RADIATION TRANSPORT IN RANDOM MEDIA (SYRT)

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ÜBERSICHT DER HAUPTVORTRÄGE UND FACHSITZUNGEN

(Hörsaal HVI)

Hauptvorträge

SYRT 1.1	Fr	11:00	(HVI)	**The Collective Atomic Recoil Laser (CARL): what atoms and fireflies have in common**, Claus Zimmermann
SYRT 1.2	Fr	11:30	(HVI)	**Coherent backscattering of light in nonlinear media**, Thomas Wellens
SYRT 1.3	Fr	12:00	(HVI)	**Experiments on the critical regime near Anderson localization of light**, Georg Maret, Martin Störzer, Peter Gross, Christof M. Aegerter
SYRT 1.4	Fr	12:30	(HVI)	**Propagation of light in disordered fiber bundles**, Ulf Peschel, Thomas Pertsch, Falk Lederer, Jens Kobelke, Kay Schuster, Hartmut Bartelt, Stefan Nolte, Andreas Tünnermann
SYRT 2.1	Fr	14:00	(HVI)	**Twin-photon light scattering**, J.P. Woerdman
SYRT 2.2	Fr	14:30	(HVI)	**Effects of strong localization of light in disordered media with loss or gain**, Johann Kroha, Regine Frank, Andreas Lubatsch
SYRT 2.3	Fr	15:00	(HVI)	**Transport of near-resonant light in cold atomic vapors**, Guillaume Labeyrie
SYRT 2.4	Fr	15:30	(HVI)	**Nonlinear transport of matter waves through disorder potentials**, Peter Schlagheck

Fachsitzungen

SYRT 1	**Radiation transport in random media I**	Fr 11:00–13:00	HVI	SYRT 1.1–1.4
SYRT 2	**Radiation transport in random media II**	Fr 14:00–16:00	HVI	SYRT 2.1–2.4

Fachsitzungen

– Hauptvorträge –

SYRT 1 Radiation transport in random media I

Zeit: Freitag 11:00–13:00 Raum: HVI

Hauptvortrag SYRT 1.1 Fr 11:00 HVI

The Collective Atomic Recoil Laser (CARL): what atoms and fireflies have in common — •Claus Zimmermann — Physikalisches Institut der Universität Tübingen, D-72076 Tübingen, Germany

Cold atoms can be trapped in the optical modes of a high finesse ring resonator. If the cavity is pumped through one of the input ports only, the atoms will scatter light from the forward into the reverse direction leading to a standing wave light field which in turn influences the atomic density distribution. This self organisation process has strong similarities to the free electron laser and can be regarded as a first experimental realisation of the long time proposed Collective Atomic Recoil Laser (CARL). There are also strong similarities to superradiant Rayleigh scattering and Bragg Spectroscopy of Bose-Einstein condensates. By adding friction with a superimposed optical molasses, one obtains a very clean experimental realization of the so called Kuramoto model which describes a large class of fundamental self organisation processes. By means of optical Bragg diffraction we can directly observe the periodic atomic density distribution. A heterodyne technique allows determining both amplitude and phase of the diffracted light and it was possible to observe the phase of resonant Rayleigh scattering for the first time. The here presented method may also be useful for diagnostics of quantum gases in optical lattices.

Hauptvortrag SYRT 1.2 Fr 11:30 HVI

Coherent backscattering of light in nonlinear media — •Thomas Wellens — Laboratoire Kastler Brossel, Université Pierre et Marie Curie, F-75231 Paris, France

The diffusive propagation of waves in disordered media may be significantly affected by interference effects such as coherent backscattering, weak and strong localization. Whereas these effects are relatively well understood in the case of linear media, the influence of nonlinearities on the interferential properties of multiple scattering has only started to be explored. In this talk, I report on our recent work [1] on coherent backscattering of light by cold atoms which, at higher intensities, become nonlinear due to the onset of saturation. Using a perturbative approach, valid for weakly nonlinear scatterers, I show that the nonlinearity has a fundamental impact on the phenomenon of coherent backscattering. In particular, nonlinear interference effects may lead to an enhancement of the backscattered intensity by more than a factor two.

[1] T. Wellens, B. Grémaud, D. Delande, and C. Miniatura, PRA 73 (2006, in press).

Hauptvortrag SYRT 1.3 Fr 12:00 HVI

Experiments on the critical regime near Anderson localization of light — •Georg Maret, Martin Störzer, Peter Gross, and Christof M. Aegerter — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany

As predicted first by P.W. Anderson diffusive transport of multiply scattered waves in disordered media may break down due to interference. This transition to localization of waves should occur for any classical or quantum wave in any media when the wavelength becomes comparable to the transport mean free path l*. Unequivocal experimental proof of the existence of wave localization in disordered bulk (3D) materials is still lacking, basically since the signatures of localization and absorption may be rather similar. Here we present measurements of time resolved non-classical diffusion of visible light in strongly scattering samples of colloidal TiO_2, which cannot be explained by absorption, sample geometry or reduced transport velocity. Deviations from classical diffusion increase strongly with decreasing l* as expected for a phase transition. This constitutes an experimental realization of the critical regime in the approach to Anderson localization of light.

