

VALLEY FILTER AND VALLEY VALVE IN GRAPHENE

A. Rycerz,

Marian Smoluchowski Institute of Physics, Jagiellonian University, Reymonta 4,
30-059 Krakow, Poland

J. Tworzydło,

Institute of Theoretical Physics, Warsaw University, Hoza 69,
00-681 Warsaw, Poland

C.W.J. Beenakker

Instituut-Lorentz, Universiteit Leiden, P.O. Box 9506,
2300 RA Leiden, The Netherlands

It is known that the lowest propagating mode in a narrow ballistic ribbon of graphene may lack the twofold valley degeneracy of higher modes. Depending on the crystallographic orientation of the ribbon axis, the lowest mode mixes both valleys or lies predominantly in a single valley (chosen by the direction of propagation). We show, using a tight-binding model calculation, that a nonequilibrium valley polarization can be realized in a sheet of graphene, upon injection of current through a ballistic point contact with zigzag edges. The polarity can be inverted by local application of a gate voltage to the point contact region. Two valley filters in series may function as an electrostatically controlled "valley valve", representing a zero-magnetic-field counterpart to the familiar spin valve.

[1] A. Rycerz, J. Tworzydło, C.W.J. Beenakker, *Nature Physics* 3, 172-175 (2007).