, because those superconductors are much easier to discover and study, and almost all applications of superconductivity involve LTS.

HTS, in contrast, are an active and exciting area of modern-day research. Anything that works as a superconductor above 70 K is generally considered an HTS. Even though that's still pretty cold, that temperature is desirable because it can be reached by cooling with liquid nitrogen, which is far more common and readily available than the liquid helium needed to cool to the even lower temperatures that are needed for LTS.

**THE FUTURE OF SUPERCONDUCTORS**

The "holy grail" of superconductor research is to find a material that can act as a superconductor at room temperatures. To date, the [highest superconducting temperature](https://pubmed.ncbi.nlm.nih.gov/33057222/) was reached with extremely pressurized carbonaceous sulfur hydride, which reached superconductivity at 59 F (15 C, or about 288 K), but required 267 gigapascals of pressure to do it. That pressure is equivalent to the interior of giant planets like Jupiter, which makes it impractical for everyday applications.

Room-temperature superconductors would allow for the electrical transmission of energy with no losses or waste, more efficient maglev trains, and cheaper and more ubiquitous use of MRI technology. The practical applications of room-temperature superconductors are limitless — physicists just need to figure out how superconductors work at room temperatures and what the "Goldilocks" material to allow for superconductivity might be.