Quantum and Classical Localisation Transitions

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Localisation of a particle moving in a random environment may occur both quantum mechanically and with classical dynamics, but the phenomenon is very different in the two cases. I will discuss a class of quantum-mechanical localisation problems for which some physical quantities can be expressed exactly in terms of averages taken in a classical counterpart. The equivalence holds despite the fact that interference effects dominate the behaviour of the quantum systems. The models are network models belonging to class C in Zirnbauer's classification, and the classical problem involves random walks that are self-avoiding but also self-attracting. The equivalence was first discovered in the context of the spin quantum Hall effect by Gruzberg, Ludwig and Read [Phys. Rev. Lett. **82**, 4524 (1999)], and the results I will describe were obtained in collaboration with Beamond and Cardy [Phys Rev B **65**, 214301 (2002) and with Ortuño and Somoza [Phys. Rev. Lett. 102, 070603 (2009)]. In the case of the spin quantum Hall effect, the equivalent classical problem is related to percolation in two dimensions, for which many exact results are known. In case of three dimensional systems, we have no exact results for the classical problem, but the mapping makes high-precision numerics possible. I will describe results from these calculations and also efforts to relate the self-avoiding, self-attracting random walks in three dimensions to other classical problems.