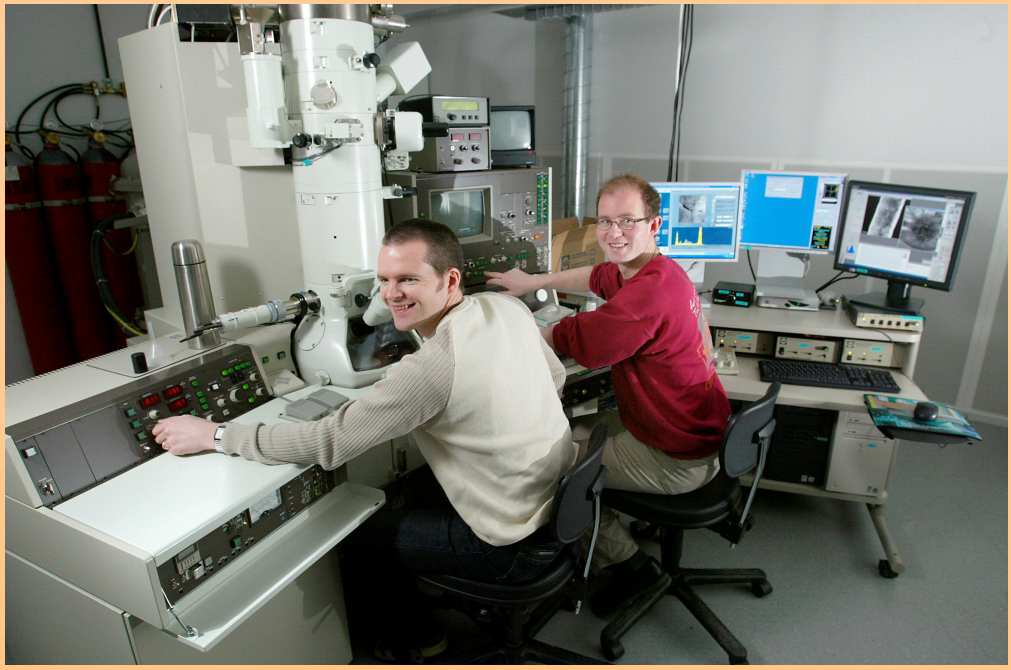
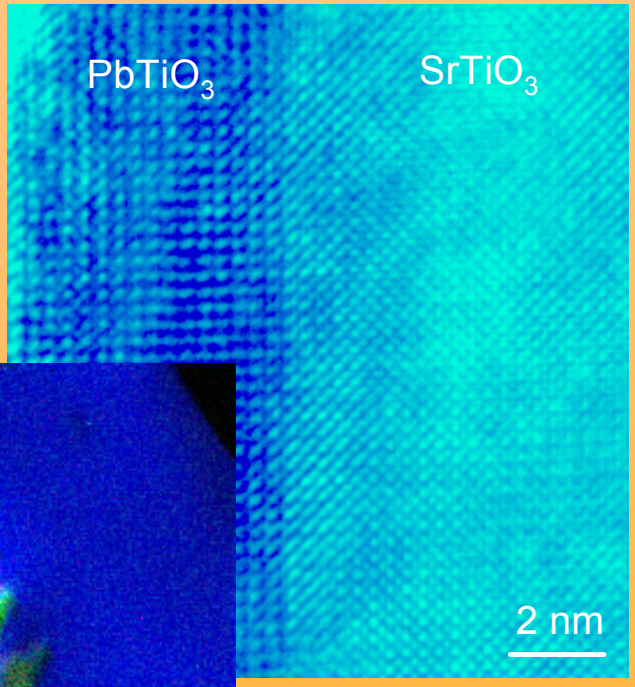
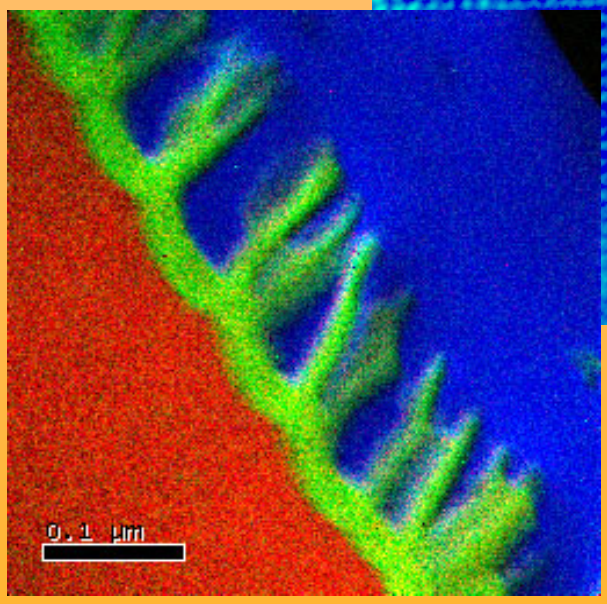
2003

ANNUAL REPORT







Department of Physics
Norwegian University of
Science and Technology
Trondheim, Norway

NTNU

DEPARTMENTAL BOARD

Head of the Department:	Professor Anders Johnsson
Deputy Head of the Department:	Professor Alex Hansen
Elected members:	
Representing the permanent scientific staff:	Professor Catharina Davies Professor Ola Hunderi Professor Berit Kjeldstad Professor Asle Sudbø
Representing the temporary scientific staff:	Dr. student Trude Støren
Representing the technical/administrative staff:	Executive Officer Margit Hagen
Representing the department's students	Student Simen Ellingsen Student Torgar Haugen
Appointed external member:	
From Electromagnetic Geoservice	Managing Director Terje Eidesmo

COVER PAGE
The cover pictures give impressions from the transmission electron microscopy activities at the Department of Physics.
Upper: A new field emission transmission electron microscope (Jeol 2010F) has been installed at the department. It is operated byTon van Helvoort and Heimir Magnusson (both at the photo), John Walmsley, Randi Holmestad and Bård Tøtdal.
Middle: High resolution transmission electron microscopy image showing the interface of a 9 nm ferroelectric thin film of $PbTiO_3$ grown on a $SrTiO_3$ substrate. Film structure and quality down to atomic resolution is shown (photo: Dr. Ton van Helvoort).
Lower: Combined energy filtered transmission electron microscopy image showing aluminium (red), oxygen (green) and carbon (blue) in an anodised aluminium surface. The image visualises the oxide morphology and penetration of adhesive into the oxide pore structure on a fine scale (photo: Prof. II John Walmsley).

DEPARTMENT OF PHYSICS, NTNU

www.phys.ntnu.no

CONTENTS

Edited by:

Sylvi Vefsnmo, Anders Johnsson, Emil J. Samuelsen, Margit C. Hagen, Brian Wall

The Annual report is also available on the net at address:

http://www.phys.ntnu.no/instdef/rapporter/index-e.htm

THE DEPARTMENT OF PHYSICS

Synopsis of events in 2003

The Department of Physics at NTNU has three main tasks: to provide top quality education to undergraduate and graduate students; to conduct research in physics at a high international level; and to disseminate popularized, high quality information on topics related to physics.

The overall goal is to ensure that society is provided with a work force of the highest standard, well suited for a broad spectrum of occupations in which knowledge of physics is necessary or advantageous.

The physics activities at the University were for the first time united in one and the same building in 2000, when the new Natural Science Building (Realfagbygningen) of the University was inaugurated. All laboratories and localities were operational in 2002. However, 2003 turned out to represent a step backwards: the Department had to relinquish 500 m^2 of its area, since other research groups were to move into the building. Autumn 2003 was, therefore, dominated by a reorganization to accommodate laboratories and offices within the remaining area. We are now preparing to optimize teaching and research within this reduced area.

The Department has been able to continue and extend its research activities only due to the fact that external funding – mostly to finance doctoral students and post doc's – has increased considerably during 2003. We hope that this trend will continue!

In 2003 a new full-time professor in Optics was appointed. Two other positions (in Condensed Matter Physics and Energy and Environmental Physics), announced in 2003, were not filled in the course of the year.

The "Quality Reform", a reform initiated by the Ministry of Research and Education, is now under implementation and provides an opportunity to further improve the teaching quality. The reform will require a substantial amount of dedicated work by the teachers, for example at the introductory courses in physics, attended by over 1000 students from other faculties. It is too early to see the "pros and cons" of the reform, but there will be a continuous interest and focus on its results both from the students and the teachers of the Department.

In this short synopsis it should be emphasized that the research at the Department has resulted in substantial progress on many fronts during the year. This is demonstrated by a satisfactory publication rate, including several publications in highly rated journals, publications of international textbooks, presentation of valuable reports and conference contributions.

In addition to the research and teaching activities, the work in the Department during 2003 included many other positive activities. Only a few ones can be mentioned here.

During the year several colleagues received prizes and awards for science writing, teaching and commercialization. Great efforts from many students and colleagues made the "Open day" of the University a success for the Department. It is also appropriate to give credit to the many colleagues and doctoral students who enthusiastically guide school classes and other guests through our laboratories and through the scientific work of our research groups. A large number of school classes passes the Department in the course of a year. Numerous letters to the Department tell us how popular this activity is for the classes and their teachers. The chairman of the Department wishes to thank heartily the involved colleagues and students for their enthusiasm and for all their effort.

We are proud of the fact that the new President of the Norwegian Physical Society, elected in 2003, is Professor Anne Borg from our Department. She is the first woman to hold this office, and the Department will try to give her every possible support in this important role. In 2005 the Norwegian Physical Society will be the host for "Year of Physics 2005", which will be supported by UNESCO, IUPAP, European Physical Society and numerous other national societies and authorities. We anticipate that the Department will be heavily involved in this arrangement.

The various committees of the Department carry out important and necessary, yet time-consuming work. The Head of the Department would especially like to thank our Educational Committee for the great amount of work the members have performed throughout the year.

We hope this short annual report contains details of the Department's activities that are of interest to the reader.

March 2004

Anders Johnsson
Head of Department

STAFF

Head of Department:
Professor Anders Johnsson

Deputy Head of Department:
Professor Alex Hansen

Permanent staff

Scientific staff:

Professors
Anne Borg, Arne Brataas, Johannes Bremer, Catharina Davies, Arnljot Elgsæter, Kristian Fossheim, Jon Otto Fossum, Alex Hansen, Eivind Hiis Hauge (University Rector 2003), Per C. Hemmer, Randi Holmestad, , Ola Hunderi, Ragnvald K. O. Høier, Johan S. Høye, Anders Johnsson, Berit Kjeldstad, Hans Kolbenstvedt, Mikael Lindgren, Tore Lindmo, Ole J. Løkberg, Thor Bernt Melø, Arne Mikkelsen, Frode Mo, Kjell Mork, Jan Myrheim, Kalbe Razi Naqvi, Kåre Olaussen, Hans M. Pedersen, Steinar Raaen, Emil J. Samuelsen, Bo-Sture Skagerstam, Helge R. Skullerud, Bjørn Torger Stokke, Asle Sudbø, Arne Valberg.

Associate professors
Per Morten Kind, Jørgen Løvseth, Tore H. Løvaas Thorarinn Stefansson, Knut Arne Strand, , Jon A. Støvneng, Bård Tøtdal, Sigmund Waldenstrøm, Ingjald Øverbø.

Adjunct professors
Einar Rofstad, Arne Skretting, Roger Solli, John Walmsley, Tor Wøhni.

Technical and administrative staff:

Manager
Brian Wall

Administrative staff
Margit C.Hagen, Inger Kosberg, Inger J. Lian, Eli Monsøy, Tove G. Stavø

Technical staff
Irene Aspli, Lars Berntzen, Arnolf Bjølstad, Rolf Dahl, Knut R.Gjervan, Oddbjørn Grandum, Ole K.Holthe, Tor Jakobsen, Dagfinn Johnsen, Erling Kristiansen, Lise Kvalø, Per Magne Lillebekken, Heimir Magnusson, Jan S. Mastad, Arne Moholdt, Anniken Paulsen, Jon Ramlo, Kåre O. Rokhaug, Inge Sandaunet, Bertil O. Staven, Tor A. Vassdal, Arild Vatn, Geir Wiker.

Temporary staff:

Post doc.
Ali Ata, Antonius Helvoort, Yves Meheust, Nils Sandberg, Pawel Tadeuz Sikorski, Renaud Toussaint, Ingunn Tufto, Roland Wittje, Yingda Yu.

Senior staff
Johannes Falnes, Knut Lønvik, Reidar Nydal, Haakon Olsen, R. Svein Sigmond, Ivar Svare.

Doctoral students

Doctor of Engineering (39)
Carmen Andrei, Jan Øystein Bakke, Håvard Huru Bergene, Torkel Bjarte-Larsson, Øyvind Borck, Dag Werner Breiby, Kjetil Børkje, Live Eikenes, Arne Erikson, Davi de Miranda Fonseca, Jesper Friis, Anders Frøseth, Martin Grønseth, Henning Frydenlund Hansen, Fredrik Hansteen, Håkon Kortner Hasting, Hans Kristian Helgesen, Jonas Hertel, Mari Juel, Steinar Kragset, Lars Løseth, Gjertrud Maurstad, Jan Petter Morten, Stine Nalum Næss, Kanak Parnar, Thomas Ramstad, Øystein Risa, Terje Røsten, Roman Shchelushkin, Stein Olav Skrøvseth, Jo Smiseth, Eivind Smørgrav, Trude Elna Støren, Torbjørn Sund, Ingeborg-Helene Svenum, Oddbjørn Sæther, Ulrik Thisted, Per Erik Vullum, Hans Magne Ådland.

Doctor of Science (16)
Tom Kristian Bardal, Bjørn Bergsjordet, Berit Bungum, Aktor Chikukwa, Signe Danielsen, Nils Erland L. Haugen, Egil Holvik, Terje Meisler, Devi Dhavraj Meena, Samsun Mohamad, Ståle Ramstad, Ellen Roll, Inger Rudvin, Marit Sletmoen, Aksel Straume, Roland Wittje.

