Workshop on

Nonlinear Effects in Photonic Materials

WIAS, Berlin, March 12-14, 2007

Edited by

Weierstraß-Institut für Angewandte Analysis und Stochastik (WIAS)
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Contents

General Information

Workshop on

Nonlinear Effects in Photonic Materials

- **Sponsored by:**

  Weierstraß-Institut für Angewandte Analysis und Stochastik (WIAS), Berlin
  http://www.wias-berlin.de

- **Organizers:**

  U. Bandelow, A. Demircan, D. Skryabin (University of Bath), A. Vladimirov

- **Focus of the Workshop and Announced Topics**

  The workshop aims at bringing together researchers working on the following topics:

  - nonlinear fiber optics
  - ultrashort pulses
  - optical solitons in space and time
  - nonlinear effects in new materials
  - photonic crystals and microresonators

- **Start:** March 12, a.m.
  End: March 14, p.m.
  Location: WIAS, Mohrenstr. 39, Berlin, Erhard-Schmidt-Hörsaal

Programme

Monday, March 12th
Duration of talks includes 10 minutes for discussion.

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09:55 – 10:35	**W. Krolikowski**, Canberra *Light control in nonlinear photorefractive lattices*
10:35 – 11:00	**Coffee Break**
11:00 – 11:40	**S. Longhi**, Milano *Quantum Mechanics in Curved Photonic Structures*
11:40 – 12:20	**F. Mitschke**, Rostock *Soliton molecules in optical fibers*
12:20 – 12:45	**D. Skryabin**, Bath *Cascaded generation of multiply charged optical vortices and spatiotemporal helical beams in a Raman medium*
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14:00 – 14:40	**L. Bergé**, Bruyere-le-Châtel *Stability of excited states in extended NLS systems*
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15:20 – 16:00	**Coffee Break**
16:00 – 16:40	**M. Taki**, Villeneuve d'Ascq *Non local effects for trapping dissipative optical solitons*
16:40 – 17:20	**M. Tlidi**, Bruxelles *Generation of ultra fast solitons in low dispersion photonic crystal fiber cavity*
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Tuesday, March 13th
Duration of talks includes 10 minutes for discussion.

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09:40 – 10:20	**L. Gallmann**, Zürich *Few-cycle pulse generation through optical filamentation in rare gases and its spectral and spatio-temporal characterization*
10:20 – 11:00	**Coffee Break**
11:00 – 11:40	**S. Skupin**, Bruyères-le-Châtel *On the Dynamics of Femtosecond Filaments*
11:40 – 12:20	**S. Turitsyn**, Birmingham *Ultralong fibre lasers*
12:20 – 12:45	**U. Bandelow**, Berlin *Limit for Pulse Compression by Pulse Splitting*
12:45 – 14:00	**Lunch**
14:00 – 14:40	**A. Sukhorukov**, Canberra *Slow light in nonlinear Bragg-grating structures*
14:40 – 15:20	**A. Yulin**, Bath *Optical solitons in the media with internal resonances*
15:20 – 16:00	**Coffe Break**
16:00 – 16:40	**C. Schmidt-Langhorst**, Berlin *Applications of highly nonlinear fibers for 160 Gbit/s all-optical data format conversion*
16:40 – 17:05	**B. Hüttl**, Berlin

Wednesday, March 14th
Duration of talks includes 10 minutes for discussion.

09:00 – 09:40	**M. Frosz**, Kgs. Lyngby *Dispersion engineering for supercontinuum spectral shaping using numerical modelling*
09:40 – 10:20	**G. Genty**, Espoo *Beyond Supercontinuum Generation: Extreme Nonlinear Propagation in Photonic Crystal Fiber*
10:20 – 10:45	**A. Demircan**, Berlin *Interplay between Soliton Fission and Modulation Instability*
10:45 – 11:20	**Coffee Break**
11:20 – 12:00	**I. Babushkin**, Berlin *Supercontinuum generation in a waveguide with a slow nonlinearity*
12:00 – 12:40	**A. Husakou**, Berlin *All-optical bistable switching in a metal-dielectric multilayer structure due to the transition of optical properties from metallic to dielectric*
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16:40 – 17:05	**A. Vladimirov**, Berlin *Dissipative solitons in nonlinear optical devices with refractive index modulation*
17:05 – 17:15	**Closing**