Hauptvortrag SYRT 1.4 Fr 12:30 HVI

Propagation of light in disordered fiber bundles — •Ulf Peschel[1], Thomas Pertsch[2], Falk Lederer[3], Jens Kobelke[4], Kay Schuster[4], Hartmut Bartelt[4], Stefan Nolte[2], and Andreas Tünnermann[2] — [1]Institut für Optik, Information und Photonik, Universität Erlangen, D-91058 Erlangen, Germany — [2]Institut für Festkörpertheorie und Theoretische Optik, Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany — [3]Institut für angewandte Physik, Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany — [4]Institut für Physikalische Hochtechnologie e.V, D-07745 Jena, Germany

We experimentally study the propagation of light in a distorted bundle of coupled optical fibers. Monitoring the field evolution in the fibers we find coherent interaction to turn over into diffusive spreading due to the presence of disorder. Parts of the propagating field even remain trapped in certain areas of the array. Increasing the power we cause the nonlinearity to successfully compete with the action of disorder. The diffusive propagation of linear fields is nonlinearly modified resulting in power controlled localization. In contrast, fields which remain trapped in the low power case, start to propagate and spread due to the action of the nonlinearity. Experimental results are compared with numerical simulations and good agreement is obtained.

SYRT 2 Radiation transport in random media II

Zeit: Freitag 14:00–16:00 Raum: HVI

Hauptvortrag SYRT 2.1 Fr 14:00 HVI

Twin-photon light scattering — •J.P. Woerdman — Huygens Laboratory, Leiden University, 2300 RA Leiden, The Netherlands

We will report our recent experimental work on the scattering of entangled twin-photons by a variety of media, such as suspensions, multimode fibers, sub-wavelength hole arrays, etc. The common aspect of all this is the central role played by the spatial degrees of freedom. This can work out in a 'positive' sense, by allowing the possibility of high-dimensional spatial entanglement of the two photons. It can also work out in a 'negative' sense, when the (unobserved) spatial degrees of freedom are coupled to the polarization degree of freedom, thus degrading the polarization entanglement ('decoherence'). In both cases the presence of a high-dimensional Hilbert space of spatial states leads to very rich physics.

Hauptvortrag SYRT 2.2 Fr 14:30 HVI

Effects of strong localization of light in disordered media with loss or gain — •Johann Kroha, Regine Frank, and Andreas Lubatsch — Physikalisches Institut, Universität Bonn, D-53115 Bonn, Germany

Despite intensive theoretical investigations the origin of coherent feedback in random laser systems has remained controversial. In this talk we present a systematical theory for the interplay of strong localization effects and absorption or gain of classical waves in 3-dimensional, disordered dielectrics [cond-mat/0511331]. The theory is based on a self-consistent Cooperon resummation, implementing the effects of energy conservation and its absorptive or emissive corrections by means of an exact, generalized Ward identity. Substantial renormalizations are found, depending on whether the absorption/gain occurs in the scatterers or in the background medium. We find a finite, gain-induced correlation volume which may be significantly smaller than the scale set by the scattering mean free path, even if there are no truly localized modes. Possible consequences for coherent feedback in random lasers as well as the possibility of oscillatory in time behavior due to memory effects caused by the interplay of interference and sufficiently strong gain are discussed.

Hauptvortrag SYRT 2.3 Fr 15:00 HVI

Transport of near-resonant light in cold atomic vapors — •Guillaume Labeyrie — Institut Non Linéaire de Nice, CNRS / UMR 6618, F-06560 Valbonne, France

Ultracold atomic vapors constitute attractive new samples to study the transport of light in disordered media. Among the most remarkable features of these gases are the very sharp resonances, the monodispersivity and absence of defects or absorption. I will review our work on both incoherent and coherent signatures of the transport in our atomic clouds, which are currently in the weak localization regime. In particular, I will show how coherent backscattering allowed us to identify several mechanisms which limit the phase coherence length in such samples. I will conclude with some prospects on the route to the strong localization regime.

Hauptvortrag SYRT 2.4 Fr 15:30 HVI

Nonlinear transport of matter waves through disorder potentials — •Peter Schlagheck — Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany

The rapid progress in technologies for trapping, cooling and manipulating ultracold atoms has lead to a number of fascinating experiments probing phenomena from condensed matter physics and nonlinear theory. A new direction in this context is the dynamics of Bose-Einstein condensates in disorder potentials, which can be induced with optical speckle potentials or on miniaturized magnetic waveguide geometries ("atom chips"), and which bears intriguing analogies to localization phenomena of electrons in solids as well as to the interplay of nonlinearity and disorder in the propagation of radiation. In our studies, we focus on the transport of a Bose-Einstein condensate through an atom-chip waveguide with smooth longitudinal disorder. We shall show that for weak atom-atom interactions an exponential (Anderson-like) decrease of the transmission with the sample length is obtained, where the localization length is reduced compared to the interaction-free case. For strong interactions, a cross-over to an algebraic (Ohm-like) decrease of the transmission is encountered, which correlates with the appearance of a permanently time-dependent scattering process of the condensate.