Antiferromagnetic Mott Insulating state and the Superconductivity in the Hyperexpanded Triply Charged Alkali Doped Fullerides

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The role of electronic correlations is in triply charged superconducting alkali doped fullerides A_3C_{60} (A=Na, K, Rb, Cs) still largely controversial even after more than a decade of intensive research. Face centered cubic (fcc) A_3C_{60} phases – molecular based superconductors with Tc's up to 33 K – are superconducting without showing Mott-Hubbard localisation. Their T_C's increase monotonically with interfulleride separation in accordance with the Bardeen-Cooper-Schrieffer (BCS) theory, i.e. as the overlap between the t_{1u} electrons decreases with increasing interfulleride distance, the density of states at the Fermi level, increases giving rise to enhanced transition temperature.

Here we report on the investigation of A_3C_{60} phases with (hyper)expanded unit cells. In the first part we focus on recently discovered body centered cubic Cs_3C_{60} phase where the superconducting state emerges directly from the ambient pressure antiferromagnetic insulating (AFI) state with the application of pressure larger than 3.6 kbar. The critical temperature shows a broad maximum at ~7 kbar where it reaches T_C = 38 K. The pressure induced metal-insulator transition takes place without any structural distortion, free of positional, chemical, or orientational disorder therefore implying that it is purely electronic effect [1]. Non-monotonic dependence of T_C with pressure and the superconductivity next to the AFI phase highlight the importance of electronic correlations in *bcc* Cs_3C_{60} and cannot be simply rationalized with the BCS predictions. In the second part we address the AFI state of non-cubic fullerides, such as $(CH_3NH_2)K_3C_{60}$, studied by EPR and NMR under ambient [2] and high-pressure conditions.

[1] Y. Takabayashi et al., Science 323 (2009) 1585.
[2] D. Arčon et al., Chem. Mater. 20 (2008) 4391. D. Arčon et al., Phys. Rev. B77 (2008) 035104.