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Graphene Channel for Guiding Charge Carriers[1] JUNXI DUAN, XINYUAN LAI, MONA ZEBARJADI, EVA Y. ANDREI, Rutgers University —
The propagation of ballistic charge carriers in high quality graphene resembles that of photons. For Fermi wavelength much smaller than the scale of a device their motion mimics ray optics but with the refraction index replaced by the Fermi wavevector which proportional to the square root of the carrier density. Similar to ray optics, when the incoming ray is on the high index side of an interface between regions with different carrier densities, there is a critical angle above which total reflection occurs. As a result, a channel with high carrier density bounded by lower density regions produces electrical guiding similar to an optical wave guide. We studied the effect of total reflection on the guiding efficiency, which defines the increase of the current collected, in high quality hBN-encapsulated graphene devices with the guiding channel defined by a thin top gate. We find that the guiding efficiency is controlled by the ratio of the carrier densities inside and outside the channel. The highest efficiency about 4.5% is observed for a channel with the largest attainable carrier ratio but with the same type of carrier inside and outside. The measurement is supported by the tight-binding simulation.

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Junxi Duan
Rutgers University

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