PhD-students (2)
Asadollah Bagheri, Binod Bhattarai

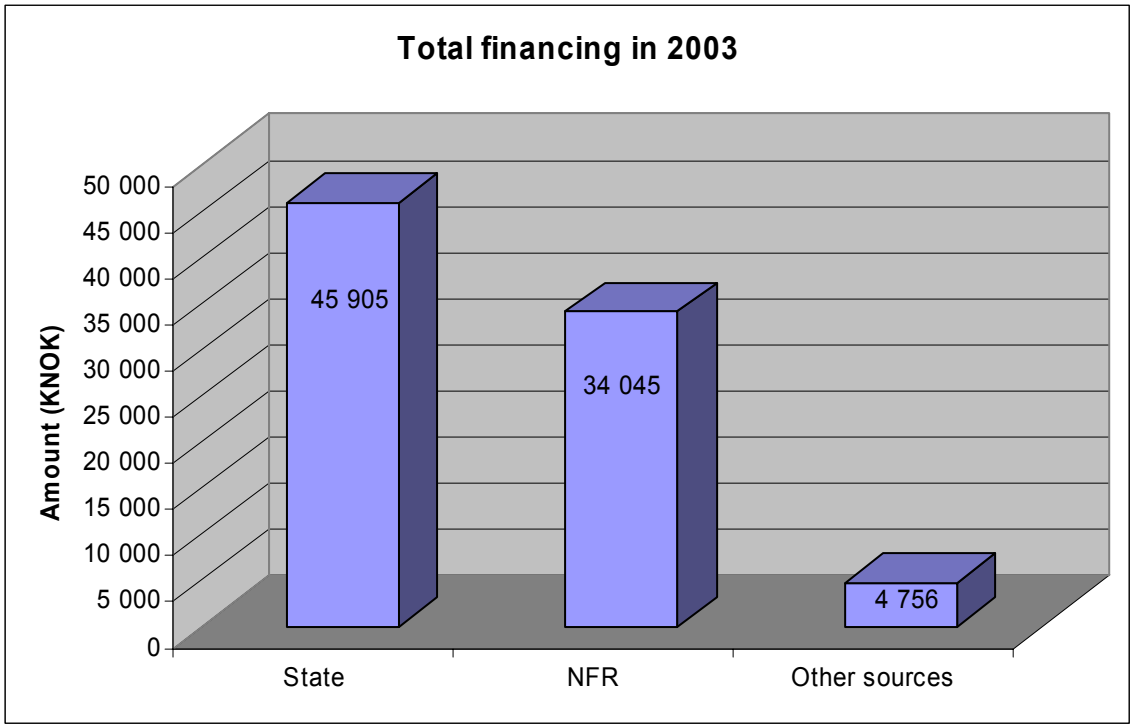
TOTAL FINANCING IN 2003

Description of project financed or name of contributor	Recipient	Amount KNOK
Financial contribution from the Government, university budget		**45 905**
Contributions from the Norwegian Research Council NFR		
Surface physics	Anne Borg	441
Structural, electronic and optical properties of atomic overlayers on surfaces	Anne Borg	635
Quantum transport in nanoscale systems	Arne Brataas	80
Transport or spin and charge in semiconductors	Arne Brataas	179
Intravital microscopy and MRI	Catharina Davies	223
Dynamics and transport properties of nanoparticles	Arnljot Elgsæter	212
Nanostructured soft and complex materials	Arnljot Elgsæter	4 000
Wave energy research	Johannes Falnes	76
Deltakelse på European World Energy Conference	Johannes Falnes	20
Experimental investigations	Jon Otto Fossum	635
Post doc. appointment for Yves Méheust	Jon Otto Fossum	687
Atomic Force Microscope	Jon Otto Fossum	1 000
SUP Complex	Jon Otto Fossum	1 000
Cooperation and exchange with France	Alex Hansen	100
Dr. ing. student	Alex Hansen	498
Complex systems and soft materials	Alex Hansen	100
Two-phase flow	Alex Hansen	201
Qantitative convergent beam electron diffraction	Randi Holmestad	142
Hydrogen storage in metal hybrids	Randi Holmestad	860
Micro- and nanostructure, materials development	Randi Holmestad	3 600
Light metal surface science	Ola Hunderi	950
Research collaboration Norway-Germany	Mikael Lindgren	40
Heat treatment fundamentals	Randi Holmestad (R. Mathiesen)	2 500
Electromagnetic fields and biological effects	Anders Johnsson	610
Factors controlling UV radiation in Norway	Berit Kjeldstad	312
Material fluxes from the Russian rivers Ob and Yenisey	Berit Kjeldstad	100
Travel support SNBL/ESRF	Frode Mo	250
Radiation-dominated accretion discs around black holes	Bo-Sture Skagerstam	45
Femtochemistry and Femtobiology	Kalbe Razi Naqvi	60
Marine biopolymers	Bjørn T. Stokke	496
Mesoscale structures	Bjørn T. Stokke	598
Polymer gel signal transducers	Bjørn T. Stokke	223
Centre for Biopolymer Engineering at NTNU	Bjørn T. Stokke	602
Vortex matter in superconductors	Asle Sudbø	20
Quantum transport in nanoscale systems	Asle Sudbø	35
Multikomponent superconductivity	Asle Sudbø	317
IKT-oxides	Asle Sudbø	12 200
	Sum	**34 045**

Contribution from other financial sources

	Recipient	Amount KNOK
NorFa	Arne Brataas	84
NEDO	Arne Brataas	100
Statoil	Alex Hansen	450
Photocure ASA	Anders Johnsson	190
Center for learning	Per Morten Kind	200
EU	Kjeldstad/Fossheim/Valberg	318
Linkøpings university, Uppsala	Mikael Lindgren	32
FOI, Totalforsvarets forskningsinstitutt	Mikael Lindgren	277
Medical technology	Tore Lindmo	136
Norwegian Cancer Society	Catharina Davies	645
NUFU	Jørgen Løvseth	814
Hydro	Randi Holmestad (R. Mathiesen)	1 200
Elkem	Randi Holmestad (R. Mathiesen)	200
Raufoss	Randi Holmestad (R. Mathiesen)	100
Thonning Owesens Legat	Arne Valberg	10
	Sum	**4 756**

Total external financing in 2003 **38 800**



RESEARCH

DIVISION OF APPLIED PHYSICS AND DIDACTIC PHYSICS

Staff
Professor Berit Kjeldstad
Professor Mikael Lindgren (from 01.08.2003)
Professor Ole J. Løkberg
Professor Hans M. Pedersen
Professor Helge R. Skullerud
Ass. Professor Per Morten Kind
Ass. Professor Jørgen Løvseth
Ass. Professor Tore Løvaas
Ass. Professor Thorarinn Stefansson
Ass. Professor Knut Arne Strand

Professor emeritus Johannes Falnes
Professor II emeritus Reidar Nydal
Professor emeritus R. Svein Sigmond

Overview

The research is mainly carried out within fields of electron and ion physics, energy and environmental physics, optics in addition to physics didactic. These contain several subfields with a large variety of topics. A brief overview is given. For the year 2003 we have chosen to give a more extended description of two research topics: Wind measurements, and Electric discharging.

Survey of research activities

The research is focused on several different topics. Electrical breakdown in fluids and gases (*Løvaas*, *Sigmond*). Transport of ionized gases (*Skullerud*). Research on video holography, and fibre optics interferometry are being performed (*Løkberg*). Signal transmission and processing methods for electromagnetic sea bed logging, coherence theory, and statistical models for the signal processing and speckle statistics in optical coherence tomography (*Pedersen*). A new research group in experimental optics was established from August 2003. The focus of the research will be on laser based spectroscopy (including nonlinear optics) and technical optics (Fourier optics). A unique time-resolved fluorescence spectrometer will be delivered during May 2004 (*Lindgren*). Thermal fluctuations in mixtures of alkanes and in natural gas in gas phase and in condensed phase, as well as on the interface, are studied by laser light scattering. Measurements are performed at reservoir conditions (*Strand*). Renewable energy sources as wind, solar radiation (*Løvseth*) and ocean waves are studied (*Falnes*). Ultraviolet (UV) climatology is studied with emphasis on processes affecting transmission of ultraviolet radiation to the surface, particular the importance of aerosols and clouds. Very low penetration of UV in the Kara Sea was found during a joint Russian cruise in August (*Kjeldstad*). There is research related to educational physics with particular emphasis on the interaction between practical work and the student's perception on the nature of science (*Kind*). Development of a learning model adjusted for the situation how to learn through laboratory work. Educational materials are developed for testing the model (*Stefansson*).

Examples of research carried out in 2003

1. Wind measurements

By Jørgen Løvseth

Figure 1: Wind turbines and NTNU students at Smøla.

The potential of wind energy in Norway is of the same order of magnitude as the present hydropower production (120 TWh/a). A joint utilisation of hydro and wind resources would give Norway a unique possibility to develop a sustainable and economic power supply for export and electrometalurgical industry.

NTNU has operated a wind measurement station located on the western part of the island of Frøya, which protrudes like a wedge into the Norwegian Sea on the coast of Mid Norway. The objective of the measurements is to reveal the structure of the wind field, both for the purpose of wind energy development, and as base for the design of wind exposed constructions in general. Thus the station has provided data for guidelines for offshore constructions on the Norwegian Shelf.

Our measurements have shown that the wind power spectrum for heights above 40 m decreases monotonically from the "weather peak" (periods of 3-5 days) to higher frequencies. The traditional "textbook" assumption is that the turbulence spectrum peaks for periods of the order of one minute, and is clearly separated from the "weather peak" by a minimum in the one-hour region. Convective phenomena over the ocean seem to fill the minimum. A second characteristic property is the low correlation in transverse direction in

the wind field, as indicated by Fig. 2. The blades of a rotating large wind turbine may meet both a minimum and a maximum in the wind field in a single rotation, whereas the one-point spectrum indicate a time difference of the order minutes between extremes. Thus the turbine fatigue load is much larger than the one-point spectrum indicates. NTNU, IFE and SINTEF were awarded a strategic wind energy program 2003-2007 by Norwegian Research Council. One of the projects is to develop "intelligent" wind turbines that adapt themselves dynamically to the wind force during rotation to reduce loading and increase lifetime. Good knowledge of wind structure is a prerequisite for such work.

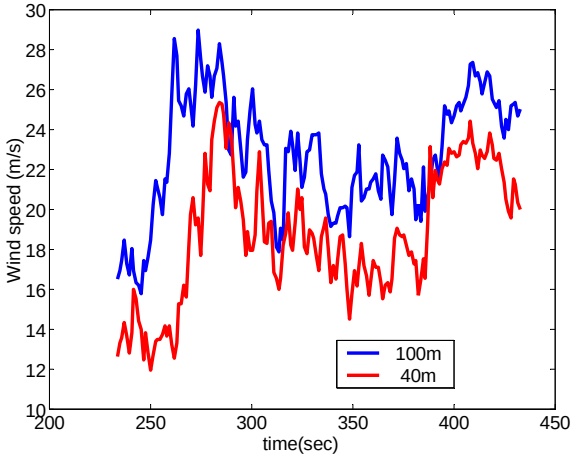


Figure 2: Time series of wind speed at two heights exhibiting delayed and limited correlation.

Precise long-term measurements of wind and thermal conditions are also of interest in relation to climate. The water vapour content of the atmosphere increases by 5-7 % per degree in the region of relevance. Thus increasing temperature gives more energy and dynamics in weather phenomena, deserving direct experimental investigation

2. The aiming of the bolt: How a flashover finds the weak spot

By R. Svein Sigmond

There are many instances in electrical engineering or in nature where spark breakdown channels are launched from high-field electrodes or cloud regions and subsequently approach sensitive objects like power lines. If backed by sufficient voltage such sparks cannot be stopped, and protection must be based on diversion strategies, as in the case of classical lightning protection by Franklin rods. The purpose of our project was to find how a spark from a positive or negative high-voltage electrode or thundercloud locates an object to connect to, or finds a weak spot in a cable insulation

To this end we have used 1-2 m discharge gaps in ambient air between a rod and a horizontal wire suspended 0.25-0.5 m above ground, subjected to fast-rise (1.2 μs) and slow-rise (150 μs) positive and negative impulse voltages, and observed with photomultipliers, streak/framing camera, and open-shutter cameras.

Our main (and original) finding is that an electrically conducting "leader channel" from the rod feels its way by spraying a conical volume in front with low-conductivity "streamer" channels. When these connect to object(s) the leader follows either the direction of the highest streamer density or the most conductive streamer channel (our cameras cannot decide). If the streamers do not connect the influence of the missed object(s) is small.

3. Functional Optical Coherence Tomography (OCT) *By Ole Johan Løkberg and Hans Magne Pedersen (Optics), and Tore Lindmo (Biophysics)*

Optical Coherence Tomography has become a well-established technique for obtaining high-resolution structural images of biological and other semi-transparent materials. In a joint effort of the Optics and Biophysics groups, and in collaboration with SINTEF Materials Technology, we are exploring the potential of OCT imaging of functional properties of materials by Doppler, spectroscopic, and polarisation sensitive OCT techniques.

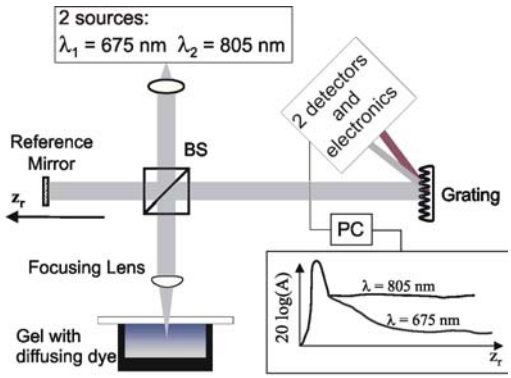


Figure 3. Schematic of the wavelength multiplexed OCT system, including the Michelson interferometer

As an example, we show results of diffusion studies by spectroscopic OCT. The motivation for the study is that the method could be used as a tool for dosimetry in photodynamic therapy (PDT). In PDT the therapeutic light exposure should be applied at a time when the concentration of sensitizer is optimal in the diseased tissue relative to normal tissue. By studying how the OCT signal changes with time and depth at two wavelengths differently affected by the diffusing dye, it should be possible to extract parameters determining diffusion of the sensitizer in live tissue. In comparison with fluorescence-based methods, this OCT approach has the advantage of better depth penetration and being able to account for attenuation effects due to scattering.

As a very simple model of tissue we have used Agar gel. The back-scattering in the gel is strong enough to give an OCT signal well above the noise level but weak enough to allow a simple model for the light propagation and attenuation to be used. The Aluminum Phthalocyanine Tetrasulfonate Chloride dye being used is strongly absorbing at 675 nm and has very low absorption at 805 nm, which is optimal for our experiment.

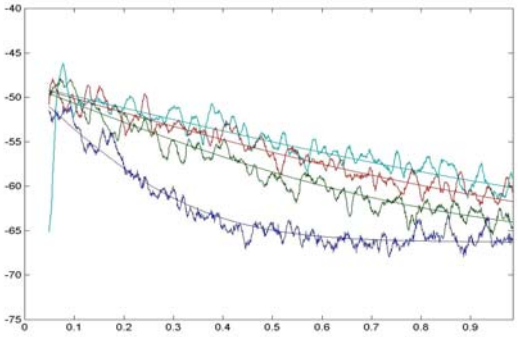


Figure 4. The logarithm of OCT amplitude at 675 nm as a function of depth in mm at four different times, with the smooth lines showing the least squares fitted mathematical model of the measurement. The resulting value for the diffusion constant is $2.9\,10^{-4}$ *mm/s.*

By combining a mathematical model of the OCT signal with a model of the one-dimensional diffusion process, we were able to determine the diffusion constant from a series of OCT measurements taken at different times after application of the dye on top of the Agar gel.

