Upper critical field reaches 90 teslas near the Mott transition in alkali-doped fulleride superconductors

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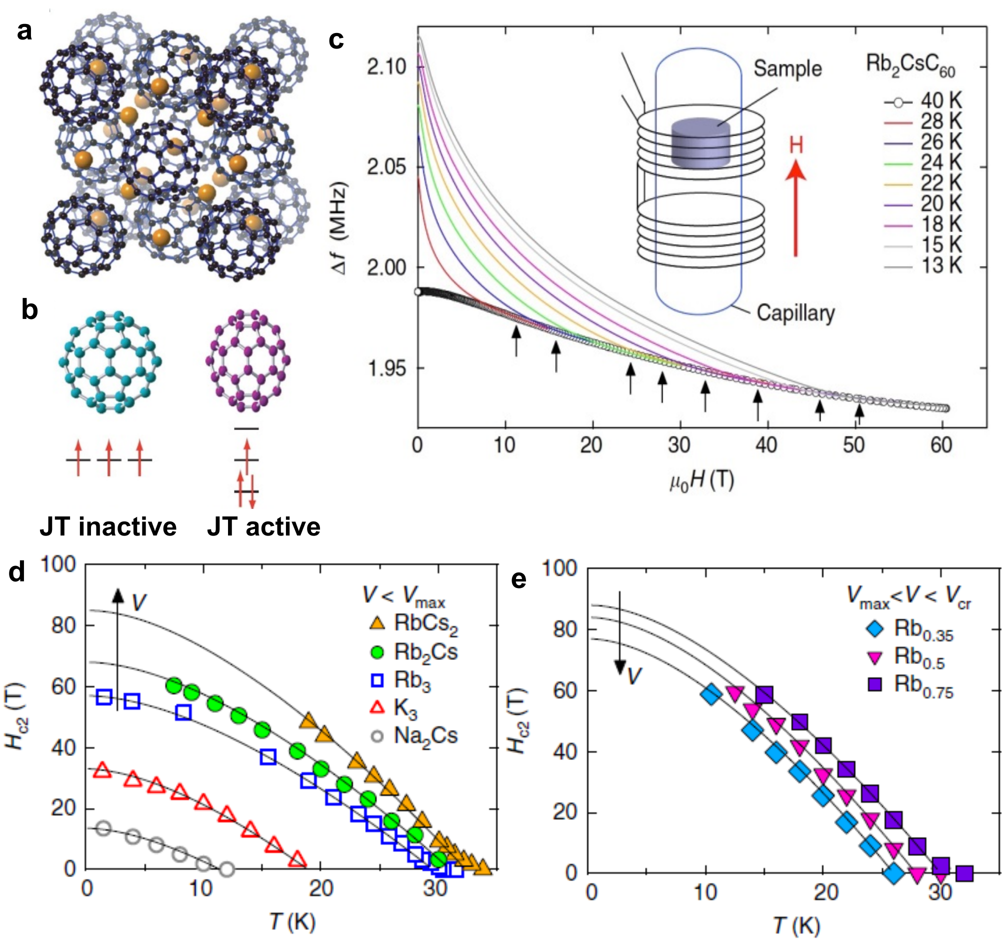
The alkali-doped fullerides provide the first example of a transition from a three-dimensional Mott insulator to a superconductor, enabling the effects of both dimensionality and electron correlations on superconductivity to be explored. Chemically, the alkali species tunes the superconductivity in the vicinity of the Mott transition by varying the unit cell volume.

Measuring the relationship between the superconducting transition temperature, Tc, and upper critical magnetic field, Hc2, revealed a crossover from weak- to strong-coupling as the Mott transition is approached, a crossover associated with the dynamical Jahn–Teller effect. The use of pulsed magnets is required because the upper critical field is enhanced in the vicinity of the Mott insulating phase, reaching 90T for $Rb_xCs_{3-x}C_{60}$ — the highest among cubic crystals. This required close collaboration between external users and MagLab scientists to design radio frequency (rf) measurements compatible with sample encapsulation in an inert atmosphere.

The increase of pairing strength with lattice volume near the Mott transition suggests that a cooperative interplay between molecular electronic structure and strong electron correlations reinforces the robust superconductivity (high-Tc and high-Hc2) found in the alkali-doped fullerides.



a) the crystal structure, b) Jahn-Teller (JT) distortion, and c) the upper critical field, Hc2, measured via the *rf*-frequency shift. d) and e) Hc2 versus Tc for all alkali metal doping compositions studied.

Facilities: Pulsed Field Facility, short pulse magnet systems.
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