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Do Fullerene Superconductors Belong to the High-Tc Superconductivity Universe?

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A3C60 (A = alkali metal) superconductors were known to adopt face-centred cubic (fcc) structures with their superconducting Tc increasing monotonically with increasing interfullerene spacing, reaching a 33 K maximum for RbCs2C60 – this physical picture had remained unaltered since 1992. Trace superconductivity (s/c fraction<0.1%) at 40 K under pressure was also reported in 1995 in multiphase samples with nominal composition Cs3C60. Despite numerous attempts by many groups worldwide, this remained unconfirmed and the structure and composition of the material responsible for superconductivity unidentified. Thus the possibility of enhancing fulleride superconductivity and understanding the structures and properties of these archetypal molecular solids had remained elusive. Here I will present our recent progress in this field in accessing high-symmetry hyperexpanded alkali fullerides in the vicinity of the Mott-Hubbard metal-insulator boundary and at previously inaccessible intermolecular separations. The physical picture that emerges for the alkali fullerides is that, contrary to long-held beliefs, they are the simplest members of the high-Tc superconductivity family. We demonstrated this by showing that in the two hyperexpanded Cs3C60 polymorphs (fcc- and A15-structured) [1-3], superconductivity emerges upon applied pressure out of an antiferromagnetic insulating state and displays an unconventional behaviour – a superconductivity dome – explicable by the prominent role of strong electron correlations.

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