Q 26: Quantum effects: Miscellaneous

Time: Tuesday 14:00–15:30 Location: DO26 208

Q 26.1 Tue 14:00 DO26 208

Many-electron approach towards the free-electron laser in the quantum regime — •Peter Kling[1,2], Rainer Endrich[1,2], Enno Giese[2], Roland Sauerbrey[1], and Wolfgang P. Schleich[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf e V, D-01328 Dresden, Germany — [2]Institut für Quantenphysik and Center for Integrated Science and Technology, Universität Ulm, Albert-Einstein-Allee 11, D-89081 Ulm, Germany

Free-electron laser (FEL) devices stand out due to their wide tunability of the emitted radiation ranging from infrared to X-rays. Although the first theoretical approaches towards the FEL were based on quantum mechanics, it turned out that a description within classical electrodynamics is sufficient - at least for all existing devices. However, due to the technological progress in recent years a regime seems in reach where classical physics fails and quantum mechanical phenomena rule.

Here, the recoil the electron experiences during the interaction with the fields becomes important and the dynamics of the electron is reduced to two possible momentum states. In contrast to our previous approach, where we have used a single-electron model and found an analogy of the quantum regime of the FEL to the Jaynes-Cummings model, we now develop a many-electron description, where all electrons interact simultaneously with the radiation field. For short times we obtain an exponential gain, similar to the case of the classical high-gain free-electron laser.

Q 26.2 Tue 14:15 DO26 208

Engineering atomic mirror by utilizing the collective effects of an interacting multi-atom system — •Qurrat-ul-ain Gulfam[1] and Zbigniew Ficek[2] — [1]Department of Physics, Jazan University, Saudi Arabia — [2]The National Centre for Mathematics and Physics, King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia

Utilizing cold atoms as highly reflecting mirrors has gained much attention recently [1]. Atoms coupled to cavity fields in certain parameter regimes behave as perfect mirrors. In [2], cold atoms coupled to a waveguide are capable of organizing themselves along the waveguide when the trapping field is applied only from the transverse direction and the atomic motion along the axial direction is not restricted. This way the response of the waveguide field mode on atomic dynamics is taken into consideration. The atoms in the proposed setup, nevertheless, are uncorrelated. Interesting collective effects occur when the correlations between/among the atoms become non-negligible. Whether the collective dynamics of the interacting multi-atom system enable it to be used as a macroscopic atomic mirror remains to be discovered. We propose to use interacting atoms instead of independent atoms and observe how the inter-atomic interactions affect the properties of the atom-mirror.

[1] S. A. R. Horsley, et al, Phys. Rev. Lett. **110**, 223602 (2013).
[2] D. E. Chang, et al, Phys. Rev. Lett. **110**, 113606 (2013).

Q 26.3 Tue 14:30 DO26 208

Squeezed light from a quantum emitter coupled to a nanostructure — •Diego Martin-Cano[1,2], Harald R. Haakh[1], Karim Murr[2,3], and Mario Agio[2,3] — [1]Max Planck Institute for the Science of Light, Erlangen, Germany. — [2]QSTAR, Florence, Italy. — [3]INO-CNR and LENS, Florence, Italy.

One of the most profound phenomena of quantum optics is the reduction of quantum fluctuations in the electromagnetic field, i.e., the existence of squeezed states of light. The approaches to create these non-classical states have commonly relied on large systems, such as nonlinear crystals and atomic vapors. However, recent experiments have shown the ability of microscopic entities to obtain squeezed light with the prospect of making quantum integrated devices with a further control on the squeezing mechanism. Among such sources of non-classical light, the most elementary one consists of a quantum emitter driven by a laser field near resonance. In this theoretical work we investigate the generation of squeezed light with a quantum emitter coupled to an nanostructure. We find that nano-architectures strongly modify the creation of squeezed light. In the far field, we observe that squeezing can be significantly boosted by suitable systems. Moreover, the physical conditions for reducing quantum fluctuations are strongly relaxed with respect to free space. Finally, we analyze the behaviour of squeezed light in the near field, opening the pathway to its manipulation at the nanoscale.

Q 26.4 Tue 14:45 DO26 208

Complex network analysis of optimal, robust geometries for coherent excitation transport — •Federico Levi, Stefano Mostarda, Diego Prada-Gracia, Rao Francesco, and Mintert Florian — Freiburg Institute for Advanced Studies (FRIAS), Albert-Ludwigs University of Freiburg, Albertstr.19 79104 Freiburg, Germany

Quantum excitation transport is strongly influenced by interference with phase relations that depend on the scattering medium. As even small changes in the geometry of the medium can turn constructive interference to destructive, a clear relation between structure and fast, efficient transport is difficult to identify. We present a complex network analysis of quantum transport through disordered systems to elucidate the relationship between transport efficiency and structural organization. We find the emergence of structural classes which share geometrical and dynamical features. Interestingly, these features are found to be recurrent; that is, smaller systems are used as building blocks in larger systems.

Q 26.5 Tue 15:00 DO26 208

Theory for all-Optics Realisation of the Quantum Kicked Rotor — •Fabian Brock[1] and Sandro Wimberger[1,2] — [1]Institute for Theoretical Physics, Heidelberg, Germany — [2]Dipartimento di Fisica e Science della Terra, Università di Parma, Via G.P. Usberti 7/a, I-43124 Parma

The kicked rotor is one of the standard examples for chaos in classical mechanics. Also its quantum version has remarkable properties such as dynamical localisation.

In this talk we investigate the behaviour of a quantum kicked particle in position space extended to a line. In particular, we examine the probability to stay in the central well of the kick potential, where the system is initially prepared. This is inspired by recent experiments at the Friedrich-Alexander-Universität in Erlangen [1]. For small kicking parameters we introduce a model based on tunneling to describe the survival probability. For stronger kicks, the system's behaviour can be explained with spectral arguments.

[1] C. Bersch, G. Onishchukov, and U. Peschel, Phys. Rev. Lett. **109** 093903 (2012).

Q 26.6 Tue 15:15 DO26 208

Quanten existieren nicht (Quantenphysik ohne Quanten) — •Falk Rühl — Auf der Alm 14, D 52159 Roetgen

Gleichungen der Quantenoptik werden, ebenso wie Gleichungen der klassischen Wellenoptik, als Grenzfälle eines lokal deterministischen Modells der Interaktion geladener oszillierender Strukturen über Wellen in $\mathbb{R}^3$ abgeleitet. Die unkorrelierten retardierten Felder der Quellstrukturen treiben statistisch unabhängige random walks in den Phasenräumen der Zielstrukturen.

Solange die akkumulierte Energie einer Zielstruktur unterhalb seiner Stabilitätsgrenze bleibt, wird klassisches Verhalten beobachtet. Sobald Felder die Energie einer Zielstruktur über die Stabilitätsgrenze treiben, kommt es zu einem schnellen Zerfall bzw. einer Umkonfiguration der Zielstruktur unter Freisetzung von Teilen der akkumulierten Energie.

Die von den Quellstrukturen ausgehenden Wellen sind gleichzeitig die Träger der Energie während der Akkumulationsphase, als auch die deterministischen Auslöser der Quantenereignisse. Paradoxien, wie *which way* oder *delayed choice* treten im Akkumulationsmodell nicht auf.

Aus dem Akkumulationsmodell ergeben sich unmittelbar die Bedingungen für die Beobachtung strukturierter Spektren, die Gültigkeit des Superpositionsprinzips, sowie den Übergang von einer klassischen zu einer quantenoptischen Beschreibung.