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The role of intrinsic regions in nanotube photodiodes DEREK STEWART, Cornell Nanoscale Facility — In this work, we consider the impact of intrinsic regions on transport in carbon nanotube diodes. Recently nanotube diodes have been fabricated in a split-gate geometry where a central intrinsic region separates two regions gated p-type and n-type, respectively. These devices show near ideal diode behavior and can also act as photodetectors. We use a self-consistent non-equilibrium Green's function approach to examine how the central intrinsic region affects the properties of a nanotube p-i-n photodiode. The charge and potential along the diode are determined self-consistently for systems with different intrinsic layer lengths. We find that the intrinsic region has little effect on the dark current in the device. However, as the size of the intrinsic region increases, the photocurrent grows as well. The presence of a central intrinsic region also leads to greater power conversion efficiency in nanotube photodiodes. These changes in the photoresponse can be related to charge redistribution caused by the introduction of the intrinsic layer. This leads to a reduction of the flat band regions near the leads, while unmasking the van Hove singularities in the central intrinsic region that enhance the photoresponse for higher photon energies. This effect is quite general and may be observed in similar p-n junctions (i.e. nanowires) where the density of states is quasi-one dimensional.

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