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Tube-tube interaction and high curvature effects in double wall carbon nanotubes¹

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Recent results will be reported on the consequences of the interaction between peapod grown inner shell carbon nanotubes and the corresponding outer shell tubes in double wall carbon nanotubes (DWCNTs). The results were obtained from resonance Raman experiments on natural and ¹³C isotope substituted nanotubes, from time resolved NMR experiments and from calculations which include tube-tube interaction and high curvature effects of the inner tubes. The Raman analysis of the radial breathing mode of the inner tubes exhibits extremely narrow line widths which indicates unusual long phonon life times. It also confirms family behaviour of the tubes and the large number of observed lines is a consequence of pair spectrum response between inner shell and outer shell tube pairs. The response from the RBM is used to demonstrate reversible filling and release of the fullerenes from the tubes. Measurements of the longitudinal relaxation time T_1 in NMR experiments from ¹³C substituted inner tubes reveal a Korringa behaviour for temperatures above 150 K. This indicates a metallic character of the inner tubes. Below 20 K the metallicity is lost and a gap of about 4 meV opens up. The properties of the inner tubes will be discussed in the frame of a inner shell-outer shell orbital hybridization and curvature enhanced electron-phonon interaction.

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