Diamagnetic monotonicities, Lifshitz tails and anisotropic transport in a random magnetic field

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The Feynman-Kac (path-integral) formula gives comparison estimates for the thermal density matrix of a spinless particle subjected to different magnetic fields, possibly having certain inhomogeneities. One consequence is a simple field-independent upper bound on the integrated density-of-states, if the particle is additionally subjected to a random (scalar) potential. Another consequence is the following: If the magnetic field has a constant direction, the particle is confined to a plane perpendicular to the field (without loosing generality) and, finally, the field is constant along one direction in the plane, then the off-diagonal of the density matrix decays like that of a free particle along this direction, but faster along the perpendicular direction in the plane. This suggests an absolutely continuous energy spectrum, ballistic behaviour along one direction and dynamical localisation along the other. These features can be proven rigorously under suitable conditions, for example, if the (remaining) inhomogeneity of the magnetic field is random in the sense of an ergodic Gaussian stochastic process with non-zero mean.