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Anomalous optoelectronic transport induced by titled energy dispersion in Weyl semimetals

Weyl semimetals is an emerging topological state of quantum matter which hosts massless Weyl fermions with opposite chirality[1]. One significant feature of Weyl semimetals is the titled energy dispersion of Weyl nodes[2], making it distinct from conventional Dirac materials such as graphene[3] or topological insulators[4]. Theoretically, the Weyl node tilt gives rise to several fascinating physical behaviors such as intrinsic photocurrent[5] and unusual magneto response[6]. However, it is still elusive in the experiments that how Weyl nodes tilt affects the (opto)electronic transport. Herein, we observe an anomalous photovoltage (PV) distribution in a typical type-II Weyl semimetal WTe_2 using a scanning photovoltage imaging technique. Different from graphene[7], few-layer WTe_2 presents asymmetric PV distribution which varies with the current direction. Supported by the theoretical model, we find the anomalous PV distribution is determinated by Weyl nodes tilt which gives an anisotropic transmission probability with two-fold symmetry. Further, based on the diffusion theory, our results demonstrate a room temperature long diffusion length of 1.5-2.5 μm in few-layer WTe_2, which explains the strong voltage signals at the area far away from electrodes. Our work shows Weyl semimetal may lead us to interesting electro-optic applications such as electron beam collimation, electron lenses, optoelectronic logic, and self-powered light and thermal detection.

References

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Figures

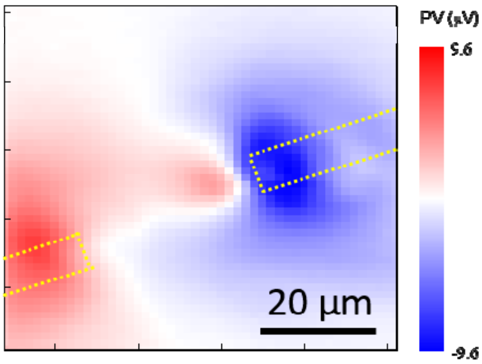

Figure 1: Anomalous photovoltage distribution in few-layer Weyl semimetals WTe_2. The yellow dashed line shows position of electrodes pair. No external voltage bias is applied to the device.