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Development of integrated quantum circuits with chiral Tomonaga-Luttinger liquids

研究成果の概要

This research aims to develop plasmon-based quantum circuits using the Tomonaga-Luttinger liquid system in the quantum Hall edge state. The goal is to establish fundamental quantum technology for achieving strong coupling with qubits and exploring the possibility of quantum information processing.

In experiments, we have observed the following results in a coupled plasmon-double quantum dot (DQD) system. Under plasmon irradiation, electron transport in the DQD is observed through absorbing or emitting single or multiple plasmons stored in a quantum Hall plasmon resonator. This plasmon-assisted tunneling process is clearly seen in the current spectra, where satellite peaks are observed around the central resonant tunneling peak in DQD. Through numerical simulations, we determine the coupling strength. The extracted value indicates that the system remains in the weak coupling regime. To obtain a stronger coupling, we considered a tunneling coupling scheme and have designed and fabricated new devices, which allows us to explore further the interaction between the plasmon and the DQD charge qubit. By measuring the new samples, we have achieved the readout of the qubit states.

In principle, by generalizing our system, it is possible to develop a plasmonic version of cavity quantum electrodynamic system with strong coupling.