

Physics 123B: Homework 3  
due February 1, 5pm in the box at the PSR

1. **IQHE:**

Assuming a 2d electron gas with fixed 2d electron density  $n$  and mass  $m$ , and assuming all electrons are spin polarized (i.e. they are all spin up), find the sequence of magnetic fields  $B_k$ , such that exactly  $k$  Landau levels are filled, with integer  $k$ . These fields correspond to the centers of plateaus in the IQHE.

2. **Topological insulators:**

In class, we showed by solving the Dirac equation that the edge state on the right side of the spin-orbit-coupled graphene system with spin up, associated with the  $K$  node, had energy  $\epsilon = \epsilon_0 - vq_y$ , i.e. it was “left-moving”.

- (a) Show by solving the Dirac equation for the  $K'$  node that the edge state on the same edge for spin down has energy  $\epsilon = \epsilon_0 + vq_y$ , i.e. it is “right-moving”.
- (b) Show that the spin up edge state on the left edge of the sample propagates in the opposite direction from the one we found in class (taking the same  $V > 0$  to occur outside the sample).