Q 58: Quantum Effects: Cavity QED II

Time: Thursday 14:30–15:45 Location: B/gHS

Q 58.1 Thu 14:30 B/gHS

Spontaneous emission inhibition via transition frequency modulation — •Mihai Macovei[1,2] and Christoph H. Keitel[1] — [1]Max Planck Institute for Nuclear Physics, Saupfercheckweg 1, D-69117 Heidelberg, Germany — [2]Institute of Applied Physics, Academiei str.5, MD-2028 Chisinau, Moldova

Excited atoms decay spontaneously because of their interaction with the environmental vacuum electromagnetic field modes. Independent atoms exhibit an exponential decaying law for instance. There is a number of techniques which enables us to modify or control this emission. Here, we demonstrate how spontaneous emission can be inhibited via frequency modulation of emitter's transition frequency [1]. Particularly, the frequency of modulation is selected to be of the order of the bare-state spontaneous decay rate. We found that the spontaneous emission suppression is due to quantum interferences among multiple induced decay channels.

[1] M. Macovei, and C. H. Keitel, Phys. Rev. A 90, 043838 (2014).

Q 58.2 Thu 14:45 B/gHS

Photon number dependent group velocity in vacuum induced transparency — •Nikolai Lauk and Michael Fleischhauer — Fachbereich Physik und Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Deutschland

We investigate the spatial separation of different photon number components of a coherent pulse in vacuum induced transparency (VIT). VIT is an effect which occurs in an ensemble of three level atoms in a Λ configuration that interact with two quantized fields. Coupling of one transition to a cavity mode induces transparency for the second field on the otherwise opaque transition similar to the well known EIT effect. In the strong coupling regime even an empty cavity leads to transparency, in contrast to EIT where the presence of a strong control field is required. This transparency is accompanied by a reduction of the group velocity for the propagating field. However, unlike in EIT the group velocity in VIT depends on the number of incoming photons. This allows one to spatially separate different photon number components of an initially coherent pulse.

In particular if one is interested in spatial separation of the single photon component from the rest, it is sufficient to consider the case of an input field which contains up to two photons. Here we present an exact solution for this case which can be obtained by numerically solving the corresponding Schrödinger equation and discuss a possible experimental realization.

Q 58.3 Thu 15:00 B/gHS

Arbitrary-quantum-state preparation of a harmonic oscillator via optimal control — •Katharina Rojan[1], Daniel M. Reich[2], Igor Dotsenko[3], Jean-Michel Raimond[3], Christiane P. Koch[2], and Giovanna Morigi[1] — [1]Theoretische Physik, Universität des Saarlandes, D-66123 Saarbrücken, Germany — [2]Theoretische Physik, Universität Kassel, Heinrich-Plett-Strasse 40,D-34132 Kassel, Germany — [3]Laboratoire Kastler-Brossel, ENS, UPMC-Paris 6, CNRS, collège de France, 24 rhe Lhomond, F-75005 Paris, France

The efficient initialization of a quantum system is a prerequisite for quantum technological applications. We show that several classes of quantum states of a harmonic oscillator can be efficiently prepared by means of a Jaynes-Cummings interaction with a single two-level system [1]. This is achieved by suitably tailoring external fields which drive the dipole and/or the oscillator. The time-dependent dynamics that leads to the target state is identified by means of optimal control theory (OCT) based on Krotov's method. Infidelities below 10^{-4} can be reached for the parameters of the experiment of Raimond, Haroche, Brune and co-workers, where the oscillator is a mode of a high-Q microwave cavity and the dipole is a Rydberg transition of an atom. For this specific situation we analyze the limitations on the fidelity due to parameter fluctuations and identify robust dynamics based on pulses found using ensemble OCT. Our analysis can be extended to quantum-state preparation of continuous-variable systems in other platforms, such as trapped ions and circuit QED.

[1] K. Rojan et al., Phys. Rev. A 90, 023824 (2014)

Q 58.4 Thu 15:15 B/gHS

Many-Body Dynamics Through Measurement and Feedback — •Jonas Lammers[1,2] and Klemens Hammerer[1,2] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover — [2]Max-Planck-Institut für Gravtitationsphysik (Albert-Einstein-Institut), Hannover

Time-continuous homodyne measurements and feedback allow for efficient quantum control of a broad range of systems, such as cavity and circuit QED, atomic ensembles, or optomechanics. Here we consider interferometric measurements on an array of such systems. We derive the corresponding feedback master equation, and apply it for the generation of many-particle entangled, stationary states (such as Bell, GHZ, and W states), and for the engineering of non-equilibrium dynamics of many-body systems (such as dissipative Ising models).

Q 58.5 Thu 15:30 B/gHS

Localization vs. delocalization of waves in circuit QED — •Bruno G. Taketani and Frank K. Wilhelm — Saarland University, Saarbrücken. Germany

Wave localization in disordered media is an important phenomenon arising from the destructive interference of waves from the many scatterers in the medium. However, interaction between localized modes may counteract this effect and lead to a localization-delocalization transition. Understanding this interplay between disorder and interaction is thus of great importance. We investigate this topic using Quasiperiodic Josephson junction arrays. This metamaterial possesses degenerate localized modes coexisting with delocalized modes which can be made to interact via the junctions Kerr non-linearity. On the quantum regime, the system presents a natural route to generate photon-photon interaction in circuit QED. The proposed experiment can be readily made with current technologies.