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Fundamental phenomena of quantum mechanics studied in matter-wave optics: Quantum Cheshire-cat and uncertainty relations

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The validity of quantum-mechanical predictions has been confirmed with a high degree of accuracy in a wide range of experiments. Although the statistics of the outcomes of a measuring apparatus have been studied intensively, little has been explored and is known regarding the accessibility of quantum dynamics and the evolutions of a quantum system during measurements. For this sort of fundamental studies of quantum mechanics, interferometric and polarimetric approaches, in particular by the use of neutron's matter-waves, provide almost ideal experimental circumstances. The former device explicitly exhibits quantum interference between spatially separated beams in a macroscopic scale. In contrast, interference effects between two spin eigenstates are exposed in the latter apparatus. Exploiting both strategies, alternative theories of quantum mechanics, Kochen-Specker theorem and so on are studied. Recently, as a study of quantum dynamics, neutron interferometer experiments are carried out: A new counter-intuitive phenomenon, called quantum Cheshire-cat, is observed. Moreover, extending the first experimental test of the new error-disturbance uncertainty relation by using a modified neutron polarimeter setup, we performed experiments investigating the validity of an extended uncertainty relation for mixed ensemble as well as a new noise-disturbance uncertainty relation in an entropic form. In my talk, I am going to give an overview of matter-wave optical approach to investigations of fundamental aspect of quantum mechanics.

Biography

Yuji Hasegawa has completed his PhD from the University of Tokyo. During and after his study, he spent several years at the Atominstitut der Österreichischen Universitäten, Vienna and became University Assistant at the University of Tokyo. He was a Lise-Meitner Fellow by Austrian Science Fund (FWF) and a PRESTO Fellow by Japan Science and Technology Agency (JST). Now, he is Associate Professor at the Vienna University of Technology (TU-Wien). He has published more than 100 papers in reputed journals.

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