Abstracts

Vibrating and shaking soliton pairs in dissipative systems

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Coupled soliton pairs in nonlinear dissipative systems modeled by the cubic-quintic complex Ginzburg-Landau equation can exist in various forms. They can be stationary, pulsating periodically, quasiperiodically or chaotically, the same way as single solitons. In particular, there are new types of vibrating and shaking soliton pairs. Each type is stable in the sense that a given bound state exists in the same form indefinitely. New solutions appear at special values of equation parameters thus bifurcating from stationary pairs. There are also mixed soliton pairs, formed by two different types of single solitons.

Supercontinuum generation in a waveguide with a slow nonlinearity

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Coherent ultrabroadband radiation (supercontinuum) is required in many physical applications. Self-phase modulation in noble-gas-filled hollow waveguides with an instantaneous Kerr-nonlinearity is the key physical mechanism for spectral broadening and compression of mJ-pulses to a duration below 5 fs or two optical cycles (see e.g. [1]). Recently an enormous spectral broadening of more than two octaves [2] with a much lower threshold has ben achieved using nJ-pulses in microstructure fibers with an instantaneous Kerr-type nonlinearity in the anomalous dispersion range which is caused by the emission of dispersive (non-solitonic) radiation by solitons [3]. On the other hand, materials with a slow nonlinearity, such as photorefractive materials, were up to now not considered as media for femtosecond nonlinear processes and spectral broadening. In the present talk we theoretically consider a planar rib waveguide with a guiding layer formed from the photorefractive-photovoltaic material (LiNbO3 doped with Cu), which possess a non-instantaneous (slow) nonlinearity with a response time in the ms range. Our numerical simulations predict that the propagation of a short optical pulse through such slow nonlinear waveguide results in self-steepening and in the generation of a supercontinuum with a spectral width of more than one octave. The spectral broadening, achieved during the propagation is strongly asymmetric, with new spectral components being formed only on the red side, in contrast to the symmetric broadening due to self-phase modulation in Kerr media. With further propagation, the self-steepening results in an increase of the peak pulse intensity and the higher peak intensity enhances the spectral red-shift which in turn yields a stronger self-steepening. Therefore at some critical propagation distance a sharp shock-like peak is formed. Thus the mechanism of spectral broadening is in this case related to shock formation and strongly differs from the both abovementioned mechanisms in instantaneous nonlinear media. One can obtain a sufficiently broad supercontinuum both in normal and anomalous dispersion regime. In the region of normal dispersion the shock arises on the leading edge of the pulse, whereas for anomalous dispersion region the shock is formed on the trailing edge. The phase of the achieved supercontinuum is smooth with low noise and suggests the possibility of pulse compression.
[1] T. Brabec and F. Krausz, Rev. Mod. Phys. 72, 545 (2000). [2] J.K.Ranka et al., Opt. Lett. 25,25 (2000). [3] A. Husakou and J. Herrmann, Phys.Rev. Lett. 87, 203901 (2001).

Limit for Pulse Compression by Pulse Splitting

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We have detected a fundamental pulse-compression limit for high-nonlinear fibers in the normal dispersion regime near the zero-dispersion wavelength. The desired generation of a broadband continuum by self-phase modulation is limited by already small amounts of third-order dispersion, which results in pulse splitting above a critical pulse power. We investigate the critical fiber length in dependence on pulse- and fiber parameters.

Stability of excited states in extended NLS systems

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We examine the dynamics of optical vortices and higher-order bound states of the cubic nonlinear Schroedinger equation with an attractive potential. A sufficient stability criterion is derived in the limit of weak powers, which only requires knowledge of the linear modes of the potential.

