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Observation of trions in single-walled carbon nanotubes

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Current methods for producing single-walled carbon nanotubes (SWCNTs) lead to heterogeneous samples, containing different chiralities as well as defective SWCNTs. To overcome this issue investigations on individual SWCNT optical properties through photoluminescence spectroscopy under different cw intensity regimes are crucial. At low excitation intensities the emission spectrum of a SWCNT exhibits a peak corresponding to the lowest energy bright state, E_{11} and a red-shifted sideband peak (Fig. 1(a)). This sideband is associated with an exciton-phonon coupling of a higher energy, finite angular momentum dark-state to a K-point phonon that scatters the exciton to a bright state [1,2]. At high intensities a saturation behavior of the luminescence is observed [3] and is explained by multi-excitonic effects, namely Auger recombination and exciton-exciton annihilation [4]. Interestingly, an additional red-shifted peak is observed (Fig. 1(b)). This peak is reversible and consistently appears when excited at saturation intensities. These observations indicate that the origin is different from the effects observed by Harutyunyan *et al* [5] with a pulsed excitation. To investigate the origin of this peak we performed high intensity studies on different chiralities of SWCNTs. Later we measured the difference in energy between this sideband with respect to the E_{11} peak (Fig. 2). Clear family patterns are noticed, supporting the idea that the origin of the peak is due to states intrinsic to the SWCNT electronic structure. We studied the dependence of the area of the peaks as a function of one another and of the intensity for (6,5) SWCNTs. There is linear dependence of the area of the red-shifted peak with the intensity but a super-linear dependence with the area of the E_{11} peak. The origin of this peak can be attributed to a trionic state[7,8] which could be formed through Auger effects.

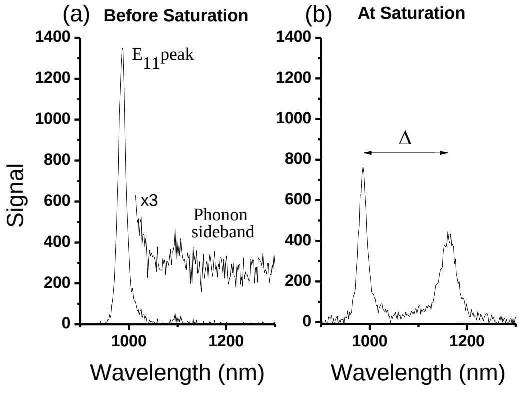

Figure 1: Individual SWCNT spectra at different excitation powers

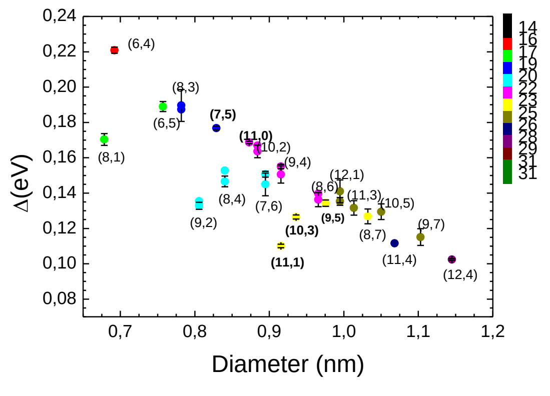

Figure 2: Energy difference (Δ) between observed peaks as a function of diameter.

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Je souhaite concourir au prix « affiche » et je déclare être une chercheuse non-permanent n'ayant pas encore soutenu ma thèse.