Hajo Leschke

Some Aspects of Random Schrödinger Operators and Random Spin Hamiltonians

Systems of condensed-matter physics with macroscopic disorder are modelled by Hamiltonians with parameters, which are randomly distributed according to some probability measure.

For example, one-particle Schrdinger operators with random potentials are used to caricature the phenomenon of Anderson localization, that is, the supression of the tunnelling effect which yields in perfect solids, in other words ordered crystals, a purely absolutely continuous energy spectrum and macroscopic charge transport by the (Bloch-Floquet)electrons.

Another example is given by Hamiltonians for macroscopically many spins interacting with each other through random coupling constants and/or with a random external magnetic field. Here one wants to better understand the static and dynamic properties of spin glasses which at low temperatures exhibit a characteristic phase without long-range order because of "magnetic frustration".

My course will have two parts of different lengths. The first (and longer) one will be devoted to random Schrödinger operators, the second one to spin glasses. Both parts will start with an introduction and then address more specific topics which are chosen mainly according to my own (research) experience.

In the first part I will concentrate on continuum models for which I will present and explain results about the integrated density-of-states, about the nature of the almost-sure energy spectrum and about anisotropic transport in a random magnetic field. In the second part I will basically restrict myself to (classical and quantum) mean-field type models in the sense of Sherrington/Kirkpatrick and discuss the almost-sure existence of the corresponding free energies.

References

[LWW] H. Leschke, S. Warzel and A. Weichlein, *Energetic and dynamic properties of a quantum particle in a spatially random magnetic* *field with constant correlations along one direction*, Annales Henri Poincarè **7**, 335–363 (2006); `math-ph/0507035`.

[BLM] K. Broderix, H. Leschke and P. Müller, *Continuous integral kernels for unbounded Schrdinger semigroups and their spectral projections*, Journal of Functional Analysis **212**, 287–323 (2004); `math-ph/0209020`.

[LW] H. Leschke and S. Warzel, *Quantum-classical transitions in Lifshitz tails with magnetic fields*, Physical Review Letters **92**, 086402: 1–4 (2004); `cond-mat/0310389`.

[LMW] H. Leschke, P. Müller and S. Warzel, *A survey of rigorous results on random Schrdinger operators for amorphous solids*, Markov Processes and Related Fields **9**, 729–760 (2003); `cond-mat/0210708` (and references therein).

[HLW2] T. Hupfer, H. Leschke and S. Warzel, *Upper bounds on the density of states of single Landau levels broadened by Gaussian random potentials*, Journal of Mathematical Physics **42**, 5626–5641 (2001); `math-ph/0011010`.

[HLMW] T. Hupfer, H. Leschke, P. Müller and S. Warzel, *The absolute continuity of the integrated density of states for magnetic Schrdinger operators with certain unbounded random potentials*, Communications in Mathematical Physics **221**, 229–254 (2001); `math-ph/0105046`.

[FLM] W. Fischer, H. Leschke and P. Müller, *Spectral localization by Gaussian random potentials in multi-dimensional continuous space*, Journal of Statistical Physics **101**, 935–985 (2000); `math-ph/9912025`.

[HLW1] T. Hupfer, H. Leschke and S. Warzel, *The multiformity of Lifshits tails caused by random Landau Hamiltonians with repulsive impurity potentials of different decay at infinity*, AMS/IP Studies in Advanced Mathematics **16**, 233–247 (2000); `math-ph/9910034`.

[BHKL] K. Broderix, D. Hundertmark, W. Kirsch and H. Leschke, *The fate of Lifshits tails in magnetic fields*, Journal of Statistical Physics **80**, 1–22 (1995); `mp_arc 95-144`.

[LRRS] H. Leschke, S. Rothlauf, R. Ruder and W. Spitzer, *On quantum Sherrington-Kirkpatrick models of spin glasses*, in preparation.

[C] N. Crawford, *Thermodynamics and universality for infinite range quantum spin glasses*, to appear in Communications in Mathematical Physics; `math-ph/0610031`.

[ASS] M. Aizenman, R. Sims and S. Starr, *Mean-field spin glass models from the cavity–ROSt perspective*, preprint; `math-ph/0607060`.

[B] A. Bovier, *Statistical mechanics of disordered systems: a mathematical perspective*, Cambridge University Press (2006).

[T2] M. Talagrand, *The Parisi formula*, Annals of Mathematics **163**, 221-263 (2006).

[T1] M. Talagrand, *Spin glasses: a challenge to mathematicians*, Springer (2003).

[GT2] F. Guerra, F. Toninelli *The infinite volume limit in generalized mean field disordered models*, Markov Processe and Related Fields **9**, 195–207 (2003); `cond-mat/0208579`.

[GT1] F. Guerra and F. Toninelli, *The thermodynamic limit in mean field spin glass models*, Communications in Mathematical Physics **230**, 71–79 (2002); `cond-mat/0204280`.

[ALR] M. Aizenman, J. Lebowitz and D. Ruelle, *Some rigorous results on the Sherrington-Kirkpatrick spin glass model*, Communications in Mathematical Physics **112**, 3–20 (1987).