Localized states and oscillations induced by wave self-diffraction in nonlinear media with non-local response

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I consider the case of wave interaction in nonlinear medium with a non-local response that has an inherent feature such as a directional phase shift between interacted waves leading to energy transfer from one wave to the other. Then one can obtain a sine-Gordon equation with a damping term to describe the temporal dynamics of the process, where the nonlinear susceptibility of the medium is changed due to two main processes: the amplification being proportional to the local wave intensity and the relaxation. This situation has natural realization at optical dynamic holography in ferroelectric crystals with non-local photorefractive gain that is considered more detail in the report. In the holographic schemes a soliton-like behavior of the light induced refractive index has been predicted theoretically [1-3] and confirmed experimentally [4]. The conditions of formation of single localized state and self-oscillations of the induced refractive index (as well as of output wave intensities) are discussed.

[1] A. Bledowski, W. Krolikowski, A. Kujawski, J. Opt. Soc. Am. B 6, No.8, 1544-1547 (1989). [2] A. A. Zozulya, M. Saffman, D. Z. Anderson, Phys. Rev. Lett. 73, No. 6. 818-821 (1994).

[3] M. Jeganathan, M. C. Bashaw, and L. Hesselink, J. Opt. Soc. Am. B 12, 1370 (1995).

[4] S. Bugaychuk, L. Kovács, G. Mandula, K. Polgár, R. A. Rupp, Phys. Rev. E 67 (4), 046603 (2003).

Interplay between Soliton Fission and Modulation Instability

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We investigate the generation mechanisms for ultrawide spectra in nonlinear optical fibers. Soliton fission and modulation instability represent fundamental mechanisms for the generation process. The primary origin of the spectral broadening changes with the pump-pulse duration. Soliton fission dominates for low input power and short pulses. Its efficiency for supercontinuum generation and especially the extend to the blue side can be increased by proper design of the dispersion profile. The modulation instability has a strong impact for high input powers and greatly enhances the generation process, but leads to a degradation of the coherence properties. Also for short pulses with durations of 60 fs the modulation instability is present and can hardly be suppressed. The interplay between these two effects leads to various characteristics of the resulting spectra, which are modified by to the relative impact of the modulation instability.

Moving and resting solitons in arrays of nonlinear cavities

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We study light propagation in arrays of weakly coupled nonlinear cavities driven by an external holding beam. We find numerically the families of resting and moving dissipative solitons for an arbitrary inclination angle of the driving field, both in the discrete and a quasi-continuous limits.

Dispersion engineering for supercontinuum spectral shaping using numerical modelling

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The invention of photonic crystal fibres a decade ago has led to dramatic advances in supercontinuum generation. Extremely broad spectra can be achieved, covering more than an octave. The main advantage of using photonic crystal fibres is not that the core can be made very small for achieving high nonlinearity, but that the dispersion profile of the fibre can be engineered to a large degree. This talk will discuss how the various nonlinear effects are influenced by the dispersion profile. Then numerical simulations are used to show how proper fibre design can be used to shape the resulting supercontinuum spectrum to some degree. This is shown for vastly different pumping regimes, going from femtosecond to quasi-CW pump pulses.

Few-cycle pulse generation through optical filamentation in rare gases and its spectral and spatio-temporal characterization

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Optical filamentation is a recent method for the generation of few-cycle pulses. We compare this method to the classical hollow-core fiber technique. Furthermore, the spectral and spatio-temporal properties of the filament output was investigated in detail and compared with theoretical predictions.

Beyond Supercontinuum Generation: Extreme Nonlinear Propagation in Photonic Crystal Fiber

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We describe generalized nonlinear envelope equation modeling of sub-cycle dynamics on the underlying ultrafast electric field carrier during one-dimensional propagation in fused silica. Generalized envelope equation simulations are compared with numerical integration of Maxwell?s equations, and quantitative agreement is obtained in the presence of shock dynamics that exhibit carrier steepening on a sub-50 attosecond timescale. In addition, by separating the effects of self-phase modulation and third harmonic generation, we examine the relative contribution of these effects in supercontinuum generation in fused silica nanowire waveguides.

