# Q 69: Quantum effects: Interference and correlations II

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

Q 69.1 Fri 16:30 DO26 208

**How much information does a parametric down-conversion state contain?** — •Vahid Ansari, Benjamin Brecht, Georg Harder, and Christine Silberhorn — Universität Paderborn, Integrierte Quantenoptik, Warburger Str. 100, D-33098 Paderborn

We present a theoretical and experimental study of the correlation time of a biphoton state generated in the process of parametric down-conversion. We show that this correlation time does not actually depend on the coherence time of the pump light, but is only determined by the crystal length and phase-matching conditions. Furthermore, we investigate the properties of the PDC biphoton wavepacket with different types of time-frequency correlations and their suitability for quantum-enhanced applications.

Q 69.2 Fri 16:45 DO26 208

**Self-trapping of photons: a dissipation-induced classical to quantum transition** — •Sebastian Schmidt[1], James Raftery[2], Darius Sadri[2], Hakan Tureci[2], and Andrew Houck[2] — [1]Institute of Theoretical Physics, ETH Zurich, Switzerland — [2]Department of Electrical Engineering, Princeton University, USA

We discuss the theoretical proposal and recent experimental observation of a novel dissipation driven dynamical localization transition of strongly correlated photons in an extended superconducting circuit consisting of two coupled resonators, each containing a superconducting qubit. Interaction with an environment has been argued to provide a mechanism for the emergence of classical behavior from a quantum system. Surprisingly, homodyne measurements reveal the observed localization transition to be from a regime of classical oscillations into a macroscopically self-trapped state manifesting revivals, a fundamentally quantum phenomenon. This experiment also demonstrates a new class of scalable quantum simulators with well controlled coherent and dissipative dynamics suited to the study of quantum many-body phenomena out of equilibrium.

Q 69.3 Fri 17:00 DO26 208

**Experimentelle Messungen der Korrelation 2. Ordnung von Breitstreifen-Superlumineszenzdioden** — •Jan Kiethe und Andreas Jechow — Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknechtstraße 24/25, 14476 Potsdam

Chaotische Lichtquellen, wie zum Beispiel Superlumineszenzdioden (SLDs), können für Anwendungen benutzt werden, bei denen die Photonenstatistik als zusätzlicher Parameter dient [1]. Zur Charakterisierung solcher Lichtquellen wird der Korrelationsgrad 2. Ordnung (DSOC) bestimmt [2]. Bei der Untersuchung von Quantenpunkt-SLDs wurde festgestellt, dass sich das emittierte Licht abhängig vom Pumpstrom in teilkohärenten, sogenannten Hybrid-Zuständen, mit einem Maximum des DSOC zwischen 1 und 2, befinden kann [3].

Hier wurden die Eigenschaften der Korrelation von verschiedenen Quantengraben-SLDs vermessen. Für eine Breitstreifendiode wurde ebenfalls die Abnahme der Korrelation bei höheren Pumpströmen beobachtet. Die Diode zeigte Maxima des DSOC zwischen 1.6 und 1.3 für kleine bzw. höhere Pumpströme. Weiterhin wurde eine Diode mit Trapezverstärkersektion untersucht, deren zusätzliche Kontaktierung einen weiteren verstellbaren Parameter liefert. Erste Messungen zeigen einen maximalen DSOC von $\approx 1.9$.

[1] Jechow et al., *Nat. Phot.*, **7**, 973-976, 2013
[2] Botier et al., *Nat. Phys.*, **5**, 267 - 270, 2009
[3] Blazek und Elsäßer, *Phys. Rev. A*, **84**, 063840, 2011

Q 69.4 Fri 17:15 DO26 208

**Quantum interference in absorption and emission of single photons by a single ion** — •Philipp Müller, Michael Schug, Christoph Kurz, Pascal Eich, Jan Huwer, and Jürgen Eschner — Experimentalphysik, Universität des Saarlandes, Saarbrücken, Germany

We generate phase-controlled quantum beats in Raman scattering of single photons from a single trapped $^{40}Ca^{+}$ ion. In two distinct excitation schemes, two disparate physical origins of quantum beats are identified.

In both schemes, we coherently prepare the ion in a certain superposition of two Zeeman sub-levels. Exciting the ion from there to a single state ($\Lambda$-shaped scheme) leads to interference in the absorption, observed as an intensity oscillation of the subsequently emitted photon. Excitation to two different states leads to interference in the emission, if both states decay into the same final state (V-shaped scheme). In this case the emission pattern rotates around the quantization axis.

Both kinds of oscillations are due to the Larmor precession of the initial superposition caused by a static external magnetic field. By setting the phase of the superposition and the input polarization we control the phase of the quantum beats.

Q 69.5 Fri 17:30 DO26 208

**Measurement of subradiance with classical sources** — •Daniel Bhatti[1], Steffen Oppel[1], 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

Super- and subradiance, i.e., the cooperative emission of spontaneous radiation by an ensemble of identical two-level atoms, is one of the intriguing problems in quantum optics. While superradiance is usually observed for ensembles occupying symmetric Dicke states, subradiance is typically attributed to systems in non-symmetric Dicke states [1]. Recently we showed that superradiance can be produced also with uncorrelated single photon emitters [2] as well as statistically independent incoherent classical sources, by repeated measurements of photons in the far field. This amounts to measuring the $m$-th order photon correlation function for $N \geq m$ emitters. Here we discuss that by the same technique we can observe also subradiance with incoherent classical sources.

[1] R. Wiegner, J. von Zanthier, G. S. Agarwal, Phys. Rev. A 84, 023805 (2011)
[2] R. Wiegner, S. Oppel, J. von Zanthier, G. S. Agarwal, ArXiv quant-ph/1202.0164 (2012)

Q 69.6 Fri 17:45 DO26 208

**Feasibility of UV lasing without inversion in mercury vapor** — •Martin Sturm and Reinhold Walser — Institut für Angewandte Physik, TU Darmstadt

Lasing without inversion has been a field of intense research over the past two decades as it offers a promising approach to UV lasing. However, despite all commitment an UV laser operating without population inversion is yet to be build. We investigate the feasibility of a proposed experiment [1] which allows for lasing on the $6^1S_0 \leftrightarrow 6^3P_1$ transition in mercury at a wavelengths of 253.7 nm. Utilizing interacting dark resonances [2], this proposal circumvents known problems occurring in lasing without inversion at short wavelengths, e.g. the effect of Doppler broadening.

We formulate the radiation damped optical Bloch equations for all relevant 13 atomic states. We generalize these equations by considering technical phase noise of the driving fields. Using semiclassical laser theory we obtain the stationary output power from the Doppler broadened susceptibilities. From the linear inhomogeneous susceptibility we calculate the modes of the ring resonator with Fourier optics. Our results [3] confirm the feasibility of UV lasing and reveal its dependence on experimental parameters.

[1] E. S. Fry, M. D. Lukin, T. Walther, G. R. Welch. Opt. Commun. **179**, 499-504, (2000).
[2] M. D. Lukin, S. F. Yelin, M. Fleischhauer, M. O. Scully. Phys. Rev. A **60**, 3225-3228, (1999).
[3] M. Sturm. Master thesis, TU Darmstadt, (2013).