Q 40: Quanteneffekte: Interferenz und Korrelationen II

Zeit: Mittwoch 16:30–18:00 Raum: VMP 6 HS-E

Q 40.1 Mi 16:30 VMP 6 HS-E

Eine Quanten-Irrfahrt in der Paulfalle — •Hector Schmitz[1,2], Robert Matjeschk[1], Christian Schneider[1], Jan Glückert[1], Axel Friedenauer[1] und Tobias Schaetz[1] — [1]MPI für Quantenoptik, Garching — [2]LMU München, Garching

Die Quantenmechanik ist reich an Phänomenen, die der Alltagserfahrung widersprechen. Dazu gehört die so genannte Quanten-Irrfahrt, (engl.: *quantum random walk*), die Abweichungen von den Vorhersagen klassischer Modelle zeigt und Potential für effiziente Quantenalgorithmen bereit hält.

Im Experiment stellen wir mit Hilfe eines einzelnen gefangenen $^{25}Mg^{+}$-Ions die asymmetrische Irrfahrt entlang einer eindimensionalen Linie vor. Zwei elektronische Hyperfein-Zustände des Ions kodieren die zwei Seiten einer Quanten-Münze (Qubit); ihr „Wurf“ wird durch einen RF-Puls realisiert, der eine Superposition der Zustände $|\mathrm{Kopf}\rangle$ und $|\mathrm{Zahl}\rangle$ erzeugt. Eine zustandsabhängige Dipolkraft verschiebt das Ion, dessen Bewegung im harmonischen Potential der Paulfalle als kohärentes Wellenpaket beschrieben werden kann, im Phasenraum gleichzeitig nach links *und* rechts. Wir beobachten im dritten Schritt in Übereinstimmung mit dem theoretischen Modell die Signatur, die nur durch Interferenzeffekte erklärbar ist, da das Ion alle möglichen Pfade gleichzeitig beschreitet.

Weiterhin untersuchen wir die Umstände, die sich durch das Lamb-Dicke-Regime ergeben und zeigen einen Weg auf, die Methode auf eine größere Zahl von Schritten zu erweitern.

Q 40.2 Mi 16:45 VMP 6 HS-E

A semiclassical approach for the fidelity decay of δ-kicked atoms — •Martina Abb[1,2], Italo Guarneri[3], and Sandro Wimberger[1,2] — [1]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 19, D-69120 Heidelberg — [2]Heidelberg Graduate School of Fundamental Physics, Albert-Ueberle-Str. 3-5, D-69120 Heidelberg — [3]Center for Nonlinear and Complex Systems, Universita degli Studi dell'Insubria, Via Valleggio 11, I-22100 Como

Fidelity, the overlap of two wavefunctions with slightly different time evolutions, constitutes a sensitive measure to changes in the parameters of a given quantum system. Recently, an experiment performed at Harvard [1] confirmed the predictions (such as saturation of fidelity for long times) made for δ-kicked atoms at exact quantum resonance conditions [2]. This group also explored their immediate vicinity, which can be theoretically described by a near-integrable system [3]. We expand the region of parameters theoretically treated so far by numerical quantum calculations and offer a semiclassical ansatz to explain the observed fidelity decay close to quantum resonance. Moreover, we predict the occurence of experimentally accessible revivals of fidelity.

[1] S. Wu, A. Tonyushkin, and M. G. Prentiss, Preprint arXiv:0801.0475v3.
[2] S. Wimberger and A. Buchleitner, J. Phys. B: At. Mol. Opt. Phys. **39**, L145-L151 (2006).
[3] S. Wimberger, I. Guarneri, and S. Fishman, Nonlinearity **16**, 1381-1420 (2002)

Q 40.3 Mi 17:00 VMP 6 HS-E

Electromagnetically induced absorption as a consequence of quantum interference — •Hsiang-Shun Chou[1,2] and Jörg Evers[1] — [1]MPI für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg — [2]Institute of Optoelectronic Sciences, National Taiwan Ocean University, Keelung, Taiwan 202

Electromagnetically induced absorption (EIA) is a quantum optical effect that leads to a substantial enhancement of the absorption rate of a probe field by the presence of a coupling field. EIA has been observed in a number of different systems, such as degenerate two-level systems [1,2,3]. The signature for EIA is an additional resonance with subnatural width observed in the spectra. So far, density matrix calculations including spontaneous coherence transfer have been suggested for a description of EIA. However, for certain cases of upper state and lower state angular momentum, it was reported that the EIA spectrum can not be explained by spontaneous coherence transfer [2]. In this paper, we propose an alternative simple physical picture which helps us gain deeper insight into EIA. We show that a constructive interference, which leads to EIA, arises naturally in the dressed state basis. This treatment illustrates the essential ingredients of EIA for all cases in a clear and simple way.