320 Gbit/s all optical wavelength conversion using Periodically Poled Lithium Niobate

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A periodically poled lithium niobate (LiNbO3) waveguide was characterised for the aplication in all optical wavelength conversion. Wavelength conversion was achieved by cascaded second harmonic generation (SHG) of the continous-wave pump and difference frequency generation (DFG) of the SH-wave and the data signal. Characterisation was done to analyse conversion eficiency for different input powers and for different input wavelengths. Conversion of phase modulated data signals of 40, 80 and 160 Gbaud is presented. Error free operation with negligible penalty is achieved for differential phase shift keying (DPSK) and differential quadrature phase shift keying (DQPSK) modulation.

Stable subdiffractive one- and two- dimensional spatial solitons in kerr-nonlinear photonic crystals

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We predict stable, collapse-free one- and two-dimensional solitonic structures of light propagating in kerr-nonlinear photonic crystals (of defocusing nonlinearity), and investigate their properties.

All-optical bistable switching in a metal-dielectric multilayer structure due to the transition of optical properties from metallic to dielectric

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The interaction of light with metal-dielectric nanostructured materials has attracted significant interest in the last decades due to possible applications in nanoscience, plasmonics and information processing. Among the different geometrical structures studied up to now a metal-dielectric multilayer structure is a particularly simple , easy to create and compact device, which exhibit bandgaps [1] and shows a strongly enhanced nonlinear transmission compared with a bulk metal with the same total thickness of the metallic layers [2]. In the present talk, we report the results of a theoretical study of light propagation through a specially designed nonlinear metal-dielectric multilayer structure with a small negative linear effective dielectric constant. We predict a highly-nonlinear, bistable transmission due to the change of the effective nonlinear dielectric constant from negative (low-transmission state) to positive (high-transmission state) values. Consider a multilayer structure consisting of many thin metallic layers embedded in a dielectric with a pitch much smaller than the wavelength. An understanding of the transmission properties of such structure can be obtained using the effective-medium approach. For appropriate volume fractions of the metal and the dielectric, one can achieve a real part of the effective linear dielectric constant slightly below zero. In this case, the linear transmission is very small. However, a field inside of the slab can increase the effective dielectric constant to positive values due to the optical nonlinearity. In turn, the positive effective dielectric constant results in a high transmission and sustains the field inside of the slab. For the calculation of light transmission through this multilayer structure we use the FDTD approach for the full numerical solution of the Maxwell equations. We consider the propagation of a cw beam with a wavelength of 633 nm through a fused-silica slab with a thickness of 950 nm which incorporates 9 silver layers with thinkness of 14 nm. The effective dielectric constant of the composite with the given parameters has a small negative real part. The calculated transmitted intensity as a function of the input intensity shows a bistable behavior with a contrast of around 4 between the high-transmission and the low-transmission states. For the lower-transmission state, the intensity of the wave near the output surface is low, and this part remains effectively 'metallic'. For an input intensity in the range of GW/cm2 the system goes over into the higher-transmission state, in this case the field penetrates deeper into the structure and the real part of the average effective dielectric constant becomes about 0.05. The transient response of the considered system is not determined by the response time of the bulk silver nonlinearity, but by the feedback of the multilayer structure. We have calculated that switching to the high-transmission state occurs with a transition time below 1 ps. In conclusion, we have numerically predicted all-optical bistable switching due to sign change of the effective dielectric constant in an ultra-compact metal-dielectric multilayer structure with an overall length of only 1 micron and an ultrafast response in the order of 1 ps.

[1] M. J. Bloemer and M. Scalora, Appl. Phys. Lett. 72, 1676 (1998). [2] N.N. Lepeshkin et al. Phys. Rev. Lett. 93, 123902 (2004).

All Optical Wavelength Conversion by Four Wavelength Mixing in Highly Nonlinear Fibers for 160 Gbit/s Phase Modulated Signals

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Future optical networks has to be flexible with respect to modulation format, data rate and channel wavelength. Therefore all optical wavelength converters, which do not limit data rates and do not disturb amplitude and phase information, are thought to be key components of next generation networks. The four wavelength mixing (FWM) in highly nonlinear fibers is an efficient process, which could be used for this application. The optimization of the FWM for wavelength conversion regarding low phase error and high conversion efficiency of data signals will be considered in this talk. An transmission experiment of 160 (320) Gbit/s of D(Q)PSK signals is demonstrated.