For a certain scattering medium, the diffusion constant is expected to be inversely proportional to the square root of the molecular weight of the diffusing substance. The measurements were in good agreement with such a relationship when comparing with literature values for diffusion of other substances in agar.

We plan to expand the study to more realistic models of tissue, including depth dependent scattering and reflectivity.

DIVISION OF BIOPHYSICS AND MEDICAL TECHNOLOGY

Staff
Professor Catharina de Lange Davies
Professor Anders Johnsson
Professor Tore Lindmo
Professor Thor Bernt Melø
Professor Kalbe Razi Naqvi
Professor Bjørn Torger Stokke
Professor Arne Valberg
Professor II Einar Rofstad
Professor II Arne Skretting
Professor II Tor Wøhni

Guest
Gunnhild Oftedal (Scientist)

Overview

The research is divided in three main activities within biophysics and medical technology: *Biopolymers*: Studies of physical properties and organisation of biological molecules. *Medical technology*: Application of molecular and functional imaging to study properties and distributions of molecules in cells and tissue. *Biosystems*: Studies if various kinds, including biophysics of plants, electromagnetic field exposure, space-related research, photosynthesis, and visual biophysics. A brief overview is given below, and some projects are presented in more details.

Survey of research activities

Transport of macromolecules in tumour tissue
(Catharina de Lange Davies)
The low and heterogeneous uptake of therapeutic macromolecules is a major obstacle to successful cancer therapy. This is partly due to the enhanced interstitial fluid pressure in tumour tissue, which reduces the transvascular convection. We therefore studied if enzymatic degradation of extracellular matrix by collagenase could affect the interstitial fluid pressure and microvascular pressure. Collagenase was found to induce a transient transvascular pressure gradient thereby increasing the uptake of antibodies in tumours.

Functional Optical Coherence Tomography (OCT)
(Tore Lindmo)
OCT is extended from structural to functional imaging. By combining the OCT signal with a mathematical model of the one-dimensional diffusion process, we are able to determine the diffusion of the dye Aluminum Phthalocyanine Tetrasulfonate Chloride placed on the top of an agar gel. The motivation for our work is to be able to measure in vivo concentration profiles during uptake of photosensitizers in photodynamic therapy. For further details see the extended report under Division of Applied and Didactic physics.

Age-related macular degeneration (AMD)
(Arne Valberg)
In our group of 13 subjects with relatively pure AMD, psychophysical measurements showed that spatial chromatic sensitivity was more reduced than luminance sensitivity. An EU-supported concerted action has been continued. In collaboration with the University Hospital we have started to develop methods to analyse the topography of photoreceptor damage by means of multifocal electroretinograms (mfERG) using the VERIS system.

Visual Evoked Potentials (VEPs) to chromatic and achromatic stimulation
(Arne Valberg)
The asymmetry reported last year of potentials recorded at the onset of chromatic gratings with symmetric luminance contrast was further analysed. A neural model has been developed that accounts for the experimental results in terms of a pattern or border response mechanism, mediated by the parvocellular pathway, that is different from the chromatic-contrast detection mechanisms operating al low spatial frequencies.

Biological Polyelectrolyte Complexes
(Bjørn Torger Stokke)
During 2003 focus has been on research within structural organisation and function of biopolymers including mechanism and competitive effects within polyelectrolyte complexation, compaction and multilayers, and single-molecule force spectroscopic studies of protein domain epimerase functionalities towards high molecular weight polysaccharide substrates.

Examples of research carried out in 2003

1. Photo (phys-/chemical) behaviour of vitamin E
By Kalbe Razi Naqvi and Thor Bernt Melø

Despite the disparity in their chemical structures and spectral characteristics, tocopherols and carotenoids are both believed to function as general-purpose antioxidants and photoprotective agents. Whether they become more effective when they act co-jointly, and whether such synergism, if it does come into play, can be ascribed to the ability of one to regenerate the other, are highly topical matters, occupying a great many investigators. While the photophysical and photochemical properties of carotenoids have been thoroughly examined, there was a surprising dearth of similar research on tocopherols. Given the widespread occurrence, in mammalian tissues and in photosynthetic systems, of alpha-tocopherol—the most plentiful and

the most potent of the four tocopherols known collectively as vitamin E—greater familiarity with photophysical properties is sorely needed. Our first experiments, summarized in Box 1, yielded results which surpassed our most sanguine expectations. One-photon ionization of alpha-tocopherol had not been observed earlier; furthermore, the paramagnetic nature and the rather long lifetimes observed imply that the species of Box 1 could be involved in photoprotection.

Box 1

EH : α-tocopherol (vitamin E); **C** : carotenoid

§: polar aprotic solvent; †: lowest triplet

$$^1\mathbf{EH} + h\nu \begin{cases} \longrightarrow {}^3\mathbf{EH}^{\dagger} \xrightarrow{+{}^1\mathbf{C}} {}^1\mathbf{EH} + {}^3\mathbf{C}^{\dagger} \\ \longrightarrow {}^2\mathbf{E}^{\square} \xrightarrow{+{}^1\mathbf{C}} {}^2\mathbf{E}^{\square} + {}^1\mathbf{C} \\ \xrightarrow[\S]{} {}^2\mathbf{EH}^{+\square} \xrightarrow[\S]{+{}^1\mathbf{C}} {}^1\mathbf{EH} + {}^2\mathbf{C}^{+\square} \end{cases}$$

2. Pigment-pigment interactions in a reaction centre

By Kalbe Razi Naqvi and Thor Bernt Melø

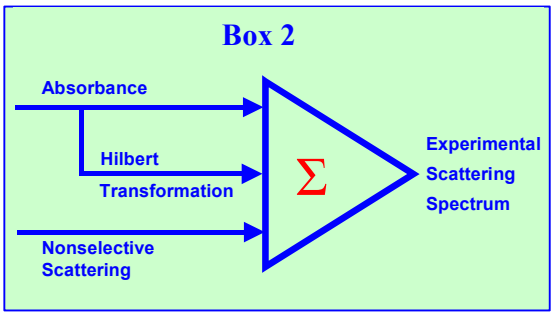
Intimate contacts between pigments are a common feature of the molecular organization in photosynthetic systems. Such contacts and the resulting intermolecular interactions determine the transition probabilities of various radiative and nonradiative processes (for instance, transfer of an electron or energy from one chromophore to another). We have investigated the interaction among neighbouring pigments in the reaction centre of three strains of *Rhodobacter sphaeroides* (wild type, antenna deficient, and carotenoid lacking) by monitoring flash-induced spectral changes in the 350-1000nm region. We succeeded in extracting some new information and in explaining the discrepancy between our results and previously published result.

3. A quantitative description of scattering of light by pigmented cells

By Kalbe Razi Naqvi and Thor Bernt Melø

The optical properties of animal tissues, plant leaves, vegetative canopies, and natural waters are determined to a large extent by the absorption and scattering properties of individual cells and/or pigmented particles. Past attempts at describing the two contributions have amounted to using analytically tractable models, capable of providing a good deal of physical insight, but unable to simulate measured spectra over the spectral range of interest. We have taken a first step towards a quantitative description of the shape of the scattering spectrum; our approach, summarised in Box 2, has met with success in simulating the spectra of many systems (human erythrocytes, chloroplasts and sub-chloroplast particles, algal cells) over a wide spectral range.

Box 2



4. Photoinduced reactions in bacteria

By Anders Johnsson and Thor Bernt Melø

We are currently investigating light reactions in some species of *Propionibacteria*, that are involved in the skin disease acne. When ALA, i.e. d-aminolevulinic acid, or esters thereof, is administered to the bacteria, they take it up and the production of porphyrins is increased. Several porphyrins produced make the bacteria sensitive towards light. The reactions initiated by the light excited porphyrin molecules lead, via several types of reaction sequences, to cell destruction. Free radical production as well as singlet oxygen reactions are involved. The combination of ALA and light treatment (denoted PDT) can therefore be a selective tool for destruction of these bacteria, and thus an alternative to conventional antibiotic destruction – treatment.

We concentrate on the basic reactions necessary to understand when it comes to uptake of the applied substances, the production of porphyrins etc. We also look for optimum light conditions for the excitation of the porphyrins in the bacteria and study the effects of different relevant light sources (broad band light sources, light emitting diodes etc). The wavelength and intensity of the light of course plays a central role for penetration in the cells and absorption in the porphyrins and thus for the cell destruction. Furthermore, the cell destruction is sensitive to pH of cell media, temperature etc., and current studies on the influence of these parameters are now going on. Identification of reactions and reaction products are carried out with the aid of different spectroscopic methods (fluorescence, ESR, MAS-NMR etc). Ultimate goals are to understand the light induced reactions and to optimise a possible clinical treatment of the acne disease. The studies are partly supported by the pharmaceutical industry.

DIVISION OF COMPLEX MATERIALS

Staff
Professor Arnljot Elgsæter
Professor Jon Otto Fossum
Professor Alex Hansen
Professor Arne Mikkelsen
Professor Frode Mo
Professor Steinar Raaen

Guests
Renaud Toussaint (Post doc.)

Overview

The division was established July 1st 2003.

The research is focused on the *Physics of Soft and Complex Material*s including *Biological Physics.* The studied phenomena include: The structure and dynamics of nanostructured surface alloys; Structural phase transitions in ferroic compounds, clay containing systems and biopolymers; Electro-rheological properties and diffusion properties of natural and synthetic clay particles; Folding and conformational dynamics of proteins and other biopolymers; Anomalous diffusion processes; Mechanical properties of rough surfaces; Brittle fracture; Mechanical properties of granular media; Multiphase flow in porous media.

The research comprises the use of experimental methods, computer simulations and theoretical *methods.*

The *home laboratories* of the division contain facilities for: Solid state surfaces in ultrahigh vacuum; Wide- angle x-ray scattering; Static and dynamic light scattering; Light microscopy; Atomic force microscopy; Preparation of soft aqueous samples for transmission electron microscopy; Measurements of static and dynamic viscoelastic properties of soft materials (rheology); Micro- and nano-calorimetry; Thermo-gravimetry; Studies of dynamic electro-optic properties of soft materials; Isolation and purification of nanoparticles including biopolymers. Some members of the section are also regular users of the synchrotron facilities in Grenoble, France and at Sao Paulo, Brazil.

The *computer simulation methods* include Brownian dynamics, Monte Carlo and deterministic particle dynamics methods.

The *theoretical studies* are mainly on Condensed matter physics theory and Statistical physics.

Survey of research activities

Experimental and theoretical studies of biopolymer dynamics and structure
(A. Elgsæter and A. Mikkelsen)
The focus of our research is on the physics of various biopolymer systems. A primary goal here is a deeper understanding of the interplay between functions and structural dynamics. Our work consists of three closely integrated parts: I) Development of the necessary formal theoretical basis for describing the nanoscale dynamics using realistic macromolecule models. II) Development of the required numerical algorithms to carry out numerical Brownian dynamics simulation of macromolecule dynamics. III) Experimental studies of macromolecule dynamics using methods such as static and dynamic light scattering, and electrically induced transient birefringence. Development of new experimental methods and improvement of older techniques make up an important part of our approach.

Synthetic clays; Experimental investigations of soft materials and complex systems
(J. O. Fossum)
The research group has during several years focused on basic understanding of problems within soft materials and complex systems, in particular physical phenomena in soft matter using synthetic silicates (clays) as the physical complex model system. Important experimental methods being used include rheology and light scattering, synchrotron x-ray scattering (at ESRF and other sources) and neutron scattering (mostly at IFE, Kjeller). A significant part of the activity also involves upgrading of instrumentation and experimental methods for soft condensed materials studies and phenomena on the nano-scale. Recent publications see publication list.

Brittle fracture, mechanical properties of granular media, two-phase flow in porous media, econophysics
(A. Hansen)
The main research interests for 2003 have been concentrated on brittle fracture and on two-phase flow in porous media, in addition to granular flow problems. We have also initiated an activity on econophysics. The fracture project is described in detail below. The two-phase flow problems concern the further development of a pore-scale flow simulator which will use lattice Boltzmann techniques to resolve the interface dynamics at junctions where the two phases meet. The granular flow problems are connected to the gravitational motion of charged grains. This is a technologically important problem occurring e.g. in the three-dimensional printing process. We are at present studying certain network topologies using Boltzmann methods. This study goes under the heading of econophysics.

Crystallography methods and instrumentation
(F. Mo)
A gas-flow thermostat sample cell with control of relative humidity was previously designed for diffraction experiments with crystals that are unstable and denature easily upon changes in temperature and/or relative humidity under X-radiation. With this cell, diffraction data of unprecedented quality were collected previously for the high-temperature paraelectric phase of the ferroelectric compound Rochelle salt. In order to suppress the formation of a multidomain state in the ferroelectric crystal, the sample cell is being further developed to include a capacitor that can be rotated with the crystal, allowing a permanent electric DC field to be applied along a fixed crystallographic direction during the experiment.

Electronic properties and chemical reactivity of surface alloys *(S. Raaen)*
Several surface alloys have in recent years been investigated by photoelectron spectroscopy, low energy electron diffraction, and thermal desorption spectroscopy. Of special interest has been alloys based on thin overlayers of rare earth metals on catalytic active transition metals. It has been shown that the electronic structure as well as chemical reactivity may be dramatically altered. Rare earths are ideally suited for formation of surface alloys in view of their relatively low surface free energies. A recent result is that self assembled nano-structured surface alloys form in the La-Rh (100) system. Some progress has recently been made in analyzing temperature programmed desorption data by use of Monte Carlo simulations.

Example of research carried out in 2003

Fracture Morphology
By A. Hansen

In 1984, Mandelbrot et al. published a letter in Nature where they had studied the morphology of fracture surfaces in aluminium. Their conclusion was that the surfaces were *self affine*. That is, when rescaling in-plane lengths by a factor λ and out-of-plane lengths by a factor λ^H, then the fracture surface is statistically unchanged. The exponent H is the *Hurst* or *roughness exponent*. This work led to a branch in materials science that has been pursued since, namely the creation of tables giving the roughness exponent for different materials and fracture mechanisms, so that it would be possible to predict the kind of fracture surface one would expect – and how it would scale. In the figure, we show an entirely artificial surface. The only input parameter is the roughness exponent.

