Detection and manipulation of quantum coherence in quantum dots and wires

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【Outline of survey】

Superposition and entanglement are fundamental concepts of quantum mechanics, and often manifest themselves in solid, strongly depending on various kinds of interactions. The Kondo effect and superconductivity are such examples, which have long been of particular interest. In addition, there has been growing interest in “quantum information technology (QIT)”, which uses the same concepts but in a more controlled manner. In this project we use semiconductor nanostructures to detect and manipulate the quantum state and explore the physics and technology of solid state QIT. We focus on three topics: i)quantum coherence of single electron spins, 2)interplay of the Kondo effect and superconductivity (or ferromagnetism), and 3)coherence breaking by observation.

In i) we use a novel concept of single electron spin resonance with a slanting Zeeman field to realize spin qubits with quantum dots (QDs), and then extend the technique to explore the physics of quantum coherence and spin correlation in QDs, In ii) we use a QD with nanogap superconducting (ferromagnetic) contacts to study the hybrid Kondo singlet and Copper pair (spin-polarized) states. In iii) we study the influence of observation on the quantum coherence in QDs and wires.

【Expected results】

The scheme of spin qubits studied here can be the most relevant for scalabilty. Demonstration of the qubit ability including fundamental gate operations will open up a way toward scalable quantum computing. Study on the hybrid spin system will provide not only the academic contribution but also a new scheme of controlling super-currentand spin current with QDs. Coherence breaking by observation is crucial for QIT. Study on this topic can give a guideline for error correction and fidelity in QIT.

【References by the principal investigator】

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【Term of project】 FY2007－2011	**【Budget allocation】 20,500,000 yen** (2007 direct cost)

【Homepage address】 http://www.meso.t.u-tokyo.ac.jp