Examining Complementarity Principle in Closed-Loop Aharonov–Bohm Interferometer

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According to Bohr's complementarity principle, the quantum entities behave as either waves or particles. The principle was demonstrated by so called '*which-path* experiment', which employed a path detector in double-slit interferometer to obtain the path information of a quantum entity; in optics [1] with photons and also in solid-state device with electrons [2]. In this study, we employed a *closed-loop* configuration for Aharonov-Bohm (AB) ring with a charge detector in one arm of the interferometer. In contrast to the *open-loop* electronic interferometer studied previously the charge detection of an electron in our device does not always provide the path information of an electron inside the interferometer. We found that interference was suppressed only when the path information was obtained out of charge detection, while no obvious dephasing was observed when the path information was not obtained from the charge detection. This clearly indicates that detection of quantum entities does not dephase the electron state unless its path information is available. This is valid even with the high disturbance (or *back-action*) from the charge detector.

Keywords : complementarity principle, which-path experiment, AB ring, dephasing, path information, charge detector

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