Understanding the Anomalous Properties of Expanded A_3C_{60} Fullerides as Strongly Correlated Superconductors

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We show that the properties of expanded fullerides of the A_3C_{60} family (A being an alkali-metal atom) are described in terms of the interplay between phonon-mediated pairing and strong correlations. While correlation effects are already present in previously known fullerides (like Rb_3C_{60} and K_3C_{60}) they become essential in the newly discovered expanded materials such as A15 Cs_3C_{60} [1-2]. In these compounds one obtains, as a function of the lattice spacing, a phase diagram which strikingly resembles that of cuprates as a function of doping: A dome-like behaviour of the critical temperature, followed by a transition to an antiferromagnetic Mott insulator.

This finding suggests that, despite the phononic nature of pairing in fullerides, these materials can be members of a wider class of correlated superconductors which includes the cuprates, heavy fermion compounds and organic materials [3].
Solving a realistic three-band model for fullerides using Dynamical Mean-Field Theory, we obtain the same phase diagram found experimentally: A bell shaped superconducting region preceding the Mott transition for increasing cell volume (increasing repulsion) [4]. We propose several experimental tests of our scenario : (i) a pseudogap in the normal phase; (ii) gain of kinetic energy and of zero-frequency optical weight at the onset of superconductivity, as in the cuprates; (iii) spin susceptibility and specific heat jumps not especially large despite the incipient Mott transition; (iv) two different energy scales governing the renormalized single particle dispersion, electronic entropy and specific heat jump.

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