Helmut Rauch and matter wave interferometry

Wolfgang P. Schleich

1 Institut für Quantenphysik and Center for Integrated Quantum Science and Technology (IQST), Universität Ulm, Albert-Einstein-Allee 11, D-89081 Ulm, Germany
2 Hagler Institute for Advanced Study and Department of Physics and Astronomy, Institute for Quantum Science and Engineering (IQSE), Texas A&M AgriLife Research, Texas A&M University, College Station, Texas 77843-4242, USA

In this talk we pay respect to the impressive achievements of Helmut Rauch not only in the field of neutron optics but also his paving the way of matter wave interferometry. His numerous discoveries and deep insight into the inner workings of quantum mechanics have been a guidance to all of us.

The superposition principle is a cornerstone of quantum mechanics and results from the linearity of the Schrödinger equation. In this talk we motivate the non-linear wave equation of classical statistical mechanics as well as the linear Schrödinger equation of quantum mechanics from a mathematical identity. Moreover, the linearity is crucial for the use of matter wave interferometers as sensors for rotation and acceleration. We show that the phase in a Kasevich-Chu atom interferometer measures the commutator of two unitary time evolutions and thus the acceleration. In addition, we report the observation of the Kennard phase using water waves and the realization of a Kennard interferometer with a scaling superior to the Kasevich-Chu interferometer.