Light control in nonlinear photorefractive lattices.

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There has been growing interest in propagation of optical beams and pulses in media with periodically varying refractive index. Such periodic structures or optical lattices lead to appearance of a band gaps in the transmission spectrum of waves. As a result, diffractional properties of optical beams can be drastically modified. Lattice-induced propagation effects become even more dramatic in the presence of the nonlinearity of the medium leading among others to the formation of discrete and gap solitons. In this talk I will present experimental and theoretical results of our studies of light localisation in optical lattices with photorefractive nonlinearity. These include formation of gap and surface solitons as well as polychromatic solitons.

Quantum Mechanics in Curved Photonic Structures

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Optical waveguide systems with a suitably curved axis offer an experimentally accessible laboratory tool for the observation of several coherent linear and nonlinear effects tupical of quantum mechanical systems. This talk will review some of these basic effects, including adiabatic stabilization, suppression of quantum diffusion, and control of quantum tunneling.

Soliton molecules in optical fibers

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Recent experimental results on compound states of fiber-optic solitons are presented, in particular regarding the phase dynamics.

Applications of highly nonlinear fibers for 160 Gbit/s all-optical data format conversion

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In future optical networks there will be a coexistence of different modulation formats in different parts of the network. Those domains with different modulation formats should be transparently connected, which requires all-optical data format conversion. We report an all-optical OOK to DPSK format converter based on highly-nonlinear fiber. The format converter was successfully operated up to 160 Gbit/s, achieving error-free performance after transmission over 320 km fiber with mid-span OOK to DPSK conversion.

Properties of spatial patterns in broad-area vertical-cavity surface-emitting lasers and their control

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Transverse modes in broad-area vertical-cavity surface-emitting lasers (VCSELs) show a distinct coupling between spatial and polarization degrees of freedom. Three mechanisms of polarization selection are found depending on the characteristic transverse length scale: intrinsic material anisotropies, the anisotropic reflection of TE- and TM-waves at the Bragg reflectors and the linear coupling of travelling waves at the incidence on the side boundaries of the device. Using frequency-selective feedback we demonstrate control over the characteristic pattern length scale.

Cascaded generation of multiply charged optical vortices and spatiotemporal helical beams in a Raman medium

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Using an example of a Raman active medium we describe how a common nonlinear process of four-wave mixing can be used to induce strong coupling between the spatial and temporal degrees of freedom in optical waves. This coupling produces several unexpected effects. Amongst those are cascaded excitation of multiply charged optical vortices, spatial focusing in a nonlinearly defocusing medium and generation of helically shaped spatio-temporal optical solitons.

On the Dynamics of Femtosecond Filaments

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General properties of the propagation of intense femtosecond laser pulses in transparent media will be discussed. Special emphasis will be laid on the application of ultra-short filaments in novel pulse-shortening techniques.

Filament self-compression of intense few-cycle pulses in noble gases

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We discuss how the interplay of plasma-induced and Kerr-type nonlinearities can lead to filament formation together with pulse self-compression into the few-cycle regime. We show experimental data indicating the generation of 7.4-fs pulses without using additional means for dispersion compensation.

Slow light in nonlinear Bragg-grating structures

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The speed of light can be dramatically reduced in photonic structures with a periodic modulation of the optical refractive index such as Bragg-gratings. We suggest the designs of structures which dispersion properties are optimized for the flexible control of slow light. We then demonstrate that by taking advantage of the enhanced nonlinear pulse self-action in the slow-light regime, it becomes possible to simultaneously suppress the dispersion-induced pulse broadening in time and in space, and realize efficient control of both the magnitude and direction of the pulse velocity. We discuss the possible applications of these effects to power-controlled routing, shaping, and switching of slow light in nonlinear Bragg-grating structures.