[1] A. M. Akulshin et al., Phys. Rev. A 57, 2996 (1998).
[2] S.-K. Kim et al., Phys. Rev. A 68, 063813 (2003).
[3] K. Dahl et al., Opt. Lett. 33, 983 (2008).

Q 40.4 Mi 17:15 VMP 6 HS-E

Intensity-field correlation of single-atom resonance fluorescence — •Sebastian Gerber[1], Lukas Slodicka[1], Daniel Rotter[1], Jürgen Eschner[2], Howard Carmichael[3], and Rainer Blatt[1] — [1]Experimentalphysik Innsbruck, Technikerstrasse 25, 6020 Innsbruck — [2]ICFO-Institut de Ciències Fotòniques, 08860 Castelldefels (Barcelona), Spain — [3]Department of Physics, University of Auckland, Auckland, New Zealand

We report measurements of an intensity-field correlation function of the resonance fluorescence of a single trapped Ba+ ion.

An Ba+ ion is loaded into a linear Paul trap and is continuously laser-cooled. Detection of a photon prepares the atom in its ground state and we observe its evolution under interaction with a laser field of well defined phase. We record the regression of the resonance fluorescence source field. This provides a direct measurement of the field of the radiating dipole of a single atom and exhibits a strong non-classical behavior. In the setup an interference measurement is conditioned on a fluorescence photon detection. Thus, the recorded third-order correlation function demonstrates an aspect of wave-particle duality at the single-atom, single-photon level.

Q 40.5 Mi 17:30 VMP 6 HS-E

Spontaneous photon transfer by coupling a two-mode light field to an atomic reservoir — •Gor Nikoghosyan and Michael Fleischhauer — Fachbereich Physik, Technische Universität Kaiserslautern, Germany

We discuss the interaction of two quantized modes of light with a spectrally broadened atomic ensemble. We show that the system is analogous to a two level system interacting with a bosonic reservoir, where the photonic modes correspond to the atomic states and the atomic ensemble corresponds to the modes of the reservoir. In contrast to the photonic reservoirs, the atomic ensembles can be easily controlled which can be used to simulate the dynamics of an open two level system in a reservoir with tunable spectrum. Due to the coupling with the atoms the analog of spontaneous decay for photons is obtained. This process leads to an irreversible transfer of photons from one mode to the other. The effect can have large variety of applications; e.g. creation of new quantum states, transfer of photons of optical frequency to microwave domain and vice versa.

Q 40.6 Mi 17:45 VMP 6 HS-E

Investigation of spatial correlation of biphotons using a blazed grating — •Dirk Puhlmann and Martin Ostermeyer — Institut of Physics and Astronomy, University of Potsdam, Potsdam, Germany

Correlations between photons can be exploited for resolution improvements in different methods of quantum imaging. Since Fock-states of N-photons of wavelength λ propagate through phase shifts N-times faster as coherent states they can appear as if they had a de Broglie wavelength of λ/N. This can be observed e.g. in diffraction experiments of biphotons at conventional gratings.

Using a blazed grating, different number states could be separated or sorted on the one hand. On the other hand evaluation of the diffraction pattern by the one-photon and two-photon rate allows for an analysis of the spatial correlation between correlated photons. An experimental demonstration of these ideas tested for a biphoton beam will be presented. A comparison to calculated diffraction patterns is carried out. Fraunhofer diffraction patterns for two-photon and one-photon detection were calculated and analyzed using a Fourier-optical approach [1].

[1] Shimizu, R., Edamatsu, K. & Itoh, *Phys. Rev. A* **74**, 013801-10(2006).