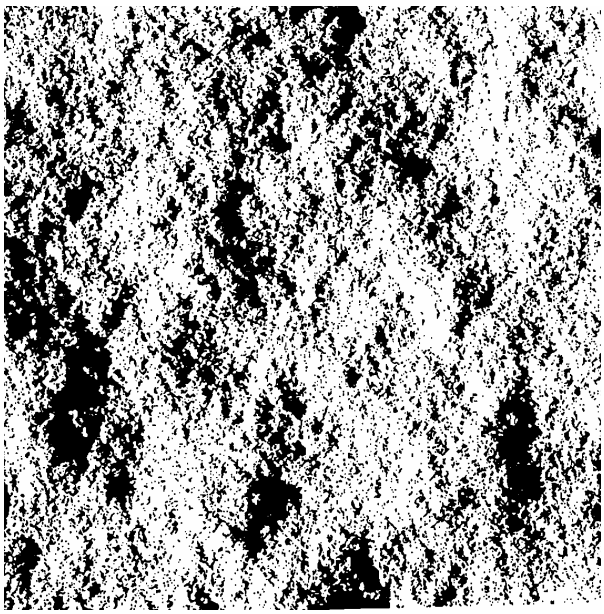


Figure: This is an entirely artificial surface where the only input is the roughness exponent H=0.8.

In 1990, Bouchaud et al. made a very radical proposal: The roughness exponent is *neither* dependent on material nor fracture mechanism: It is universal. This idea can be recon ciliated with the original Mandelbrot proposal of a roughness exponent that depends on material properties when one recognizes that the latter behaviour is found on scales very close to the intrinsic material length scales such as grain size etc, while the former behaviour is found on larger scales. The idea of a universal roughness exponent H, which experimentally was found to be very close to 0.8, was followed up numerically by us in 1991 for so-called fuse systems, and experimentally in 1992, where we studied a large number of very different brittle materials. The question of why this universality and why the value 0.8 remained a complete mystery until 2003 when we published two papers in Physical Review Letters. Here we show that $H=4/5$ in brittle fracture based on a gradient percolation analysis of the damage zone where the final crack appears. Our results are definitely not the entire story – there are clearly regimes where our initial assumptions are not fulfilled, and still the universal value of the roughness exponent is found. Our results are also controversial in that there have been competing theories published. However, these theories have not been able to predict the "magic" 0.8-value. The dust has by no means settled when this is being written. Only the future will reveal who – if any – were "right."

DIVISION OF CONDENSED MATTER PHYSICS

Staff
Professor Anne Borg
Professor Johannes Bremer (deceased)
Professor Kristian Fossheim
Professor Randi Holmestad
Professor Ola Hunderi
Professor Ragnvald Høier (until September)
Professor Emil J. Samuelsen
Ass. professor Bård Tøtdal
Professor II John Walmsley
Professor emeritus Ivar Svare

Guests
Dr. Ali Ata (Post doc.) (until July)
Dr. Ton van Helvoort (Post doc.) (from February)
Dr. Nils Sandberg (Post doc.) (from September)
Dr. Yingda Yu (Post doc. 20%)

Overview

The research activities include a variety of topics in experimental *Condensed Matter Physics*. The members of the division work with many different experimental techniques for studying physical properties of materials and material structures. A brief survey of the research is given. For the year 2003 two research projects are described in more details.

Survey of research activities

Superconductivity in low-T_c and high-T_c superconductors
(K. Fossheim)
One of the most intensely discussed subjects in cuprate high temperature superconductors in recent years is the so-called T*-line in the phase diagram for T vs. doping. Indications have been found that Cooper pairs exist between the T*-line and the T_c–line. Connected with this is the observation of a pseudo-gap in the same region.

Measurements of magnetic susceptibility in single crystal $La_{2-x}Sr_xCuO_4$ were carried out. They revealed, in addition to the usual negative susceptibility below T_c, a strong diamagnetic response in a temperature range of up to 3 degrees above T_c when very low ac probing fields were used. The observations were made in a range up to 10 kHz, and the negative susceptibility persisted in magnetic fields up to about 0.5T for both fields along the c-axis. Furthermore, the onset temperature of the diamagnetic anomaly, which was interpreted as T*, was found to be associated with a specific heat step of mean field type (BCS-like), while at T_c a very pronounced critical behaviour was observed. The two anomalies found in our work are interpreted as being associated with T*.

In a study of low- T_c superconductivity, the magnetic properties of very thin lead films were investigated theoretically and experimentally. We refer to a separate item below regarding this work.

Transmission electron microscopy (TEM)
(R. Holmestad, B. Tøtdal, J.Walmsley)
The activity of the research group includes nanoscale structure studies within materials physics and the connection to the macroscopic properties. In 2003 projects have included:

- Micro/nano structure studies of functional perovskite materials, ferroelastic sintered materials, ferroelectric thin films
- Materials for hydrogen storage (alanates)
- Bonding in materials studied by convergent beam electron diffraction (CBED),
- Analysis of alloy nanoparticles in catalysts,
- Alloy development, nucleation of precipitates in aluminium alloys; structure determination of metastable, hardening phases
- Atomistic modelling and *ab initio* methods in materials science
- Surface studies of light metals; nanoscale oxide layers, and corrosion behaviour.

The new field emission gun transmission electron microscope (FEG-TEM) offers a small probe and new possibilities of energy filtering, spectroscopic imaging and X-ray mapping from miniscule regions. The group runs a strategical university program (SUP) 'Nano- and micro-structure based materials development' and is strongly involved in the competence project (KMB) ’Heat treatments fundamentals’ on aluminium alloys.

Optical studies of interface dielectric anisotropy
(*O. Hunderi)*
This is one of the first successful direct studies of the interface anisotropy between two semiconductors, a quantity of importance in semi-conductor hetero-structures. In the present work reflectance anisotropy spectroscopy (RAS/RDS) was applied to the GaAs-AlAs (001) interface for measuring the interface dielectric anisotropy (IDA) by in-situ experiments performed in molecular beam epitaxy (MBE). For very thin AlAs overlayers (1-40 monolayers) on GaAs (001) the contribution of surface, bulk and interface were separated. For the analysis a three-layer model was used consisting of a single AlAs layer sandwiched between a well separated and anisotropic interface and surface layer. The upper limit for the ‘thickness’ of the surface and interface layers could be determined. An improved analytical formula for the deconvolution of surface and interface anisotropies was derived.

Optical and magnetooptical properties of substituted iron garnet films

(A. Borg and O. Hunderi)

We have studied a series of approximately 4 μm thick Bi:ferrimagnetic garnets films grown by liquid phase epitaxy on (100) oriented gallium gadolinium garnet substrates. The films have in-plane magnetization and were grown for magnetic-field imaging purposes. From variable angle spectroscopic ellipsometry and magnetooptical Kerr effect measurements on magnetically saturated films, we have determined the diagonal and off-diagonal permittivity tensor elements of the garnet films in the range 1.5-5eV. The spectral behaviour of the off-diagonal tensor elements have been interpreted in terms of electric dipole transitions and related to the composition of the samples.

Furthermore, optical second harmonic generation (SHG) of purely magnetic origin has been observed in these films. When studied in transmission at normal incidence all relevant elements of the crystallographic second order susceptibility tensor vanish identically, while a magnetisation induced contribution to the second order non-linear remains. We have demonstrated that the observed rotational anisotropy SHG signal in a transverse magnetic field is of purely magnetic origin, and that it can be switched off by applying a longitudinal magnetic field. This all fits well with predictions of electromagnetic theory.

Scanning tunneling microscopy studies and DFT calculations of surfaces

(A. Borg)

Progress has been made in the effort on using the tip in a scanning tunneling microscope (STM) to etch nanoscale structures in perovskite materials. A threshold voltage between 2.2 and 2.5 V has been established for the formation of holes in $SrRuO_3$ at ambient conditions. Optimal etching conditions for $SrRuO_3$ have been determined to be a bias voltage of 2.8 V and tunneling current below 100 pA. Structures 5-10 nm wide and up to 5 nm deep are routinely obtained.

As part of the research project “Light metal surface science”, adsorption of methanol on the surface of α-Al_2O_3 has been investigated using density functional theory. CH_3OH is found to bind to Al-atoms on the surface with a binding energy varying from 1.22 eV (0.25 monolayers) to 1.03 eV (1 monolayer) The adsorption of CH_3OH changes the surface structure. Most pronounced is that the Al atom is pulled out from its stable position of the clean surface when interacting with CH_3OH. The bond length between the Al atom and the O atom in the adsorbed CH_3OH is shorter at low coverage, 1.929 Å at 0.25 monolayers, than at higher coverages, 1.995 Å at 1 monolayer.

Polymer and molecular organic semiconductors

(*E. J. Samuelsen)*

The research has focussed on self-assembling of organic semiconducting polymers when deposited as thin films and micro-fibres. The grazing incidence diffraction and reflectometry studies by synchrotron radiation (at the ESRF) of ultrathin layers floating on water have been the subject of detailed analysis and interpretation. Films consisting of only five molecular layers were shown to exist, with an appreciable degree of crystalline order, which, however, declines from the air-polymer interface to the polymer-water interface. In situ doping could be achieved by injecting $NOPF_6$ acetonitrile solution into the water subphase, showing colour change and lattice parameter expansion. Here I add some words Preliminary attempts were performed of electro spinning of polythiophene fibres.

The diffractometer LØFTE has been fully computer-programmed. An international tender process has been carried through on a small-angle installation (SAXS) at the rotationg anode x-ray generator.

Examples of research carried out in 2003

1. Magnetic properties of thin superconducting films of lead

By Ulrik Thisted and Kristian Fossheim

The critical magnetic field H_c is greatly enhanced in thin films compared to bulk samples when the magnetic field is directed parallel to the film. This effect was first explained by Vitaly Ginzburg and Lev Landau in their famous work from 1950 for which Ginzburg was awarded the Nobel prize in physics in 2003. The theory predicts that the critical magnetic field for very thin films should be inversely proportional to the thickness. An assumption was made, however, that the local density of superconducting electrons (Cooper-pairs) is constant across the thickness of the film.

We have performed similar type of calculations, but without such assumption. Using the theory of Ginzburg and Landau we were able to calculate the variations of the Cooper-pair density and the magnetic induction in the films. The conclusion is that in spite of these variations the critical magnetic field is still inversely proportional to the thickness for thin films.

By a standard vapour deposition technique thin films of lead with thickness between 10 and 80 nm were fabricated. Upon cooling to below the superconducting temperature (7.2 K), their response to a small oscillating magnetic field was measured. This allowed a determination of the critical magnetic field of the films. The experiments confirmed the theoretical finding that the critical field increases inversely proportional to the thickness, even when the Cooper-pair density varies across the film.

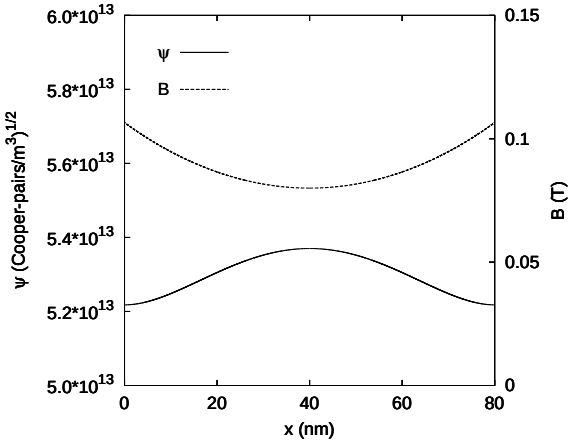


Figure 1. An example of numerical results showing the variation of magnetic induction and Cooper-pair density in a film with a thickness of 80 nm.

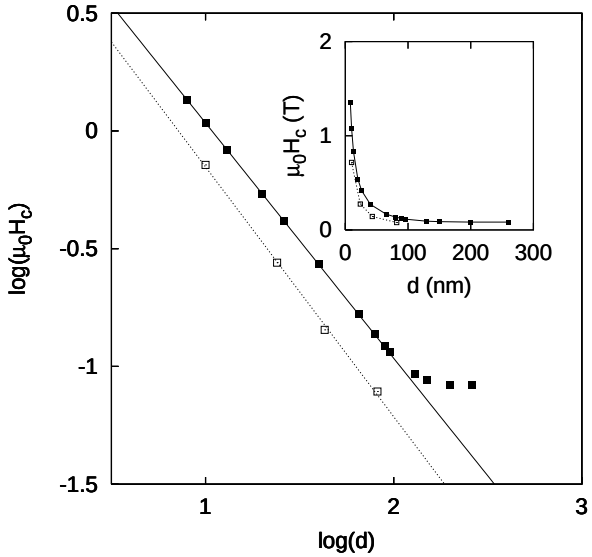


Figure 2: Log-log plot of the critical field H_c vs. film thickness for numerical (filled squares) and experimental work (open squares). Both curves show a linear dependence for small thickness with slope -1. Insert: Linear plot of the critical field vs. film thickness.

Another result of the numerical calculations is the prediction that for films thinner than a limiting thickness d_c the magnetically induced phase transition is of second order, as opposed to a first order transition in bulk material. For lead d_c was found to be 91 nm at zero temperature and to be somewhat temperature dependent.

2. Existence of non-nuclear maximum in simple hcp metals Be and Mg

By J. Friis, K. Marthinsen and R. Holmestad

Non-nuclear maximum (in the meaning of 'off-nuclear') in the charge density is an exotic electron accumulation in the space between the atoms. The possible existence of this effect in simple hexagonal closed packed (hcp) metals has recently been subject to discussions. At normal pressures, this is a very weak feature which is experimentally difficult to detect. In this study we have used convergent beam electron diffraction (CBED) to very accurately measure the low order Fourier coefficients of the charge density in Mg. In this method the electron beam in a transmission electron microscope is focused onto a perfect crystalline region of the sample, a few nanometer in diameter. A resulting diffraction pattern is shown in Figure 3. Because of the finite range of incident beam angles, the diffraction spots are broadening to discs. The low order Fourier coefficients are determined by adjusting the parameters in a Bloch-wave simulation of the CBED patterns until a perfect match is obtained between theory and experiment. The measured low order Fourier coefficients have been compared to density functional theory, trying nine different functionals. It was found that the functional based on the self-interaction corrected local density approximation best describes the valence charge density observed in Magnesium. Figure 4 shows the total charge density calculated with this functional, in the basal plane of Be and Mg.

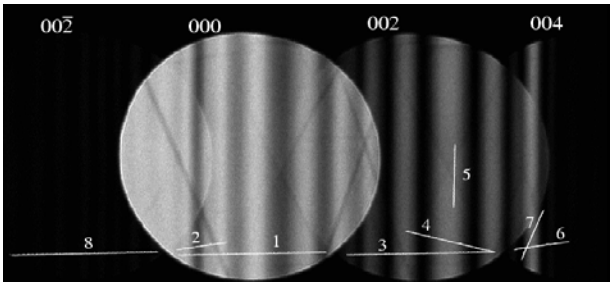


Figure 3. CBED pattern from Magnesium. Each point inside a disc corresponds to one incident beam angle.

