

Transverse spin current and spin polarization induced by a charge current in two-dimensional electron systems with spin-orbit interaction

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Electric field and/or temperature gradient in two-dimensional electron systems with spin-orbit interaction lead in a general case to transverse spin current (spin Hall and spin Nernst effects, respectively). Apart from this, charge current can also induce a nonequilibrium spin polarization, vertical to the corresponding electric field (Edelstein effect). The above mentioned phenomena in two-dimensional electron gas, single-layer and bilayer graphene, and also in other graphene-like systems will be presented and briefly discussed. As the spin-orbit interaction we assume the Rashba coupling due to a substrate and also the intrinsic spin-orbit coupling in the case of graphene and graphene-like systems. The case of spatially fluctuating Rashba coupling will also be considered.

- [1] V. K. Dugaev, M. Inglot, E. Ya. Sherman, J. Barnaś, Phys. Rev. B **82**, 121310(R) (2010).
- [2] A. Dyrdał, M. Inglot, V. K. Dugaev, J. Barnaś, Phys. Rev. B **87**, 245309 (2013).
- [3] V. K. Dugaev, M. Inglot, E. Ya. Sherman, J. Berakdar, J. Barnaś, Phys. Rev. Letters **109**, 206601 (2012).
- [4] A. Dyrdał and J. Barnaś, Phys. Rev. B **86**, 161401 (R) (2012).
- [5] A. Dyrdał and J. Barnaś, J. Phys.: Condens. Matter **24**, 275302 (2012).
- [6] A. Dyrdał and J. Barnaś, Phys. Status Solidi RRL **6**, 340 (2012).