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James C. McGroddy Prize Talk: Superconductivity in alkali-metal doped Carbon-60

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Carbon sixty (C_{60}), which was first identified in 1985 in laser desorption experiments, is unquestionably an arrestingly beautiful molecule. The high symmetry of the 12 pentagonal and 20 hexagonal faces symmetrically arrayed in a soccer-ball like structure invites special attention and continues to stimulate animated speculation. The availability in 1990 of macroscopic amounts of purified C_{60} derived from carbon-arc produced soot allowed the growth and characterization of both bulk and thin-film samples. Crystalline C_{60} is a molecular solid held together by weak van der Waals forces. The fcc structure has a 74% packing fraction thus allowing ample opportunity (26% available volume) for the intercalation of foreign atoms into the interstitial spaces of the three dimensional host. This opportunity catalyzed much of the collaborative work amongst chemists, physicists and materials scientists at Bell Laboratories, and resulted in the discovery of superconductivity in alkali-metal doped $C_{60}$with transition temperatures (T_c) in the mid-30-kelvin range. In this talk I will review how the successes of this initial team effort stimulated a worldwide collaboration between experimentalists and theorists to understand the promise and potential of an entirely new class of superconductors containing only two elements, carbon and an intercalated alkali metal. Although the cuprates still hold the record for the highest T_c, there are still open scientific questions about the mechanism that gives rise to such unexpectedly high T_c's in the non-oxide carbon-based superconductors. The doped fullerenes have unusual attributes (e.g., narrow electronic bands, high disorder, anomalous energy scales, and a tantalizing proximity to a metal-insulator Mott transition), which challenge conventional thinking and at the same time provide useful insights into new directions for finding even higher T_c materials. The final chapter of the 'soot to superconductivity' story has yet to be written.