MAR05-2004-000267

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Resonant spin Hall effect in two dimensional electron gas

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Remarkable phenomena have been observed in 2DEG over last two decades, most notably, the discovery of integer and fractional quantum Hall effect. The study of spin transport provides a good opportunity to explore spin physics in two-dimensional electron gas (2DEG) with spin-orbit coupling and other interaction. It is already known that the spin-orbit coupling leads to a zero-field spin splitting, and competes with the Zeeman spin splitting if the system is subjected to a magnetic field perpendicular to the plane of 2DEG. The result can be detected as beating of the Shubnikov-de Haas oscillation. Very recently the speaker and his collaborators studied transport properties of a two-dimensional electron system with Rashba spin-orbit coupling in a perpendicular magnetic field. The spin-orbit coupling competes with the Zeeman splitting to generate additional degeneracies between different Landau levels at certain magnetic fields. It is predicted theoretically that this degeneracy, if occurring at the Fermi level, gives rise to a resonant spin Hall conductance, whose height is divergent as 1/T and whose weight is divergent as -lnT at low temperatures. The charge Hall conductance changes by $2e^2/h$ instead of e^2/h as the magnetic field changes through the resonant point. The speaker will address the resonance condition, symmetries in the spin-orbit coupling, the singularity of magnetic susceptibility, nonlinear electric field effect, the edge effect and the disorder effect due to impurities. This work was supported by the Research Grants Council of Hong Kong under Grant No.: HKU 7088/01P.

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