Problem Sheet 6

1. Consider a single-band tight-binding Hamiltonian on the square lattice of lecture 22. A crude way of taking into account a surface parallel to the y-direction would be to asssign an extra potential V_0 to the "edge" lattice points. What conditions must V_0 satisfy relative to the tight-binding hopping matrix element t to permit a surface state for $k_y = 0$? What would be the energy of such a state? Is there a limit on the allowed values of k_y?

2. A particle of spin 1/2 is described (in 2D real space) by a spinor wave function corresonding to a spatially varying spin orientation which is rotated away from the z-axis in the plane of z and r by an angle theta (r) (i.e. the spin-1/2 version of the ^3He-A "boojum" texture). Verify that (the spin-1/2 version of) the differential Mermin-Ho relation is satisfied.

3. Consider the "6-terminal" experiment of Roth et al., Science **325**, 294 (2009) (cf. lecture 23). If one were to imagine that the sample is in a simple quantum Hall state, with transmission probabilities $T_{i,i+1}$=1, all others zero, what would one predict for $R_{14,14}$ and $R_{14,23}$?

Please submit solutions by 9:00 am on Monday, 25 November