



ANDERSON LOCALISATION

A condensed matter physicist view

Why are physicists interested in localisation?

The primary reason that physicists are interested in localisation is that many materials are strongly disordered. These include alloys (substitution or disordered), doped semiconductors and amorphous materials (topological disorder). This disorder can have a profound affect on the electronic status of a material. Disorder can cause electronic states to become exponentially localised with a corresponding transition from a metal to an insulator.

The theory of Anderson localisation

The scaling theory is the basis for most physicists understanding of the Anderson localisation phenomenon. The key points of this theory are:

- the existence of the beta function
- the assumption that the beta function is monotonic
- assumptions concerning its limiting form for very large and very small conductance
- perturbation theory calculation of the form of the beta function for large conductance

This last point is particularly important. The theory of weak localisation can be used to calculate the first correction to the beta function for large conductance. The result is

$$\beta(g) = d - 2 - \frac{a}{g} + \dots \quad (a > 0).$$

This calculation is the basis of the claim that all states are localised in two dimensions. Unfortunately, scaling theory (and its formalisation in the non-linear signal model) has not yielded much in the way of quantitative predictions.

Numerical simulations

Numerical simulations continue to be the main tool in theoretical research of Anderson localisation and the Anderson transition. The main results that I presented in my talk were:

- the first clear-cut numerical verification that the critical exponents for the orthogonal, unitary and symplectic symmetry classes are different
- simulation results on fractals that suggest that the lower critical dimension for systems with symplectic symmetry may be less than 2

I expect that numerical work will continue to provide many new insights into Anderson localisation and the Anderson transition.

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