Non local effects for trapping dissipative optical solitons

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Spatial dissipative solitons (or localized structures) in extended systems has attracted much attention in fields as different as physics, hydrodynamics, chemistry, and biology. Nonlinear optics, in particular, represents a fruitful area of activity. This is due to the fact that, on the one hand, dissipative solitons arise naturally in many optical systems from the interplay of diffraction, nonlinearities and dissipation. On the other hand, nonlinear optical devices have recently appeared as very promising devices for their potential applications, including low-noise measurement and detection, information technology, and image processing.

In this contribution we first give a brief introduction of the origin of transverse effects giving rise to spatio-temporal instabilities in spatially extended nonlinear optical systems. This enables us to emphasize the importance of pattern forming instabilities in the occurrence and dynamics of dissipative solitons. Second, we focus our investigations on the impact of non linear effects in the formation and the dynamics of dissipative solitons in optical parametric oscillators. Here, non local effects mainly result from advection (drift stemming from the crystal anisotropy or walk off) and inhomogeneous pumping that are largely encountered in the experiments. We show that they drastically affect the formation, the shape, and the dynamics of the solitons. In particular, we have identified and analytically characterized new convective and absolute instabilities giving rise to trapped solitons in monostable regime. In bistable regime, our analytical investigations show the crucial role of non local effects in the nonlinear dependence of the frequency and velocity of dissipative solitons on their intensity. This makes it possible to explain the self-frequency shift, the slowing down and the nonlinear symmetry breaking observed in the envelope of dissipative solitons emitted by optical parametric oscillators.

Generation of ultra fast solitons in low dispersion photonic crystal fiber cavity

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Taking up to fourth order dispersion effects into account, we show that fiber resonators become stable for large intensity regime. The range of pump intensities leading to modulational instability becomes finite and controllable. Moreover, by computing the thresholds and frequencies of these instabilities, we demonstrate the existence of a new unstable frequency at the primary threshold. This frequency exists for arbitrary small but nonzero fourth order dispersion coefficient. Numerical simulations for a low and flattened dispersion photonic crystal fiber resonator confirm analytical predictions and opens the way to experimental implementation. More importantly, when the modulational instabilities appear subcritically, dissipative localized structures or solitons are formed in this system.

Ultralong fibre lasers

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Recent results on ultra-long fibre lasers will be presented. I will discuss basic physics and mathematics of ultra-long lasers and their applications in high-speed optical communication.

Dissipative solitons in nonlinear optical devices with refractive index modulation

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We study pattern formation in nonlinear cavities with a photonic crystal film inside. We demonstrate the existence of modulational instability, resting and moving dissipative solitons resulting from the Bragg scattering at the refractive index modulation and investigate role played by the defects in periodicity.

Optical solitons in the media with internal resonances

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Propagation of short pulses in the media with non-instantaneous resonant polarization response is discussed in the work. The example of such media is the system with inclusions of metallic nanostructures into a dielectruc host. At certain frequencies the linear and nonlinear properties of such systems are strongly affected by the surface plasmon resonances of the metallic inclusions. Modern technology allows engineering of the properties of the media by appropriate design of the metallic nanoparticles. To describe the propagation of short pulses in the system in question the differential equation for the polarization must be retained and so the light dynamics is described by the coupled equations for the electromagnetic field and for the polarization. We derived slow varying amplitude description of the system. Within this approach it is shown that optical solitons can form from the short pulses launched in the media. These solitons in some sense can be treated as an analogy to self-induced transparency solitons when the front part of the pulse excites the medium and the rear part of the soliton removes the excitation of the polarization. The effect of dissipation on the solitons is also discussed. It is demonstrated that the dissipation can lead either to acceleration or to deceleration of the solitons. We also consider the interactions of the solitons with quasilinear waves. It is shown that there may be Cherenkov radiation of the dispersive waves by the solitons and the frequency generation resulting from the resonant scattering of the radiation on the solitons.

