Nickel age of high-temperature superconductivity

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Superconductivity is a remarkable physical phenomenon where certain materials can conduct electric currents with zero resistance when cooled below a specific critical temperature. This ability to conduct electricity without resistance makes superconductors valuable for various applications, including magnetic resonance imaging, particle accelerators, magnetic levitation devices and potentially for power transmission and quantum computing. However, the requirement for the very low operating temperatures needed for most superconductors limits their widespread practical use. To date, the highest operating temperature of superconductivity at ambient pressure has remained in oxide compounds containing copper, the cuprate. Despite recent observations of superconductivity in nickel-oxide-based compounds (the nickelates), evidence of Cooper pairing above 30 K in a system that is isostructural to the cuprates, but without copper, at ambient pressure and without lattice compression, has remained elusive.

This talk will present the discovery of the first high temperature superconductor in an oxide compound without copper with a superconducting transition temperature at ambient pressure surpassing the initial achievement of copper oxides in the 30 K range. We demonstrate superconductivity with a T_c approaching 40 K under ambient pressure in the hole-doped, late rare-earth infinite-layer nickel oxide (Sm-Eu-Ca-Sr)NiO_2 thin films with negligible lattice compression, supported by observations of a zero resistance state at 31 K and the Meissner effect. Our findings demonstrate the potential of achieving high-temperature superconductivity using strongly correlated *d*-electron metal oxides beyond copper as the building blocks for superconductivity, offering a promising platform for further exploration and understanding of high-temperature Cooper pairing.