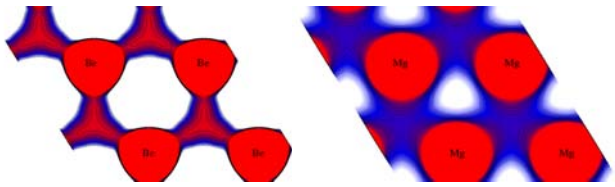


Figure 4: Charge density in the basal plane of Be and Mg calculated from the model in closest agreement with experimental observations. Increasing charge density goes as white □ blue □ red.

A maximum in the charge density is seen for Be, but not for Mg, in the center of the bipyramidal space where atoms lie directly above and below the basal plane. It should be noted that the off-nuclear maximum found in Be is very weak and cannot be obtained by simple inverse Fourier transformation of the measured Fourier coefficients.

DIVISION OF THEORETICAL PHYSICS

Staff
Professor Arne Brataas
Professor Eivind Hiis Hauge (University rector)
Professor Per Chr. Hemmer (until June)
Professor Johan S. Høye
Professor Hans Kolbenstvedt
Professor Kjell Mork
Professor Jan Myrheim
Professor Kåre Olaussen (Sabbatical from August)
Professor Bo-Sture Skagerstam
Professor Asle Sudbø
Ass. Professor Sigmund Waldenstrøm
Ass. Professor Ingjald Øverbø
Ass. Professor Jon Andreas Støvneng
Professor II Roger Sollie

Professor emeritus Per Chr. Hemmer (from June)
Professor emeritus Haakon A. Olsen

Guests
Dr. T. Øvergård (Scientist)
Dr. D. Østvang (Scientist)

Overview

Research is mainly carried out within the broad fields of *Condensed Matter Physics*, *Statistical Physics*, and *Quantum Physics*. These contain several subfields with a large variety of topics for research. A brief overview is given. For the year 2003 we have chosen to give a more extended description of two research topics

Survey of research activities

Investigations of phase transitions in colloid mixtures are continued (*P. C. Hemmer*). The SCOZA (self-consistent Ornstein-Zernike approximation) has been used to study polymers on a lattice. In this connection an investigation of the role of repulsive forces (hard cores) between polymers has been initiated. (*J. S. Høye*). Ionic fluids where the Debye-Hückel theory has been generalized to molecules with extended charges is further studied (*J.S. Høye*). The thermal behaviour of the Casimir force between metallic surfaces has been studied (*J. S. Høye*).

Quantum transport in nanostructures and spin injection and spin dynamics in normal metals, semiconductors and superconductors are considered. We published eight articles during the year, of which two articles in Physical Review Letters (*A. Brataas et al*). Research activities focus on effective gauge theories of strongly correlated systems in 2+1 dimensions (two spatial dimensions at zero temperature), in order to study novel quantum critical phenomena in such systems. Another research effort focuses on spin and charge flow in hybrid structures of unconventional superconductor heterostructures (*A. Sudbø*). Matter at high density in strong magnetic fields (neutron stars) is studied (*J. Myrheim*).

We have studied entanglement in the ground state of a class of models defined by quadratic Hamiltonians. These are finite-size approximations of a corresponding class of quantum field theories. The study of entanglement properties appears to be an efficient way to localize regions of quantum criticality in models in 1+1 dimensional space-time. This is achieved by looking for the known signature of conformal invariance in such regions (*K. Olaussen*). The electromagnetic properties of massive neutrinos, and the possibility of observable electromagnetic interactions with such neutrinos have been investigated (*K. Olaussen*).

On request from the Editors-in-Chief of *Radiation Physics and Chemistry* (RPC) a contribution to a special issue on the subject of Pair Production Processes and Applications has been prepared. The topic of this contribution is Relativistic Positronium Production and Positronium Particle Physics, a field to which the author made pioneering contributions (*H. A. Olsen*).

The energy-momentum tensor of a relativistic and thermalized electron-positron gas in a homogeneous external magnetic field has been studied in detail including vacuum polarization effects which are dominant for sufficiently large magnetic fields. The work will be submitted for publication (*B.-S. Skagerstam*). Various aspects of the notion of a quantum phase operator have been studied. Quantum mechanical post selection constraints have been incorporated when comparing with actual experimental results (*B.-S. Skagerstam*). The Jaynes-Cummings (JC) model provides in some cases for a quantum-mechanical description of the basic physical unit of a quantum computer. A two-level system (the qubit system) is then coupled to e.g. a resonant second-quantized radiation field (the reservoir). It has recently been argued that a realization of a qubit in terms of a superconducting Josephson junction coupled to a suitable resonator is naturally described in terms of such a JC model. In such a model state preparation can be studied in a dynamical manner. We have found that, under experimental feasible conditions, a general mixed qubit state can be purified at the cost of transferring entropy to the reservoir (*B.-S. Skagerstam*).

Temporal evolution and revival features of wave packets for some simple systems have been studied (*S. Waldenstrøm, K. Razi Naqvi, K. J. Mork).* Quantum chemical modeling based on density functional theory, related to polymerization and catalysis (*J. A. Støvneng).*

Examples of research carried out in 2003

1. Thermal behaviour of the Casimir force

By J. S. Høye

More than 50 years ago it was shown by Casimir that as a consequence of the quantization of the electromagnetic field there should be an attractive force between a pair of neutral parallel metal plates. The basis for this force was the influence upon the eigenfrequencies of the electromagnetic field from the boundary conditions enforced by metal surfaces. As this influence depends upon the separation of the plates there will be a corresponding variation in (free) energy leading to an attractive force that was verified experimentally.

Together with I. Brevik (Department of Energy and Process Engineering) we have earlier evaluated the Casimir force in an alternative way using methods of statistical mechanics of systems consisting of polarizable particles on the molecular level developed earlier by one of us together with Professor G. Stell (USA). Methods of classical statistical mechanics are then extended to the quantum mechanical regime using the Feynman path integral representation.

The controversy with metallic plates is the temperature dependence of the Casimir free energy and thus the Casimir force. Contributions to the free energy come from separate TM (transverse magnetic) and TE (transverse electric) modes. In the ideal metal limit they contribute the same. The controversy, however, comes from the zero frequency TE mode. Taking the zero frequency limit the TE mode and TM mode contribute the same. But taking the metal limit first, i. e. letting the dielectric constant approach infinity, the TE mode remains absent for zero frequency. The difference in these two viewpoints means for the free energy a term linear in temperature which by differentiation means a non-zero difference in entropy. Thus one of the viewpoints must violate thermodynamics as entropy should be zero at temperature $T=0$ (Nernst theorem). For metals inclusion of the zero frequency TE mode gives apparently a well-behaved result, and it was considered to be the correct one by a majority of people working in the field.

However, we and other groups have put this conclusion into question. By our statistical mechanical derivation we find there can no zero frequency TE mode as there is no such solution of Maxwells equations and thus no such dipolar pair interaction. Then using a more realistic dispersion relation (Drude model) for the dielectric constant of a metal, our analysis shows that the problems with the linear term will vanish. However, now the Casimir free energy (and also the force) will decrease with increasing temperature (but will increase at even higher temperatures). This seems counterintuitive in view of increasing thermal fluctuations. To shed light upon this situation we have considered a simpler system where such behavior is present, but not violating thermodynamics. Experiments to possibly measure the influence of temperature upon the Casimir force and thus settle the dispute, have been performed. However, due to the high accuracy required the question is so far not settled.

2. Quantum mechanical spin and charge-transport in nanostructures and mesoscopic structures

By A. Sudbø

An understanding of the interplay between spin- and charge transport in nano-scale and micro-scale is of great importance to meet the technological challenges one is faced with in electronic technology today, where miniatyrization, increase of number of Gbytes per unit area of storage medium, increase in number of active elements per unit area, and challenges regarding readout, are central key words. In addition, such understanding is of importance from the standpoint of fundamental physics, since it is now possible to design and manufacture extremely well-defined and well-characterised systems that can be used as laboratories for studying new types of charge- and spin-dynamics, for instance in nano-scale heterostructures of superconductors / feromagnetic metals/semiconductors.

Current projects include computations based on tunneling Hamiltonian, Kubo-formula, and Keldysh-formalism, analytical and numerical, of the interplay between spin- and charge transport in the one- and two-particle channels between heterostructures consisting of **PSC:** unconventional, superconductors of p-wave type, i.e. where Cooper-pairs form spin-triplets as opposed to spin-singlets. Such superconductors have the feature that superconducticvity can coexist alongside with ferromagnetism, opening new vistas for novel effects.

F: ferromagnetic metals
N: Paramagnetic metals

Heterostructures under consideration include PSC1-PSC2, PSC-F-PSC, PSC-N-PSC, F-N-PSC. Such systems in principle can include novel phenomena like for instance the *spin-Josephson effect (*PSC1-PSC2). The charge-Josephson effect is the phenomenon that a DC current can flow between two superconductors in the absence of any applied potential. The spin-Josephson is the effect that one has a spontaneous spin-current in the Josephson channel. It is of great current interest to identify precisely under what conditions and in what materials such an effect can exist. Novel AC and DC effects have been found, which are sensitive to the spin-texture of the superconducting order parameter on either side of the tunneling junction, effects which have no counterpart in conventional superconductors.

PUBLICATIONS IN REFEREED JOURNALS AND BOOKS

Aasprong, Einar; Smidsrød, Olav; Stokke, Bjørn T.: *Scleroglucan gelation by in situ neutralization of the alkaline solution.*Biomacromolecules 4: 914-921. 2003.

Andrei, Carmen; Yu, Yingda; Walmsley, J.C.; Brinks, Henrik; Hauback, Bjørn; Holmestad, Randi: *Electron microscopy studies of TbNiAl compound processed by the HDDR route.* Journal of Alloys and Compounds 356-357: 658-663. 2003.

Auradou, Harold; Måløy, Knut Jørgen; Hansen, Alex; Schmittbuhl, Jean: *Drainage in rough gouge-filled fractures.* Transport in Porous Media, 50, 267-305 (2003).

Bakk, Audun; Høye, Johan S.: *One-dimensional Ising model applied to protein folding.* Physica A: Statistical Mechanics and its Applications 323: 504-518. 2003.

Bakke, Jan Ø. H; Bjelland, Johannes, Ramstad, Thomas, Stranden, Torun, Hansen, Alex; Schmittbuhl, Jean: *Roughness of brittle fractures as a correlated percolation problem*. Phys. Script. T 106, 65, 2003

Batrouni, G. George; Hansen, Alex; Schmittbuhl, Jean*: In-plane roughness of brittle cracks*, Int. J. Modern Physics, B, 17, 5631, 2003.

Bauer, Gerrit E. W.; Tserkovnyak, Yaroslav; Huertas-Hernando, D.; Brataas, Arne: *From Digital to Analogue Magnetoelectronics: Theory of Transport in Non-collinear Magnetic Nano-structures.* B. Kramer (ed.). Adv. i Solid State Physics 43: 383-387. 2003.

Bauer, Gerrit E. W.; Brataas, Arne; Tserkovnyak, Yaroslav; van Wees, B. J.: *Spin-torque Transistor*. Appl. Phys. Lett. 83: 1584-1586. 2003.

Bauer, Gerrit E. W.; Tserkovnyak, Yaroslav; Huertas-Hernando, D.; Brataas, Arne: *Universal Angular Magnetoresistance and Spin torque in Ferromagnetic/Normal Metal Hybrids*. Phys. Rev. B 67: 224403-1-224403-4. 2003.

Brataas, Arne; Zarand, Gergely; Tserkovnyak, Yaroslav; Bauer, Gerrit E.W.: *Magnetoelectronic Spin Echo*. Phys. Rev. Lett. 91: 166601-1-166601-4. 2003.

Breiby, Dag W.; Samuelsen, Emil J.; Konovalov, Oleg; Struth, Bernd: *Drying behaviour of thick poly(octylthiophene) solutions*. Synthetic Metals 135-136: 345-346. 2003.

Breiby, Dag W.; Sato, Shuichi; Mizoguchi, Kenji; Samuelsen, Emil J.: *Electron Spin Resonance Studies of Anisotropy in Semiconducting Polymeric Films*. J. Polymer Science: Part B: Polymer Physics 41: 3011-3025. 2003.

Breiby, Dag W.; Samuelsen, Emil J.: *Quantification of Preferential Orientation in Conjugated Polymers Using X-ray Diffraction*. Journal of Polymer Science: Part B: Polymer Physics 41: 2375-2393. 2003.

Breiby, Dag W.; Samuelsen, Emil J.; Konovalov, Oleg; Struth, Bernd: *Self-organization in nanoscopic poly (alkylthiophene) films on water*. Synthetic Metals 135-136: 363-364. 2003.

Breiby, Dag W.; Samuelsen, Emil J.; Groenendaal, L. Bert; Struth, Bernd: *Smectic Structure in Electrochemically Prepared Poly (3,4-ethylene-dioxythiophene) Films*. Journal of Polymer Science: Part B: Polymer Physics 41: 945-952. 2003.

Breiby, Dag W.; Samuelsen, Emil J.; Konovalov, Oleg: *The drying behaviour of conjugated polymer solutions.* Synthetic Metals 139: 361-369. 2003.

Dobler, Wolfgang; Haugen, Nils Erland Leinebø; Yousef, Tarek; Brandenburg, Axel: *Bottleneck effect in three-dimensional turbulence simulations*. Physical Review E 68: 026304-1-026304-8. 2003.

Draget, Kurt I.; Stokke, Bjørn T.; Yuguchi, Yoshiaki; Urakawa, Hiroshi; Kajiwara, Kanji: *Small-angle X-ray scattering and rheological characterization of alginate gels*. 3. Alginic acid gels. Biomacromolecules 4: 1661-1668. 2003.

Falnes, J. (co-editor): *Wave Energy Conversion.* ISBN 0-08-044212-9. Elsevier Science Ltd., 2003

Friis, Jesper; Madsen, Georg; Larsen, Finn Krebs; Jiang, Bin; Marthinsen, Knut; Holmestad, Randi: *Magnesium: Comparison of density functional theory calculations with electron and x-ray diffraction experiments.* Journal of chemical physics 119(21): 11359-11366. 2003.

Friis, Jesper; Jiang, Bin; Spence, John; Holmestad, Randi: *Quantitative Convergent Beam Electron Diffraction Measurements of Low-Order Structure Factors in Copper*. Microscopy and Microanalysis 9: 379-389. 2003.

Frøseth, Anders; Høier, Rangvald; Derlet, Peter; Marioara, C.D.; Andersen, S.J.: *Bonding in MgSi and Al-Mg-Si compounds relevant to Al-Mg-Si alloys*. Physical Review B 2003.

Frøseth, Anders; Holmestad, Randi; Derlet, Peter; Marthinsen, Knut: *Improved tight binding parametrization for the simulation of stacking faults in Aluminium*. Physical Review B 68(1): 0121005-1-012105-4. 2003.

