MAR13-2012-001471

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Quantum Anomalous Hall Effects and Topological Phase Transitions in Silicene

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Silicene is a monolayer of silicon atoms forming a two-dimensional honeycomb lattice, which is experimentally manufactured this year. The low energy theory is described by Dirac electrons, but they are massive due to a relatively large spin-orbit interaction. I will explain the following properties of silicene: 1) The band structure is controllable by applying an electric field [1]. Silicene undergoes a phase transition from a topological insulator to a band insulator by applying external electric field [1]. 2) The topological phase transition can be detected experimentally by way of diamagnetism [7]. 3) There is a novel circular dichroism and spinvalley selection rules by way of photon absorption [6]. 4) Silicene shows a quantum anomalous Hall effects when ferromagnet is attached onto silicone [3]. 5) Silicene shows a photo-induced quantum Hall effects when we apply strong laser onto silicene [8]. 6) Single Dirac cone state emerges when we apply photo-irradiation and electric field, where the gap is open at the K point and closed at the K' point [8].

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