Multipath Interference Tests of Quantum Mechanics

Gregor Weihs[1], Sebastian Gstir[1], Edmond Chan[1,2], Robert Keil[1], Toni Eichelkraut[3], and Alexander Szameit[4]

[1]*Institut für Experimentalphysik, Universität Innsbruck, Technikerstraße 25, 6020 Innsbruck, Austria*

[2]*Ecole Normale Superieure de Lyon, 65 Allee d'Italie, 69007 Lyon, France*

[3]*Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany*

[4]*Institut für Physik, Universität Rostock, Albert-Einstein-Str. 23, 18059 Rostock, Germany*

Quantum mechanics can be considered a special case of the class generalized probabilistic physical theories, which can be classified by how they deviate from classical probabilistic theories. Quantum mechanics, for example, deviates because it derives probabilities from wavefunctions and thus exhibits interference. By virtue of Born's rule, all interference terms stem from pairs of paths. Other probabilistic theories could go beyond that [1] and allow higher-order interference terms, thus violating Born's rule.

Using multipath interferometers [2,3] we were able to tighten the bound on the deviation from ordinary quantum interference to a level of 10^{-5} of the expected, ordinary interference, with a good part of the uncertainty originating from our limited accuracy in determining detector nonlinearity. More recently we have begun to apply our multipath interferometers towards tests for the generalization of quantum mechanics in terms of the underlying numbers, i.e. whether hypercomplex quantum mechanics is allowed or not [4]. For these tests, the achievable interferometer contrast is crucial [5]. Our latest interferometer, an integrated photonic circuit with electrically controllable interferometric shutters, allows us to improve the bound on higher-order interferences and hypercomplex quantum mechanics at the same time.

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