Frøseth, Anders; Holmestad, Randi; Derlet, Peter; Marthinsen, Knut: *Improved tight-binding parametrization for the simulation of stacking faults in aluminum*. Physical Review B 68: 2003.

Hassan, T. H.; Naqvi, Kalbe Razi; El-Wakil, S. A.; Abulwafa, E. M.: *Transient radiative heat transfer through thin films using Laguerre-Galerkin method*. J. Phys. D: Appl.Phys. 36: 3014-3026. 2003.

Haugen, Nils Erland Leinebø; Brandenburg, Axel; Dobler, Wolfgang: *Is nonhelical hydromagnetic turbulence peaked at small scales*? The Astro-physical Journal 597: L141-L144. 2003.

Heinrich, Bret; Tserkovnyak, Yaroslav; Woltersdorf, G.; Brataas, Arne; Urban, R.; Bauer, Gerrit E. W.: *Dynamic Exchange Coupling in Magnetic Bilayers*. Phys. Rev. Lett. 90: 187601-1-187601-4. 2003.

Hove, Joakim; Sudbø, Asle: *Criticality versus q in the (2+1)-dimensional Zq clock model*. Physical Review E 68(046107): 2003.

Høye, Johan S.; Lee, Chi-Lun; Stell, George: *A Self-consistent Study on Lattice Polymers Using Correlation Function Theory*. Molecular Simulations 29: 729. 2003.

Høye, Johan S.; Raineri, Fernando O.; Stell, George; Rooth, Jennifer: *Debye-Hückel theory for charged aligned needles and for polyeletric solutions*. Journal of Statistical Physics 101: 835-860. 2003.

Høye, Johan S.; Brevik, Iver; Aarseth, Jan Bjarte; Milton, Kimball A.: *Does the transverse electric zero mode contribute to the Casimir effect for a metal*? Physical Review E 67: 056116. 2003.

Jiang, Bin; Zuo, Jian Min; Friis, Jesper; Spence, John: *On the Consistency of QCBED Structure Factor Measurements for TiO2 (Rutile)*. Microscopy and Microanalysis 9: 457-467. 2003.

Johansen, Yngve; Widerøe, Hege; Krane, Jostein; Johnsson, Anders: *Proton magic angle spinning NMR reveals new features in photodynamically treated bacteria*. Z. Naturforsch. 58c: 401-407. 2003.

Juel, Mari; Raaen, Steinar: *Thermal desorption of CO from Mo(110)*. Philsophical Magazine 83(21): 2475-2486. 2003.

Karlsdottir, Ragnheidur; Stefansson, Thorarinn: *Predicting performance in primary school subjects*. Perceptual and Motor Skills 97: 1058-1060. 2003.

Kjeldstad, Berit; Thorseth, Trond Morten: *Ground-based ultraviolet radiation - measurements in Trondheim*. Proceedings of SPIE, Ultraviolet Ground- and Space-based measurements, models and effects III. Editors: J.Slusser, J.Herman, W.Gao 5156: 101-107. 2003.

Kjeldstad, Berit; Erga, Svein Rune; Frette, Øyvind; Browmann, Howard; Kuhn, Penny; Stamnes, Jakob: *UV (280 to 400 nm) optical properties in a Norwegian fjord system and an intercomparison of underwater radiometers*. Marine Ecology progress series 256: 1-11. 2003.

Kovalev, A. A.; Bauer, Gerrit E. W.; Brataas, Arne: *Magnetovibrational Coupling in small Cantilevers*. Appl. Phys. Lett. 83: 1584-1586. 2003.

Maurstad, Gjertrud; Danielsen, Signe; Stokke, Bjørn T.: *Analysis of compacted semiflexible polyanions visualized by AFM: Influence of chain stiffness on morphologies of polyel*. Journal of Physical Chemistry B 17: 8172-8180. 2003.

Måløy, Knut Jørgen; Schmittbuhl, Jean; Hansen, Alex; Batrouni, G. George*: Scaling and dynamics of an interfacial crack front*, Int. J. Fracture, 121, 9, 2003.

M. V. B. T.; Mello, M. A.; Hansen, Alex; Batrouni, G. George: *Comment on dynamical foundation of nonextensive statistical mechanics*. Phys. Rev. Lett. 90, 218901, 2003

Naqvi, Kalbe Razi; Melø, Thor Bernt; Sliwka, Hans-Richard; Mohamad, Samsun B. B.; Partali, Vassilia: *Photochemical and photophysical behaviour of vitamin E: interaction of its long-lived transient photoproducts with carotenoids*. Photochemical & Photobiological Sciences 2: 381-385. 2003.

Olsen, H. A.: *Differential Bremsstrahlung and pair production cross sections at high energies.* Physical Rev. 68D, 033008 (2003)

Prytz, Gunnar; Futsæther, Cecilia; Johnsson, Anders: *Self-sustained oscillations in plant water regulation*: Induction of bifurcations and anomalous rhythmicity. New Phytologist 158(2): 259-267.2003.

Prytz, Gunnar; Futsæther, Cecilia; Johnsson, Anders: *Thermography studies of the spatial and temporal variability in stomatal conductance of Avena leaves during stable and oscillatory transpiration*. New Phytologist 158(2): 249-258. 2003.

Schmittbuhl, Jean; Hansen, Alex; Batrouni, G. George: *Roughness of interfacial cracks fronts: Stress-weighted percolation in the damage zone*. Phys. Rev. Lett. 90, 045505, 2003

Serpa, Carlos; Arnaut, Luis; Formosinho, S. J.; Naqvi, Kalbe Razi: *Calculation of triplet-triplet energy transfer rates from emission and absorption spectra. The quenching of hemicarcerated triplet biacetyl by aromatic hydrocarbons.* Photochemical & Photobiological Sciences 2: 616-623. 2003.

Sharma, V; Bardal, Tom Kristian; Johnsson, Anders: *Light-dependent changes in the leaflet movements rhythm of the plant* Desmodium gyrans. Z. Naturforschung 58c: 81-86. 2003.

Sigmond, Reidar Svein: *Comments on "The stepped nature of lightning, and the upward connecting streamer*" by R Morrow and T R Blackburn. J. Phys. D.: Applied Physics 36: 414-415. 2003.

Sikorski, Pawel; Atkins, Edward D T; Serpell, Louise C.: *Structure and texture of fibrous crystals formed by Alzheimer's Abeta (11-25) peptide fragment*. Structure 11: 915-926. 2003.

Sletmoen, Marit; Maurstad, Gjertrud; Sikorski, Pawel; Paulsen, Berit Smestad; Stokke, Bjørn T.: *Characterisation of bacterial polysaccharides: Steps towards single-molecular studies*. Carbohydrate Research 23: 2459-2475. 2003.

Smiseth, Jo; Smørgrav, Eivind; Sudbø, Asle; Nogueira, Flavio S.: *Phase structure of (2+1)-dimensional compact lattice gauge theories and the transition from Mott insulator to fractionalized insulator*. Physical Review B67 (205104): 2003.

Stefansson, Thorarinn; Karlsdottir, Ragnheidur: *Formative evaluation of handwriting quality*. Perceptual and Motor Skills 97: 1231-1264. 2003.

Støren, Trude; Løkberg, Ole Johan; Lindmo, Tore; Svaasand, Lars; Røyset, Arne; Simonsen, Annette: *Measurement of dye diffusion in agar gel by use of low-coherence interferometry*. Optics Letters 28(14): 1215-1217. 2003.

Sudbø, Asle; Nogueira, Flavio S.; Kleinert, Hagen: *Kosterlitz-Thouless like deconfinement mechanism in the (2+1)-dimensional Abelain Higgs model*. Nuclear Physics B 666: 361-395. 2003.

Sudbø, Asle; Nogueira, Flavio S.; Hove, Joakim; Smørgrav, Eivind; Smiseth, Jo: *Phase Structure of d=2+1 Compact Lattice Gauge Theories and the Transition from Mott Insulator to Fractionalized Insulator*. Physical Review B 67(205104): 2003.

Thisted, Ulrik; Nyhus, Jørgen; Suzuki, T; Hori, J; Fossheim, Kristian: *Strong diamagnetic response and specific heat anomaly above Tc in underdoped La2-xSrxCuO4*. Physical Review B 67: 184510-1-184510-5. 2003.

Tserkovnyak, Yaroslav; Brataas, Arne; Bauer, Gerrit E. W.: *Dynamic Exchange Coupling and Gilbert Damping in Magnetic Multilayers* (invited). J. Appl. Phys. 93: 7354-7362. 2003.

Tserkovnyak, Yaroslav; Brataas, Arne; Bauer, Gerrit E. W.: *Dynamic Stiffness of Spin Valves.* Phys. Rev. B 67: 94421-1-094421-4. 2003.

Valberg, Arne; Fosse, Per: *Contrast sensitivity and reading in subjects with age-related macular degeneration*. Visual Impairment Research 3: 111-124. 2003.

Van Beurden, P.; Bunnik, B. S.; Kramer, G. J.; Borg, Anne: *Mechanism and Dynamics of the CO-Induced Lifting of the Pt(100) Surface Reconstruction*. Physical Review Letters 90(6): 066106-1-066106-4. 2003.

Waldenstrøm, Sigmund; Naqvi, Kalbe Razi; Mork, Kjell J.: *The Force Exerted by the Walls of an Infinite Square Well on a Wave Packet: Ehrenfest Theorem, Revivals and Fractional Revivals.* Physica Scripta 68(1): 45-53. 2003.

Zarand, Gergely; Brataas, Arne; Goldhaber-Gordon, David: *Kondo effect and spin filtering in triangular artificial atoms*. Solid State. Commun. 126: 463-466. 2003.

Ådland, Hans Magne; Mikkelsen, Arne: *Rotational diffusion of two-segmented macromolecules with a ball-socket joint*: *A kinetic theory approach.* Journal of Chemical Physics 118(7): 3376-3391. 2003.

CONFERENCES, OTHER TALKS, REPORTS, PATENTS AND COMPENDIA

Conferences

Andrei, Carmen; Walmsley, J.C.; Knowles, Kevin; Hauback, Bjørn; Holmestad, Randi: *TEM studies of microstructure evolution of TbNiAl during HDDR process*. I: IoP conference series. Electron Microscopy and Analysis Conference (EMAG2003), Oxford, UK, 2003-09-02 - 2003-09-05

Braataas, Arne: *Scattering Theory and Spin Current Induced Magnetization Reversal.* American Physical Society, Austin, TX, March 2003

Chen, De; Yu, Zhixin; Tøtdal, Bård; Holmen, Anders: *Carbon nanofiber production and applications in (electro)catalysis*. International symposium on electrocatalysis in fuel cell, NTNU, Trondheim, Norway, 2003-05-05

Danielsen, Signe; Maurstad, Gjertrud; Sletmoen, Marit; Skjåk-Bræk, Gudmund; Vårum, Kjell Morten; Christensen, Bjørn Erik; Stokke, Bjørn T.: *Nanotechnology at the interface of biopolymers*. I: Proceedings. Nanotech 2003 + future, Tokyo, 2003-02-25 - 2003-02-28

Davies, Catharina de Lange; Hjelstuen, Mari H.; Brekken, Christian; Veliyulin, Emil; Gribbestad, Ingrid S.; Bruland, Øyvind S; Frengen, Jomar: *Tumor growth delay and early changes in tumour microvasculature after combined Caelyx (liposomal doxorubicin) and radiation treatment of human osteosarcoma xenografts.* I: Proceedings 2nd ESTRO workshop on biology in radiation oncology. 2nd ESTRO workshop on biology in radiation onclogy, Nijmegen, Nederland, 2003-06-01 - 2003-06-03

Davies, Catharina de Lange; Eikenes, Live; Lundstrøm, Lisa M.; Tari, Maryam R; Brekken, Christian; Frengen, Jomar; Kaalhus, Olav; Bruland, Øyvind S.: *Distribution of therapeutic macromolecules in osteosarcoma xenografts*. I: Bruland Ø, and Flægstda T, (Editors) "Targeted cancer therapy". 183-188. Tromsø, Norway: Raventrykk, University of Tromsø, Tromsø Symposium, 2003, Tromsø, Norway, 2003-06-22 - 2003-06-24

Falnes, Johannes; Lillebekken, Per Magne: *Budal's latching-controlled-buoy type wave-power plant*. Fifth European Wave Energy Conference, Cork, Irland, 2003-09-17 - 2003-09-20

Friis, Jesper; Jiang, Bin; Spence, John: *Physical properties of crystals from bonding study by quantitative electron diffraction (QCBED)*. I: ECDM-III proceedings, 2003. ECDM-III, Sandbjerg estate, Danmark, 2003-06-24 - 2003-06-29

Friis, Jesper; Jiang, Bin; Marthinsen, Knut; Holmestad, Randi: *Combination of structure* factors from *x-ray and convergent beam electron diffraction*. Workshop on Advanced Methods in X-ray Diffraction Analysis, Buffalo NY, 2003-05-12 - 2003-05-17

Friis, Jesper; Madsen, Georg; Larsen, Finn Krebs; Jiang, Bin; Marthinsen, Knut; Holmestad, Randi: *Comparison of density functional theory with electron and X-ray diffraction experiments on magnesium*. I: ECDM-III proceedings 2003. ECDM-III, Sandbjerg Estate, Denmark, 2003-06-24 - 2003-06-29

Friis, Jesper; Marthinsen, Knut; Holmestad, Randi: *Retrieval of anisotropic displacement parameters in Mg from convergent beam electron diffraction.* Electron Microscopy and Analysis Conference (EMAG2003), Oxford, UK, 2003-09-02 - 2003-09-05

Fossheim, Kristian: *Concluding remarks: Vortex Conference III*. I: Published as Proceedings of Vortex III Conference on a CD in 2003, distributed to participants. To be publised in printed form in Physica C as Proceedings of Vortex Conference III, May 2004. ESF Vortex Conference III, Aghia Pelagia , Crete, September 21-28, 2003

Gederaas, O.A., Schønberg, S.A., Ramstad, S., Johnsson, A. & Krokan, H.: *Effects of poly-unsaturated fatty acids on 5-aminolevulinic acid based photosensitisation in four different human cancer cell lines*. - Xth Eur. Photobiol. Conference, Vienna 2003.

