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Quantum Hall effect analogs in photonic crystals: semi-classical treatment of "chiral" (unidirectional) edge modes[1] SRINIVAS RAGHU, F.D.M. HALDANE, Princeton University — Previously, we have shown that "photonic crystals" (periodic metamaterials that transmit electromagnetic waves) made of non- reciprocal media (Faraday effect) can theoretically possess channels that allow light to propagate in one direction only. These channels are the direct photonic analog of the "chiral edge states" of electronic systems exhibiting a quantum Hall effect. Here, we construct exactly soluble models of photonic systems having these properties. The models considered here correspond to photonic systems with smoothly varying domain walls across which the Faraday coupling changes. The spectrum of bound states of this model contains bi-directionally propagating modes localized to the interface, and "zero modes," in which light remains localized to the interface and propagates only in a forward direction perpendicular to it. In the semiclassical treatment of this model, we show that the quantization condition for the bound states has an additional contribution from a Z2 Berry phase factor picked up by the modes as they encircle points of degeneracy.

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