Resistively Monitoring Electron - Nuclear Spin Interactions in a Two-Dimensional Electron System

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By taking advantage of spin-related phase transition physics in the fractional quantum Hall regime of a two-dimensional electron system, we have succeeded in developing a “nuclear magnetometer”, a scheme based on a resistance measurement for detecting the net average spin of nuclei residing in the same plane as the electrons. Its utilization has helped to investigate the nuclear spin polarisation background experienced by the two-dimensional electrons as a function of their filling factor. An unanticipated large variation is observed. These results allow to distil procedures for imprinting a particular value of net nuclear spin in a reproducible fashion. This systematic read/write capability of nuclear spin polarisation has opened up prospects for devising an RF-free pendant of “saturation-recovery” methods, commonly employed in conventional NMR experiments, for the study of the electron-nuclear spin interactions in a single layer system at the lowest temperatures presently available. We apply such techniques to look for complex low-energy collective spin excitations in the electronic system, which emerge by virtue of Coulomb correlations and promote the transfer of spin angular momentum between the electronic and nuclear spin subsystems. One specific example of such excitations will be discussed to some extent and is tentatively associated with the properties of a skyrme crystal.

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