Error-Disturbance Uncertainty Relation in Successive Spin Measurements

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The uncertainty principle, which prohibits precise measurements of certain pairs of quantum mechanical observables, is one of the most remarkable consequences of quantum mechanics. It is well-known that Heisenberg, using the famous gamma-ray microscope thought-experiment [1], suggested a trade-off relation where the product of the error of the position measurements and the disturbance on the momentum measurement is not less than a bound set by the commutator between these two observables. Recently, Ozawa reconsidered this relation between the error and the disturbance by rigorous and general theoretical treatment of quantum measurements and derived a new relation, which suggests the violation of Heisenberg's original uncertainty relation [2,3].

In this talk, a neutron optical experiment that determines the error of a spin-component measurement as well as the disturbance caused on another spin-component measurement is reported. This experiment confirms that the trade-off between the error and the disturbance completely obeys the new relation but violates the old one in a wide range of an experimental control parameter. Our results are the first evidence of the solution of a long-standing problem to describe the relation between the measurement accuracy and the disturbance caused by that measurement [4].

REFERENCES

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