Plenary Talk PV VI Wed 8:30 Audimax

Sharp versions of Heisenberg's error-disturbance trade-off — •Reinhard Werner — Institut für Theoretische Physik, Leibniz Universität Hannover

Quantum mechanics textbooks usually explain and prove the uncertainty relation as an inequality on the variances of two canonically conjugate observables in the same state. However, this does not cover the scenario which is most prominent in Heisenberg's 1927 paper: a "gamma ray microscope" in which an approximate position measurement disturbs the conjugate momentum. In this talk I will show how to set up and prove a quantitative and general uncertainty relation for error and disturbance in Heisenberg's scenario and for more general joint measurements of canonically conjugate observables. This is in apparent contradiction to a recent claim by Ozawa and coworkers, of having experimentally refuted Heisenberg's relation, so I will comment on the different approaches.

The talk emphasizes conceptual issues: One should not think of "the uncertainty relation" in the singular, but rather in the plural, as a group of results differing in the scenario they address, but also in the mathematical terms employed to quantify "uncertainty". Quantitative relations, as opposed to hand waving order of magnitude arguments, are increasingly of interest as more and more experiments approach the uncertainty-limited regime. As an example I will discuss the use of entropic uncertainty relations with side information in security proofs of quantum cryptography