

Photon sources and the foundations of quantum mechanics

Gregor Weihs, Institut für Experimentalphysik, Universität Innsbruck, Austria

Our desire to develop a deeper understanding of quantum mechanics has generated k

Originally more a curiosity than science the debate about the foundations and the interpretation of quantum mechanics sparked what we now sometimes call the quantum revolution. The discovery of entanglement and the computational power of quantum information processing have led to a slew of new potential technologies for the future. In return, the tools we have been developing for applications now enable us to make ever more precise tests of the foundations and potential limitations of quantum theory.

In our research we develop sources of nonclassical light, single photons and entangled photon pairs and then apply them towards quantum communication and in testing the foundations of quantum mechanics. Two examples of the sources we recently developed are semiconductor waveguides [1] for a future integrated quantum optics platform and semiconductor quantum dots delivering single photons and entangled photon pairs [2].

As an unconventional application I will present our tests for potential higher-order interferences that would go beyond quantum mechanics [3] and interference tests that could reveal the necessity for a quaternion-based quantum mechanical description of nature. Even if these tests only yield null results, they are able to rule out alternative theories and thus give us tighter bounds on where to look for possible extensions and modifications of quantum theory.

1. R. Horn, P. Abolghasem, B. J. Bijlani, D. Kang, A. S. Helmy & G. Weihs, *Monolithic Source of Photon Pairs*, Phys. Rev. Lett. **108**, 153605 (2012).
2. U. Sinha, C. Couteau, T. Jennewein, R. Laflamme & G. Weihs, *Ruling Out Multi-Order Interference in Quantum Mechanics*, Science **329**, 418-421 (2010).
3. H. Jayakumar, A. Predojević, T. Huber, T. Kauten, G. S. Solomon & G. Weihs, *Deterministic Photon Pairs and Coherent Optical Control of a Single Quantum Dot*, Phys. Rev. Lett. **110**, 135505 (2013).

CV

Gregor Weihs is Professor of Photonics at the University of Innsbruck and Adjunct Associate Professor at the University of Waterloo's Institute for Quantum Computing. He received his MSc degree from Innsbruck University in 1994. His PhD degree from Vienna University was awarded "sub auspiciis praesidentis" by the President of the Austrian Republic in 2000. Further positions included a junior faculty position at the University of Vienna, Consulting Assistant Professor at Stanford University. Major awards were the Canada Research Chair in Quantum Photonics and a Starting Grant by the European Research Council. In 2011 he was elected into the Austrian Academy of Sciences as a member of the Young Academy and is a Fellow in the QIP program of the Canadian Institute for Advanced Research. His research interests include fundamental physics, quantum and semiconductor optics and quantum information.