Haugen, Nils Erland Leinebø: *Experience and results from a large MHD simulation*. A CMA-workshop on Computational methods in astrophysical problems, Oslo, 2003-11-03 - 2003-11-04

Hjelstuen, Mari H.; Brekken, Christian; Veliyulin, Emil; Gribbestad, Ingrid S.; Bruland, O.S.; Davies, Catharina de Lange; Frengen, Jomar: *Tumour growth delay and early changes in tumour microvasculature after combined Caelyx (liposomal doxorubicin) and radiation treatment of human osteosarcoma xenografts*. 2nd ESTRO Workshop on biology in radiation oncology, Nijmegen, Nederland, 2003-06-01 - 2003-06-03

van Helvoort, A.J.T.; Knowles, Kevin; Holmestad, Randi: *Compositional characterisation of electrostatic bonds*. I: IoP conference series. Electron Microscopy and Analysis Conference (EMAG2003), Oxford, UK, 2003-09-02 - 2003-09-05

Johnsson. A.: *Environmental considerations. Possible effects of electromagnetic fields on marine life.*Seminar "Introduction to Seabed Logging", 15-16 Oct 2003, Trondheim.

Kjeldstad, Berit and Sechmeyer, Gunther: *Topics of interest in solar UV measurements*. The international symposium on Optical Science and Technology, San Diego, U.S.A. 2003. In CD rom with abstracts: The international symposium on Optical Science and Technology, San Diego, U.S.A. 2003

Kjeldstad, B. and Thorseth T.: Invited talk: *Ground-based ultraviolet radiation – measurements in Trondheim* . The international symposium on Optical Science and Technology, San Diego, U.S.A. 2003 . In CD rom with abstracts: The international symposium on Optical Science and Technology, San Diego, U.S.A. 2003

Kleinert, Hagen; Nogueira, Flavio S.; Sudbø, Asle: *Compact U(1) gauge theories in 2+1 dimensions and the physics of low dimensional insulating materials*. Aachen HEP2003 conference, Aachen, Germany, 2003-07-17 - 2003-07-23

Luzny, W.; Samuelsen, Emil J.; Breiby, Dag W.: *The structural properties of the PANI/CSA conducting polymer system studied by synchrotron radiation surface diffraction*. I: FIBRES & TEXTILES in Eastern Europe. Vol. 11. 97-100. 5th International Conf. on X-ray Investigations of Polymer Structures (Satellite conf. of. 20th Euro. Crystallogr. Meeting), Szczyrk, Poland, 2003-12-01 - 2003-12-03

Maurstad, Gjertrud; Danielsen, Signe; Stokke, Bjørn T.: *Quantitative analysis of xanthan condensates visualised by atomic force microscopy*. I: Book of Abstract, EUROCARB 12. European Carbohydrate Symposium, EUROCARB 12, Grenoble, Frankrike, 2003-07-06 - 2003-07-11

Maurstad, Gjertrud; Danielsen, Signe; Stokke, Bjørn T.: *Nanosized polyelectrolyte complexes involving polysaccharides*: *A variety of morphologies*. I: Proceedings. Frontiers in Polysaccharide Engineering, Sakai, Osaka, Japan, 2003-06-08 - 2003-06-11

Maurstad, Gjertrud; Danielsen, Signe; Stokke, Bjørn T.: *Polyelectrolyte Complexes Formed between Polycations and Semiflexible Polyanions of Different Chain Stiffness: Analysis*. I: Proceedings. EUPOC 03, European Polymer Federation, Stockholm, Sweden, 2003-06-23 -2003-06-28

Naqvi, Kalbe Razi: *Sunlight, pigments and oxygen: Players in the deadly game of life*. I: Proceedings of the International Conference on Advancement in Science and Technology (iCAST 2003). 11-15. Kuala Lumpur: Research Center, International Islamic University Malaysia. 2003-08-05 - 2003-08-07

Naqvi, Kalbe Razi: *Franck-Condon factors for electron and energy transfer*. I: Book of Abstracts. European Science Foundation ULTRA Programme Summer School on "Molecular Basis of Fast and Ultrafast Processes" Vilamoura, Algarve, Portugal, 2003-06-12 - 2003-06-15

Naqvi, Kalbe Razi: *Fermi's golden rule*. I: Lecture Notes. European Science Foundation ULTRA School on "Ultrafast Processes in Photochemistry and Photobiology". Torun, Poland, 2003-08-25 - 2003-08-30

Naqvi, Kalbe Razi: *The adiabatic approximation in quantum mechanics*. I: Lecture Notes. European Science Foundation ULTRA School on "Ultrafast Processes in Photochemistry and Photobiology". Torun, Poland, 2003-08-25 - 2003-08-30

Naqvi, Kalbe Razi: *Two-step photoselection and rotational diffusion*. I: Lecture Notes. European Science Foundation ULTRA School on "Ultrafast Processes in Photochemistry and Photobiology" .Torun, Poland, 2003-08-25 - 2003-08-30

Nogueira, Flavio S.; Sudbø, Asle: *Topological phase transitions in (2+1) dimensions*. Mini-symposium on Strongfly Correlated Electron Systems, NORDITA, Copenhagen, Denmark, 2003-06-13 - 2003-06-14

Oftedal, Gunnhild; Straume, Aksel; Johnsson, Anders: *Mobile phone use and increase in skin temperature due to insulation*, *heat conduction and RF absorption*. I: Book of abstracts, EBEA 2003. 6th International Congress of the European Bioelectromagnetic Association EBEA). Budapest, Ungarn, 2003-11-12 - 2003-11-15

Ramstad, Thomas; Stranden, Torunn; Bakke, Jan Øistein; Bjelland, Johannes; Hansen, Alex: *Universality of fracture roughness exponent in different fuse models*. I: Geophysical Research Abstracts. 5. 11372. European Geophysical Society, EGS-AGU-EUG Joint Assembly, Nice, France, 2003-04-06 - 2003-04-11

Samuelsen, E. J. and Carlsen. P: *Polymeric semiconductors: Band-gap by structural engeneering.* Foredrag på NTNU seminar "Polymers, polymer composites, soft materials and applications" Jægtvolden Turisthotell 2003-10-23/24

Seland, John Georg; Washburn, Kate; Sørland, Geir H; Anthonsen, Henrik W.; Krane, Jostein: *Correlations Between Transverse Relaxation and Internal Gradients in* Porous Systems Containing Oil and Water. EUCHEM CONFERENCE Structure and Molecular Mobility in Heterogeneous Systems, Gøteborg, Sverige, 2003-08-27 - 2003-08-29

Sikorski, Pawel; Stokke, Bjørn T.; Skjåk-Bræk, Gudmund: *Structural components of alginic acid*. Poly (beta-D-mannuronic-alfa-L-guluronic acid). I: Book of abstract, EUROCARB 12. 12th European Carbohydrate Symposium, EUROCARB 12, Grenoble, Frankrike, 2003-07-06 - 2003-07-11

Sikorski, Pawel; Stokke, Bjørn T.; Wada, Masahisa; Heux, Laurent: *Cellulose Triacetate I (CTA I). Fibre X-ray diffraction and Molecular Modeling Study.* SNBL Highlights Meeting, Tromsø, Norge, 2003-06-23 - 2003-06-25

Skjetne, Bjørn; Hansen, Alex; Helle, Torbjørn: *Paper modeled as a disordered system that buckles during fracture*. I: Preprints 2003 International Paper Physics Conference. 211-217. 2003 International Paper Physics Conference, Victoria,British Columbia, Canada, 2003-09-07 - 2003-09-11

Smørgrav, Eivind; Smiseth, Jo; Nogueira, Flavio S.; Sudbø, Asle: *Confinement deconfinement transition and charge fractionalization*. Minisymposium on strongly correlated systems, NORDITA, Copenhagen, Denmark, 2003-06-13 - 2003-06-14

Stefansson, Thorarinn: *Laboratorieundervisningen for 1. og 2. år av teknologistudiet i fysikk og matematikk*. Faglig pedagogisk dag på NTNU, Trondheim, 2003-11-28

Straume, Aksel; Oftedal, Gunnhild; Johnsson, Anders: *Does the radio frequency field increase the temperature in the ear region of the mobile phone user*? I: Fysikermøtet 2003,Oslo August 9th -12th, Program and abstracts. Fysikermøte 2003, Sundvolden Hotel, 2003-08-09 - 2003-08-12

Straume, Aksel; Oftedal, Gunnhild; Johnsson, Anders: *Low frequency magnetic fields from GSM mobile phones*. I: Abstract Book at BEMS Twenty-Fifth Annual Meeting.. 207-208. Bioelectromagnetics Society 25th. Annual Meeting, Wailea, Hawaii, USA, 2003-06-22 - 2003-06-27

Straume, Aksel; Oftedal, Gunnhild; Johnsson, Anders: *Mobile phones cause temperature increase in the ear region*. I: Abstract Book at BEMS Twenty-Fifth Annual Meeting. 62-63. Bioelectromagnetics Society 25th. Annual Meeting, Wailea, Hawaii, USA, 2003-06-22 - 2003-06-27

Sudbø, Asle: *Charge fractionalization in the compact Abelian Higgs model*. Hidden Symmetries in Strongly Correlated Electron Systems and Low Dimensional Field Theories, Waterloo Campus, King's College, London, 2003-07-08 - 2003-07-12

Sudbø, Asle: *Topological phase transition in (2+1) dimensions*. Institute of Complex and Adaptive Matter, Conference Quantum Criticality, Columbia University, New York, USA, 2003-03-20 - 2003-03-23

Thisted, Ulrik; Nyhus, Jørgen; Suzuki, T; Hori, J; Fossheim, Kristian: *Evidence for thermally induced vortex fluctuations above Tc in high temperature superconductors*. I: Superconductivity and magnetism: Materials Properties and developement, Extended abstracts of 24th Risø international symposium on materials science. 24th Risø international Symposium on materials Science Superconductivity and Magnetism, Risø, Denmark, 2003-09-10 - 2003-09-13

Thisted, Ulrik; Nyhus, Jørgen; Suzuki, T; Hori, J; Fossheim; Kristian: *Evidence for thermally induced vortex fluctuations above Tc in high temperature superconductors*. 2nd International Onsager conference, Trondheim, 2003-06-01 - 2003-06-05

Thisted, Ulrik; Nyhus, Jørgen; Suzuki, T; Hori, J; Fossheim; Kristian: *Strong diamagnetic response and specific heat anomaly above Tc in underdoped La2-xSrxCuO4*. I: Abstract Booklet for The 9th Joint Vortex Dynamics and Vortex Matter Workshop, Boyardville, France, Boyardville, Isle d`Oleron, France, 2003-06-22 - 2003-06-27

Tybell, Thomas; Dahl, Øystein; Grepstad, Jostein K.; Borg, Anne: *Etching of nanostructures in metallic perovskites using STM*. STM2003, Eindhoven, Nederland, 2003-07-21 - 2003-07-25

Tybell. T, Dahl Ø., J. K. Grepstad and A. Borg: "*Etching of nanotructures in metallic perovskite using STM*", 12th International Conference on Scanning Tunneling Microscopy/ Spectroscopy and Related Techniques (STM2003), July 2003, Eindhoven, The Nederlands.

Wittje, Roland: *Robert W. Pohl and the reformation of lecture demonstrations during the interwar period*. "From the itinerant lecturers of the 18th century to popularising physics in the 21st century - exploring the relationship between learning and entertainment" organised by the Deutsches Museum, Munich, Pognana sul Lario (Lake Como), Italy, 2003-06-01 - 2003-06-06

Yu, Zhixin; Chen, De; Tøtdal, Bård; Holmen: Anders: *Role of the Catalyst Structure in Large-Scale Carbon Nanotube Synthesis on Fe Catalysts*. I: Book of abstracts. Lausanne, Switzerland: EUROMAT 2003, Lausanne, Switzerland, 2003-09-01 - 2003-09-05

Other talks

Borg, A.: *Subsurface impurities in Pd(111) and their influence on surface adsorbates; a STM study*". Invited talk. University of Eindhoven, 20.01.2003

Braataas, Arne: *Spin-Pumping and Spin Dynamics in Magnetic Nanostructures.* Karlsruhe, Germany, December 2003, Spin Echo,

Braataas, Arne: *Magnetoelectronic Spin Echo.* NEDO, Japan, November 2003

Braataas, Arne: *Spin Echo, Spin-Pumping and Spin Dynamics in Magnetic Nanostructures.*New York University, USA, December 2003

Braataas, Arne: *Spintronics.* The Norwegian Academy of Technological Sciences, Trondheim, February 2003.

Chen, De; Yu, Zhixin; Tøtdal, Bård; Holmen, Anders: *Large scale production of carbon nanofibers and applications*. Statoil Research Center, Trondheim, Norway, 2003-03-11

Davies, Catharina: *Hvorfor kureres ikke kreft? Transport av terapeutiske makromolekyler i kreftvev.* Foredrag "Fredagskollokviet i fysikk", september 2003, NTNU.

Fossheim, Kristian; Thisted, Ulrik; Nyhus, Jørgen; Suzuki, T; Hori, J.: *Can a superconductor show diamagnetic response above T_c*? Seminar in honour of Professor Torstein Jøssang's 70th birthday, Oslo, 2003-11-28

Haugen, Nils Erland Leinebø: *Masseoverføring til (kompakte stjerner og) svarte hull*. Trondheim Astronomiske Forening, Trondheim, 2003-02-19

Johnsson, Anders: *Biologiske klokker*. Foredrag ved "Åpent hus", NTNU, 2003-10-12.

Kjeldstad, Berit: *Mitt liv som adept*. *Mentor og adept prosjekt ved NTNU* Universitetet i Oslo 14.01.2003.

Løvseth, Jørgen: *Wind power in the perspective of sustainable development and physics.* Foredrag "Fredagskollokviet i fysikk", oktober 2003, NTNU.

Mo, Frode: *Krystallografi - til glede og nytte*. DKNVS, Trondheim, 2003-01-20

Mork, Kjell: *Nobelprisen i fysikk 2002*. Foredrag "Fredagskollokviet i fysikk", januar 2003, NTNU.

Raaen, Steinar: *Nano-structured surface alloys - electronic properties and chemical reactivity*. Foredrag "Fredagskollokviet i fysikk", mars 2003, NTNU.

Stefansson, Thorarinn: *Enkel komponentkunnskap gjennom eksperimentering*. Kurs ved Skolelaboratoriet, NTNU, Trondheim, 2003-11-12 - 2003-11-13

Reports and Patents

Emil J. Samuelsen (Editor): *Nordsync Annual Report 2002.* Nordsync Reports. Trondheim Oct. 2003

Sigmond, Reidar Svein: *Overflate-elektroskop for måling av elektrostatiske egenskaper til helt eller delvis isolerende overflateskikt.* Norsk Patent nr. 3/5916. The Norwegian Patent Office 2003.

