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Observation of quantum phase shift in an Aharonov-Bohm ring with a fully controlled flying charge qubit MICHIHISA YAMAMOTO, Department of Applied Physics, University of Tokyo, CHRISTOPHER BAUERLE, Institut Neel, CNRS, SEIGO TARUCHA, Department of Applied Physics, University of Tokyo, and ICORP-JST — Aharonov-Bohm effect is one of the most typical interference phenomena of electrons. Although a number of experiments have been performed to date, observation of phase shift at each path has been rather difficult due to the phase rigidity in the two-terminal setup. In this study, we employed a hybrid device consisting of a parallel coupled-wire and an AB ring, in which each coherently propagating electron acts as a flying qubit. In this device, phase rigidity no longer exists as there are two output contacts. The qubit is defined as superposition of two quantum states: an electron exists in one of the two wires. Then, the inter-wire tunnel coupling gives flipping between the two quantum states, and the evolution of the phase in the AB ring is translated into rotation about the z-axis of the Bloch sphere. In the experiment, we defined the initial qubit state by injecting electrons into only one of the two wires, and obtained the arbitrary output state by tuning gate voltages. The output state also oscillates as a function of perpendicular magnetic field B with the AB oscillation period. We observed the shift of k-vector in one of the two wires works equivalently as the shift of$B$. This is the direct observation of the phase shift $\Delta\theta = \Delta k{\cdot}L$.

Michihisa Yamamoto
Department of Applied Physics, University of Tokyo

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