Q 48: Quantum effects: Interference and correlations I

Time: Thursday 16:30–18:00 Location: DO26 208

Q 48.1 Thu 16:30 DO26 208

Multi-Photon Interference in Integrated Waveguides — •Jasmin D. A. Meinecke[1], Jacques Carolan[1], Pete Shadbolt[1], Nicholas J. Russell[1], Nur Ismail[3], Kerstin Wörhoff[3], Terry Rudolph[2], Mark G. Thompson[1], Jeremy L. O'Brien[1], Jonathan C. F. Matthews[1], and Anthony Laing[1] — [1]Centre for Quantum Photonics, University of Bristol, Tyndall Avenue, Bristol, BS8 1TL, UK — [2]Institute for Mathematical Sciences, Imperial College London, London SW7 2BW, UK — [3]Integrated Optical Microsystems Group, MESA+ Institute for Nanotechnology, University of Twente, Enschede, The Netherlands

Multi-particle interference effects are fundamental for quantum information science. Interferometric stability and long coherence times are necessary in order to achieve large scale circuitry. Here photons and in particular integrated photonics are an attractive platform allowing complex circuits and precise control of quantum states.

Multiple photons propagating in planar and 3-dimensional waveguide arrays have been shown to enable observation of large scale quantum interference effects [1,2] known as quantum walks with applications in quantum computation and simulation. Here we present experimental results of three and four photons injected into waveguide circuits implementing quantum walks and also general linear optical operations [3].

[1] J. D. A. Meinecke et al., Phys. Rev. A 88, 012308 (2013) [2] K. Poulios et al., arXiv:1308.2554 [3] J. Carolan et al., arXiv:1311.2913

Q 48.2 Thu 16:45 DO26 208

Time multiplexed photonic quantum walks — •Thomas Nitsche[1], Andreas Schreiber[1,2], Fabian Katzschmann[1], Sonja Barkhofen[1], Aurél Gábris[3], Peter Rohde[1], Kaisa Laiho[1,2], Martin Štefaňák[3], Václav Potoček[3], Craig Hamilton[3], Igor Jex[3], and Christine Silberhorn[1] — [1]Applied Physics, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany — [2]Max-Planck-Institute for the Science of Light, Günther-Scharowsky-Str. 1 / Bau 24, 91058 Erlangen, Germany — [3]Department of Physics, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Brehova 7, 11519 Praha, Czech Republic

Linear optical networks with a large number of optical modes have been investigated intensively in various theoretical proposals. Most recently their relevance for studies of photonic quantum walk systems has attracted attention, because they can be considered as a standard model to describe the dynamics of quantum particles in a discretized environment and serve as a simulator for other quantum systems, which are not as readily accessible. A key element for a versatile simulator is the ability to dynamically control the quantum-coin, which is the main entity responsible for the evolution of the quantum walk. The utilization of the polarization state as coin state allows for easy manipulation by introducing controlled phase shifts through an electro optic modulator to selectively modify the coin state. This enables us to tune interaction strengths and patterns to simulate different kinds of particles or environments and thus enhancing the abilities of photonic experiments.

Q 48.3 Thu 17:00 DO26 208

Superresolving multiphoton interferences with regular and irregular arranged independent incoherent light sources — •Felix Waldmann[1], Thomas Mehringer[1,2], Steffen Oppel[1,2], and Joachim von Zanthier[1,2] — [1]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, 91058 Erlangen — [2]Erlangen Graduate School in Advanced Optical Technologies (SAOT), Universität Erlangen-Nürnberg, 91052 Erlangen

We show that multiphoton interferences of statistically independent light sources can be used to gather information about the spatial distribution of the sources with enhanced resolution. So far, the algorithm has been limited to a regular source arrangement. Here we show that the scheme can be applied also for irregularly distributed sources. After a discussion of the theoretical achievements we present experimental results with up to four independent thermal light sources proving that measurements of spatial correlation functions of higher order can be used as an efficient tool in quantum imaging.

Q 48.4 Thu 17:15 DO26 208

Classification of the coherence in multipath interference patterns — •Kai von Prillwitz, Lukasz Rudnicki, and Florian Mintert — Freiburg Institute for Advanced Studies, Albert-Ludwigs University of Freiburg, Freiburg 79104, Germany

In multipath experiments the contrast of the interference pattern depends strongly on the number of coherently interfering path alternatives, and the contrast decreases with increasing decoherence. We show how to infer the number of interfering paths from the statistical moments of the interference patterns, and demonstrate that a few moments are enough information to obtain a reliable characterization of coherence properties.

Q 48.5 Thu 17:30 DO26 208

Einfluss der räumlichen Moden auf die induzierte Kohärenz bei der parametrischen Fluoreszenz — •Kevin Pinkal, Axel Heuer und Ralf Menzel — Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24/25, 14476 Potsdam

In dem Versuch zur induzierten Kohärenz von Wang et al. [1] werden in zwei nichtlinearen Kristallen mit nur einem Pumpstrahl mittels parametrischer Fluoreszenz (SPDC Typ I) Photonenpaare erzeugt. Es wurde gezeigt, dass die einen Photonen aus je einem Paar (Signals) Einzelphotoneninterferenz zeigen, wenn die Strahlengänge des jeweils anderen Photons der Paare (Idler) örtlich und zeitlich überlagert werden.

Eine quantenmechanische Erklärung dieses Phänomens liegt darin, dass die Welcher-Weg-Information, die durch die Existenz des jeweiligen Idler-Photons gegeben ist, aufgrund der Überlagerung beider Idler-Strahlengänge zerstört wird und dadurch die jeweiligen Signal-Photonen interferieren können.

In unserem Experiment werden die Kristalle mit unterschiedlichen, räumlichen Moden (TEM_{00} und TEM_{10}) gepumpt und somit die Ununterscheidbarkeit der Photonen gestört. In unterschiedlichen Pumpanordnungen wird untersucht, welchen Einfluss die Modenfunktion auf die Kohärenz der einzelnen Photonen hat und wie sich die Interferenzfähigkeit verändert.

[1] L. J. Wang, X. Y. Zou und L. Mandel, *Phys. Rev. A* **44** 4614 (1991)

Q 48.6 Thu 17:45 DO26 208

Hanbury Brown and Twiss and beyond - super- an subradiant emission from incoherent classical and non-classical sources — Daniel Bhatti[1], Ralph Wiegner[1], Steffen Oppel[1,2], and •Joachim von Zanthier[1,2] — [1]Institut für Optik, Information und Photonik, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Erlangen Graduate School in Advanced Optical Technologies (SAOT), Universität Erlangen-Nürnberg, Erlangen, Germany

Super- and subradiance gained increased interest recently due to a number of ground-braking experiments with single-photon excited Dicke states observing collective Lamb shifts in regular arrays of nuclei [2,3] or forward scattering from atomic clouds [3]. One option to produce super- and subradiant Dicke states is the repeated measurements of photons starting from the fully excited system. This amounts to measure the m-th order photon correlation function for $N \geq m$ statistically independent incoherent scatterers. Due to the collective coherence of the Dicke states super- and subradiance is expected to occur for quantum mechanical systems only. Here we show that super- and subradiant spatial emission patterns can also be observed with statistically independent incoherent classical sources. Experimental results with thermal light confirm the theoretical predictions.

[1] R. Röhlsberger et al., Science 328, 1248 (2010).
[2] M. O. Scully, A. A. Svidzinsky, Science 328, 1239 (2010).
[3] C. W. Chou et al., Nature (London) 438, 828 (2005); T. Chanelire et al., ibid. 833 (2005); M. D. Eisaman et al., ibid. 837 (2005).