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The quantum spin Hall effect and the topological magneto-electric effect

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Search for topologically non-trivial states of matter has become a important goal for condensed matter physics. Recently, a new class of topological insulators has been proposed. These topological insulators have an insulating gap in the bulk, but have topologically protected edge states due to the time reversal symmetry. In two dimensions the edge states give rise to the quantum spin Hall (QSH) effect, in the absence of any external magnetic field. I shall review the theoretical prediction[1] of the QSH state in HgTe/CdTe semiconductor quantum wells, and its recent experimental observation [2]. The QSH effect can be generalized to three dimensions as the topological magneto-electric effect (TME) of the topological insulators [4]. I shall also present realistic experimental proposals to observe fractional charge [3], spin-charge separation and the deconfinement of the magnetic monopoles in these novel topological states of matter.

[1] A. Bernevig, T. Hughes and S. C. Zhang, Science, 314, 1757, (2006)
[2] M. Koenig et al, Science 318, 766, (2007)
[3] X. Qi, T. Hughes and S. C. Zhang, Nature Physics, 4, 273 (2008)
[4] Xiao-Liang Qi, Taylor Hughes and Shou-Cheng Zhang, "Topological Field Theory of Time-Reversal Invariant Insulators", Phys. Rev B. 78, 195424 (2008)