List of Participants

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Computer Facilities

All workshop participants have the possibility to check emails in room no. 010, ground floor, opposite from the lecture room. Any workstation in this room may be used.
For log-in please use the following selections and input

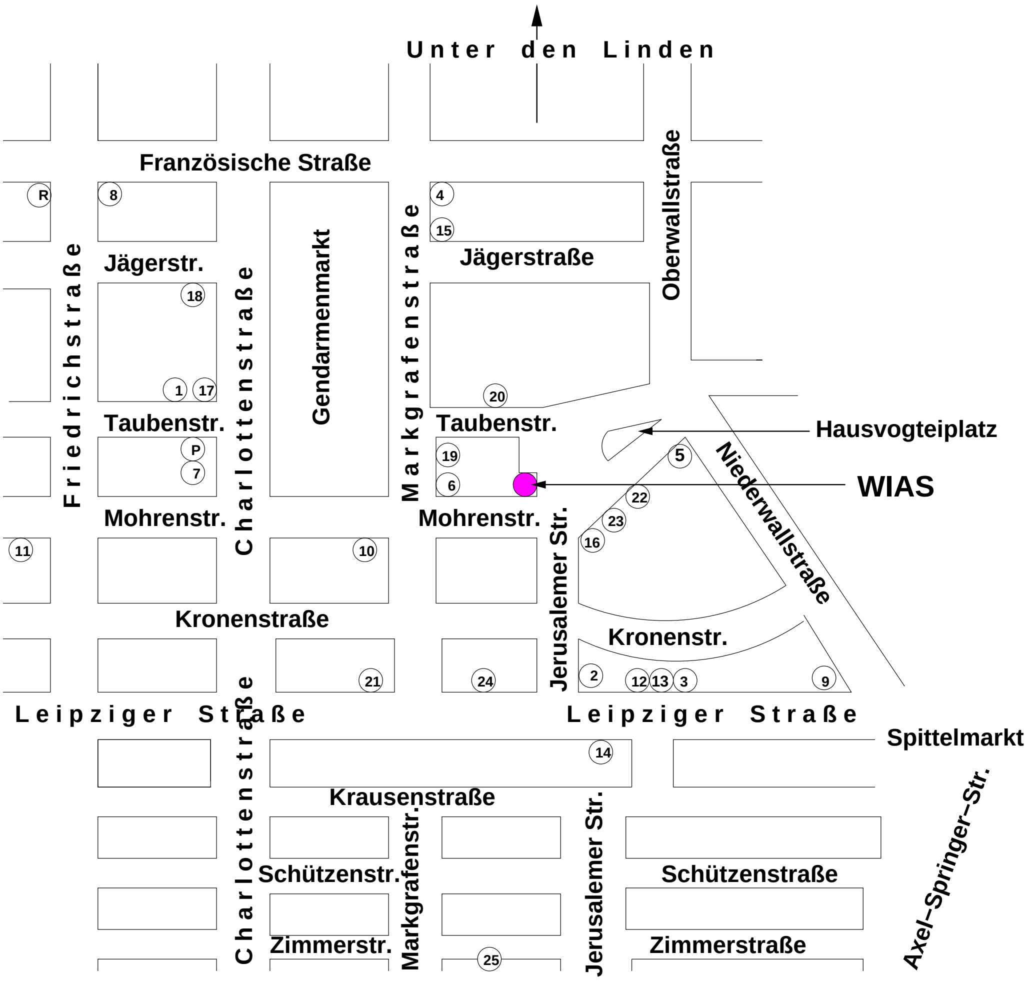
`Please enter your user name:` **photons07** [OK]

`Please enter your password:` ***photons*** [OK]

for log-out: either use the [Log out...]-selection on the root window or the [EXIT] button of the desktop.

Please be aware that this account is used by all workshop participants. So, don't leave any confidential data in its home directory. All left over data will be removed after the workshop.

Places to have lunch/dinner



1	Mensa Konzerthaus	13	Irish Times
2	Efendi Modern Bistro	14	China-City Restaurant
3	Croissanterie	15	Französischer Hof
4	“Bistro am Gendarmenmarkt”	16	Pastakontor
5	“the coffee shop”	17	Lutter und Wegner
6	KAFFEE EINSTEIN	18	Café Möhring
7	“Foodcourt” in Friedrichstadtpassage	19	Trenta Sei
8	“Galéries Lafayette”	20	Brasserie
9	Markt	21	Löwenbräu
10	“Hilton”	22	Açaí café
11	Leopold’s Kontorhaus	23	Good Time
12	Fontana di Trevi Ristorante	24	Ur-Saalfelder
P	Post Office	R	Reiseland “American Express”

25 Springer Building (Lunch meals, Snack bars, Coffee bars), Zimmerstraße

Many of the collaborators of WIAS spend their lunch break in the restaurant for the staff of Konzerthaus am Gendarmenmarkt (① on the map, entrance via Taubenstrasse, 2nd floor, or on the 1st floor there is the “Cafeteria” where you can also have lunch). A set lunch is to be had there for less than 5 €.

