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Spontaneous Exciton Dissociation and the Stark Effect in Carbon Nanotubes

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Under an application of longitudinal electric fields, we have performed simultaneous photoluminescence and photocurrent measurements on individual single-walled carbon nanotubes. We observe nonzero photoconductivity at small fields, indicating that the injected excitons are spontaneously dissociating into free electron-hole pairs [1]. By modeling the excitation power and voltage dependences of emission intensity and photocurrent, we find that a significant fraction of excitons are dissociating before recombination. The absorption cross section and the oscillator strength can also be estimated from the same model.

In addition, we observe field-induced redshifts of photoluminescence that scale quadratically with electric fields. As the shifts do not depend on excitation power or energy, effects from heating or relaxation pathways are ruled out, and we attribute the shifts to the Stark effect [2]. These results show the potential for controlling excitons in individual nanotubes using external electric fields.

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[2] M. Yoshida, Y. Kumamoto, A. Ishii, A. Yokoyama, and Y. K. Kato, manuscript in preparation.