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Magnetic field control of the Franck-Condon coupling of few-electron quantum states[1]

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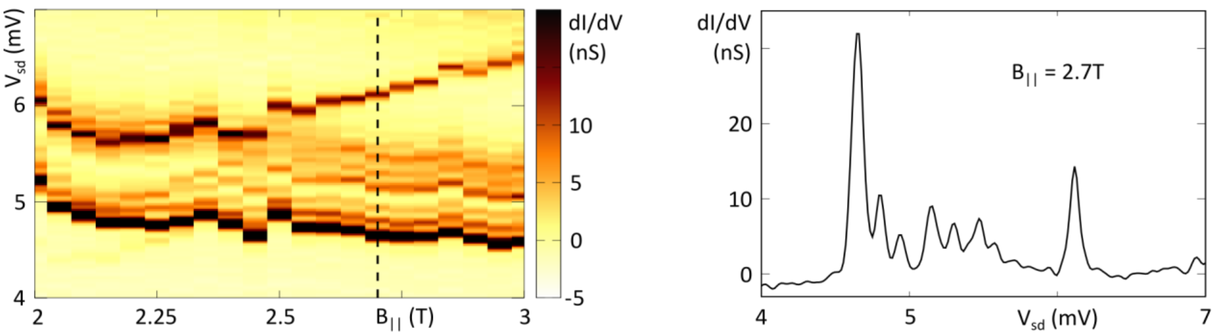
Abstract:

The longitudinal vibration of a suspended carbon nanotube has been observed many times in low temperature transport spectra via distinct harmonic Franck-Condon sidebands.[1-5] Typically, strong Franck-Condon coupling has been attributed to disorder-induced or deliberately targetted charge localization. Here, we present the observation of a strong, tunable coupling in an ultra-clean carbon nanotube with *N*=1 or *N*=2 electrons in the conduction band.

The clean transport spectrum allows a tentative identification of the electronic base quantum states according to their valley quantum number. Interestingly, the Franck-Condon coupling strength *g*, as extracted from our data, both depends on the magnetic field and on the precise electronic quantum states participating in transport. While spin-dependent Franck-Condon phenomena have already been observed,[6] our results clearly point towards a valley-dependent origin

As possible cause of this phenomenon, re-shaping of the electronic wavefunction envelope by the magnetic field[7-9] is discussed. A simple calculation demonstrates that variations of *g* as observed in the experiment can be reproduced by the theory, paving the way towards more realistic and detailed quantum-mechanical modelling.



Franck-Condon sidebands in the two-electron excitation spectrum. From Ref. 1.

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