Another good place for having lunch is the Springer Building ㉕ Zimmerstrasse, there are Snack bars, coffee bars where you can have lunch meals. *5 €upwards*

Please find here a choice of other restaurants and snack stalls:

Snacks

②“Efendi modern Bistro” (Mon.-Sat. 7 a.m.–2 a.m.)
Leipziger Strasse 58
Turkish snacks (“Döner” kebap, shish kebab, salads, etc.) *2–8 €*

③“Croissanterie” (Mon.–Sun. 7 a.m.–10 p.m.)
Leipziger Strasse 56
Breakfast, coffee, snacks, icecream *from 1 € upwards*

④“Bistro am Gendarmenmarkt”
(Mon.–Fri. from 11 p.m., Sat./Sun. from 1 a.m.)
Markgrafenstrasse / corner Französische Strasse
Soups, small snacks *4–8 €*

⑤“the coffee shop” (Mon.–Fri. 8 a.m.–6 p.m.)
Hausvogteiplatz 13
Bagels, muffins, brownies, croissants, sandwiches *2–4 €*

⑥“KAFFEE EINSTEIN” (Mon.–Sat. 7:30 a.m.–8 p.m., Sun. 10 a.m.–6 p.m.)
Mohrenstrasse / corner Markgrafenstrasse
Baguettes, muffins, sandwiches *from 2 € upwards*

When entering the Friedrichstadt Passage from Mohrenstrasse ⑦ and going down the escalator to the basement you find the “Foodcourt” with “Nk Insel”, “Bistro ‘B’ ”, “Asia-Fast-Food”, “MR. BAR-B-Q” and “Orient Grill” where you can have a tasty snack. *6–10 €*

In the department store “Galéries Lafayette” ⑧ in Friedrichstrasse,
on the basement, you are offered French delicacies (oysters, pies, cheese ...).
from 3 € (snacks) upwards

In Leipziger Strasse there are various snack stalls. On Mondays, Wednesdays and Fridays there is a flower and food market near the fountain Spindlerbrunnen ⑨ with some selection of snacks (baked potatoes, chinese snack, ...). You may enjoy your snack on a bench in the near-by park. *about 3 €*

Restaurants

(10) "Hilton"
Mohrenstrasse 30
There are several restaurants in the Hilton hotel.
The self service restaurant on Markgrafenstrasse (Mon.–Fri. 11:30 a.m.–3 p.m.) is suitable for a short lunch break.
Salads bar, pasta, soups, various warm meat and vegetable dishes, ice cream, etc. *3,50–10 €*

(11) "Leopold's Kontorhaus" (10 a.m.–12 p.m.)
Friedrichstr. 185 - 190 (between Mohren- and Kronenstrasse) *5–15 €*

(12) "Fontana di Trevi Ristorante" (12 a.m.–12 p.m.)
Leipziger Strasse 56
Italian food *5–15 €*

(13) "Irish Times" (Sun.–Thur. 10 a.m.–1 a.m., Fri./Sat. 10 a.m.–2 a.m.)
Leipziger Strasse 56
Irish restaurant *4–10 €*

(14) "China-City Restaurant" (11:30 a.m.–12 p.m.)
Leipziger Strasse 46
Chinese restaurant *6–15 €*

(15) "Französischer Hof" (from 10 a.m.)
Jägerstrasse 56
French restaurant *from 14 € upwards*

(16) "Restaurante Pastakontor" (8 a.m.–10 p.m.)
Hausvogteiplatz 10
Italian Restaurant *from 5 € upwards*

Your Notes

Your Notes

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