Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Maximum values of the conserved spin and orbital Hall conductivities in the generic k-linear spin-orbit coupled semiconductor systems TZU-CHEN LIN, CHIEN-HUANG LEE, TSUNG-WEI CHEN, Department of Physics, National Sun Yat-sen University, Kaohsiung 80424, Taiwan — The effective conserved spin current is composed of the conventional spin current and the torque spin current. We analytically calculate the intrinsic spin Hall conductivity in the generic k-linear spin-orbit coupled semiconductor systems by using Kubo formula. We find that the magnitude of the conventional spin-Hall conductivity depends on the orientation of the system. Furthermore, the conventional spin-Hall conductivity has a maximum value when the spin current occurs in the direction with the smallest band splitting, which is shown to be the manifestation of the Berry curvature. However, when the torque spin-Hall conductivity is considered, the resulting total spin-Hall conductivity reaches a maximum when the spin current occurs in the direction with the largest band splitting. We also calculate the conventional and torque orbital Hall conductivities in the generic k-linear systems and show that the sum of spin-Hall and orbital Hall conductivities vanishes in the systems with conservation of total angular momentum.

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Date submitted: 15 Nov 2013 Electronic form version 1.4