Compendia

Rossing, Nils Kr.; Stefansson, Thorarinn; Bungum, Berit: *Elektronikk for skolen*. Trondheim: Program for lærerutdanning, 2003 (162 s)

Stefansson, Thorarinn: *Mekanikk og gravitasjon i laboratoriet. Arbeidsmåter i eksperimentalfysikk.* Kurshefte, 3. utg, januar 2003 (251 s)

Stefansson, Thorarinn: *Mekanikk og gravitasjon i laboratoriet, Arbeidsmåter i eksperimentalfysikk.* Lærerveiledning, 1. utg., februar 2003 (149 s)

COOPERATING INSTITUTIONS

Europe

Borg, A.:
* Schuit Institute of Catalysts, Eindhoven University of Science and Technology (G. J. Kramer)

Brataas, A.:
* TU Delft, Nederland (G. E. W. Bauer), Theoretical Physics
* Univ. of Basel (W. Belzig), Theoretical Physics
* Budapest Univ. (G. Zarand), Theoretical Physics
* Lunds Universitet (K.-A. Chao), Condensed Matter Physics

Davies, C.:
* Dept. of Internal Medicine with Oncology, Austria (G Baumgartner), Biophysics

Fossheim, K.:
* Institute of Microelectronics Technology, Moscow (Zhilyaev), Condensed Matter Physics
* Institute of Solid State Physics, Sofia (Christova), Condensed Matter Physics

Fossum, J.O.:
*SNBL/ESRF Grenoble

Hansen, A.:
* Université de Nice-Sophia Antipolis (Batrouni)
* Ecole Normale Superieure, Paris (Schmittbuhl)
* Technical University of Budapest (Kertesz)
* Nordita/NBI, Copenhagen (Sneppen, Jensen) Complex Systems, Condensed Matter Theory

Holmestad, R.:
* TU Delft (H. Zandbergen, J. Janssen) Electron microscopy
* Paul-Scherrer Institute, Villingen-PSI (P.Derlet, A. Frøseth), Atomistic modelling
* Århus University (F.K. Larsen) Electron microscopy
* Rouen University/CNRS, France (F. Daniox, W. Lefebvre), Atom probe

Hunderi, O.:
* Techn Univ., Berlin (W. Richter), Surface Optics
* University of Nijmegem (T.Rasing), Magnetooptics
* University of Liverpool (P. Weightman), Surface Optics.

Johnsson, A:
* Arbetmiljöinstitutet, Umeå (K. Hansson Mild), Biophysics

Kjeldstad, B:
* EU-prosjekt EDUCE and INSPECTRO, Environmental Physics
* University of Hanover, Meteorological Institute (Gunther Seckmeyer), Environmental Physics
* University of Thessaloniki, Department of Physics (Alkis Bais), Environmental Physics
* Univerity of Innsbruck, Institute of medical Physics, (Mario Blumthaler), Environmental Physics
* University of Manchester, Institute of Science and Technology, (Ann Webb) Environmental Physics

Løvaas, T.H.;
KTH Stockholm, Alfvenlab. (S.Rosander), Electron Physics.

Løvseth, J;
* Risø National Laboratorium, Roskilde (Larsen), Wind Energy
* Danmarks Tekniske Universitet, København (Hansen), Wind Energy

Mo, F.:
* SNBL, ESRF, Grenoble (J.A. Beukes, V. Dmitriev), Condensed Matter Physics
* Institut Pasteur, Paris (P.M. Alzari), Condensed Matter Physics

Naqvi, K.R.:
* Institute of Natural Resources and Agrobiology, Spain (J. B. Arellano), Biophysics
* Universidade de Coimbra, Portugal (L. G. Arnaut), Biophysics
* King's College, London (R. E. Dale), Biophysics
* Hungarian Academy of Sciences (G. Garab, T. Javorfi), Biophysics
* Universidade Nova de Lisboa (ITQB), Biophysics
* Moscow State University (Mark N. Merzlyak), Biophysics
* Institute of Physical Chemistry, Spain (CSIC) (J. Gonzalez-Rodriguez), Biophysics

Olaussen. K.:
* Polish Academy of Sciences (Dr. A. Maciolek), Theoretical Physics

Samuelsen, E. J.:
* Linköping University (O. Inganäs), Condensed Matter Physics
* Risø National Laboratory, Roskilde (D. Breiby) Condensed matter Physics
* Univ. of Mining and Metallurgy, Krakow (W. Luzny), Condensed Matter Physics
* Experimental Division, ESRF, Grenoble (O. Konovalov and B. Struth), Condensed Matter Physics
* Kazan State Technological University, Kazan (Vladimir A. Petrov), Condensed Matter Physics

Sigmond, R.S.:
* École Superieure d'Électricité (SUPELEC), Laboratoire de Physique des Gaz et des Plasmas, (A. And M. Goldman), Gif-sur-Yvette

Skagerstam, B.S.;
* Imperial College, London (P.L. Knight, P.K. Rekdal)
* Chalmars TCTH, Gőteborg (Gőran Wendin)

Skullerud, H.R.:
* Universität Innsbruck, Inst. für Theoretische Physik (S.Kuhn), Plasma Physics

Stefansson, T:
* Haskoli Islands, Reykjavik (R. Olafsson), Didactics in Physics
* Universität Leipzig, Inst. für Vergleichende Pädagogik (W. Hörner), Comparative pedagogics

Stokke, B. T.:
* Bristol Univ. (T. Atkins), Biophysics
* La Sapienza University, Roma (M. Dentini), Biophysics
* München Techn. Univ. (A. Bausch, E. Sackmann), Biophysics
* Univ. Joseph Fourier, Grenoble (E. Geissler), Biophysics

Sudbø, A.:
* Freie Universitaet Berlin (F. S. Nogueira, H. Kleinert, K.H. Benneman), Condensed Matter Theory
* Katholieke Universiteit Leuven (V. Moschalkov), Condensed Matter Theory
* Loughboro University (F. Kusmartsev), Condensed Matter Theory
* Leiden University (J. Zaanen)

Valberg, A.:
* University of Freiburg (L. Spillmann and T. Otte), Vision Biophysics
* University of Tübingen (J Kremer), Vision Biophysics

Africa

Løvseth, J;
* University of Durban, Westville, Sør-Afrika (Heetkamp, Reinhardt, McPherson), Renewable Energy
* Eduardo Mondlane University, Mosambik (Cuamba), Solar Energy

America

Borg, A.:
* Materials Science Division, Lawrence Berkeley National Laboratory, Berkley (M.Salmeron)

Brataas, A.:
* Harvard University, (Y. Tserkvonyak), Theoretical Physics
* University of Brasilia, (C. Egues), Condensed Matter Theory.

Davies, C.:
* Harvard Medical School Boston (R. K. Jain), Biophysics

Fossheim, K.:
* National High Magnetic Field Laboratory, Tallahassee, Florida (Schneider-Muntau), Condensed Matter Physics

Fossum, J.O.:
* Brookhaven National Lab.,Upton L.I. Complex Materials
* University of Brasilia, Brazil, Complex Materials

Hansen, A.:
* Uni Ceara, Fortaleza, Brazil (Soares)
* University of Brasilia (Oliveira)
* University of Arizona (Franzikonis)
Complex Systems, Condensed Matter Theory

Holmestad, R.:
* Arizona State University, Tempe, Arizona (J. Spence, B. Jiang) Electron microscopy
* McMaster University, Hamilton, Ontario (G. Botton) Electron microscopy

Høye, J.S.:
* Stony Brook University, New York, (G. Stell, F. Raineri, C.-L. Lee), Theoretical Physics
* Oklahoma University, Norman, Oklahoma, (K. A. Milton), Theoretical Physics

Lindmo, T;
* Beckman Laser Institue, University of California, Irvine (J. S. Nelson, Z. Chen), Biophysics

Olaussen, K.:
* University of Berkeley (R. Chiao), Theoretical Physics

Skagerstam, B.S.:
* University of Florida (J.R. Klauder)
* Syracuse University, N.Y. (A.P. Balachandran)

Stokke, B.T.:
* California, Irvine, California (D. A. Brant) Biophysics
* Univ. of California, Santa Barbara, California (H. Hansma), Biophysics

Sudbø, A.:
* John Hopkins University (Z. Tesanovic), Condensed Matter Theory
* Bell Laboratories (C. M. Varma), Condensed Matter Theory
* Brown University (J. B. Marston), Condensed Matter Theory
* University of California LA (J. O. Fjærestad), Condensed Matter Theory
* Los Alamos National Laboratory (Z. Nussinov)
* Cornell University (E. Babaev)

Tøtdal, B.:
* Lehigh University, USA (C.E.Lyman), Analytical electron microscopy

Asia

Brataas, A.:
* Nagoya (J. Inoue), Theoretical Physics

Fossheim, K;
* Department of Physics, University of Hiroshima (T. Suzuki, J. Hori), Condensed Matter Physics

Johnsson, A.:
* J. Nehru Centre for Advanced Scientific Research , Bangalore (V. Sharma), Biophysics

Mo, F.:
* Nanyang Techn. University, Singapore (J. Lescar), Condensed Matter Physics

Naqvi, K.R.:
* International Islamic University Malaysia, Kuala Lumpur (T. Hj. Hassan), Biophysics

Stokke, B.T.:
* Osaka Prefecture Univ., Osaka (S. Kitamura), Biophysics
* Kyoto Inst. of Technology, Kyoto (K. Kajiwara) Biophysics

Australia

Skullerud, H.R.;
* Australian National University, Canberra, Atomic d Molecular Physics Lab., Electron and Ion Physics

National cooperation

* Photocure ASA, Oslo
* Division of Biophysics and Medical Technology, Radiumhospitalet, Oslo (Ø. Bruland, A.Skretting)
* Statoil Research Centre, Trondheim (F. Antonsen, H. Widerøe)
* Department of Physics, University of Oslo (J.M.Leinaas, A.Dahlback, E.G.Fjelløy, K.J.Måløy)
* Department of Biology (Dag Hessen), University of Oslo
* Optomed (R. Ellingsen, D.R. Hjelme, B. Falch),
* FMC Biopolymers (E. Onsøyen)
* Norwegian Institute for Air Research (G. Braathen, Arve Kylling, Kaare Edvartsen)
* Hydro Aluminium (Oddvin Reiso)
* ElectroMagnetic GeoServices (EMGS)
* Norwegian Radiation Protection Authority (Bjørn Johnsen, Terje Christensen)
* Tambartun National Resource Center for the Visually Handicapped, Melhus (P.Fosse)
* Institute for Energy Technology, Kjeller (B. Hauback, K.D. Knudsen, A. Skjeltorp, P.G. Helgesen)
* SINTEF (C.Marioara, S.Andresen, J.Walmsley, R. H. Mathiesen, B. S. Tanem)
* Elkem (E. K. Jensen)
* Raufoss (O. Jensrud)

Local cooperation

* Institutt for petroleumsteknologi NTNU
* Institutt for konstruksjonsteknikk, NTNU (I. Brevik og J.B. Aarseth)
* Pedagogisk institutt, NTNU (R. Karlsdottir)
* Skolelaboratoriet for matematikk, naturfag og teknologi, NTNU (N. K. Rossing)
* Organic Chemistry, NTNU (P.H. Carlsen)
* Plantebiosenteret NTNU (T.-H. Iversen)
* Department of Process Technology, NTNU (P.V. Hemmingsen and J. Løvland)
* Department of Chemistry, NTNU
* Institute of Reservoir Technology and Applied Geophysics, NTNU
* Inst. for bioteknologi, NTNU (B.E. Christensen, K.M. Vårum, G.S.B. Bræk, S. Valla, O. Smidsrød, K.I. Draget)
* Inst. for kreftforskning, NTNU (T. Espevik, A. Sundan)
* Institutt for sirkulasjon og bildediagnostikk, NTNU
* Materialteknologi, NTNU (K. Marthinsen, M.-A. Einarsrud og T. Grande)
* Fysikalsk elektronikk, NTNU (T. Tybell, J.K. Grepstad)
* Kjemisk prosessteknologi NTNU (Z. Yu, Chen, A. Holmen)

EDUCATION

SUBJECTS AND STUDENT ATTENDANCE

Some subjects were self-study courses in 2003

Subjects	*Student Attendance*
M.Sc. Technology 1st and 2nd year.	
Physics for Civil and Environmental Engineering	156
Physics for Geology and Petroleum (incl. lab)	127
Physics for Electronics and Cybernetics (incl. lab)	177
Physics for Chemistry and Metallurgy (incl. lab)	129
Physics for Informatic	244
Physics for Machine Technology (incl. lab)	255
Physics for Marine (incl. lab)	98
Mechanical Physics (incl. lab)	282
Electromagnetism (incl. lab)	135
Wave Physics (incl. lab)	119
Thermal Physics (incl. lab)	115
Physics for Energy and Environmental (incl. lab)	93
Chemical Physics and Quantum Mechanics	117
M.Sc. Technology 3rd year.	
Physics 2 for Electronics	74
Electronics (incl. lab)	74
Instrumentation (incl. lab)	84
Statistical Physics	49
Electromagnetic Theory	46
Atomic and Molecular Physics	71
Optics (incl. lab)	93
Quantum Mechanics	61
Electron and Ion Physics	10
Cell Biology 1 (incl. lab)	61
Atmospheric Physics (incl. lab)	9
Material Physics and Characterization (incl. lab)	23
M.Sc. Technology 4th year.	
Solid State Physics (incl. lab)	62
Energy and Environmental Physics	30
Non-linear Dynamics	20
Optics, Advanced Course (incl. lab)	13
Applied Quantum Mechanics	18
Solid State Physics, Advanced Course	7
Theory of Classical Fields	15
Molecular Biophysics (incl. lab)	30
Biophysics (special)	25
Classical Transport Theory	10
Signal Processing incl. lab	16
Subatomic Physics	14
Medical Physics (incl. lab)	26
Nuclear and Radiation Physics (incl. lab)	78
Particle Physics	10
Physics of Materials (incl. lab)	5
Computational Physics	25
Experts in Team, Interdisciplinary Project	52

M.Sc. Technology 5th year.

Biophysical Micromethods (incl. lab)	11
Biophysics, Specialization	20
Physics, Specialization	24

B.Sc.

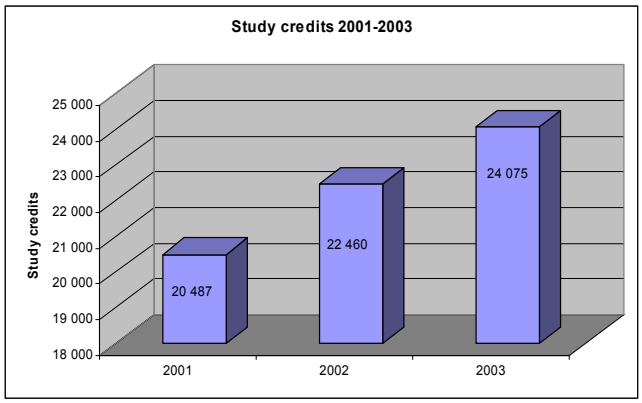
User Course in Physics (incl. lab)	55
General Physics I (incl. lab)	84
General Physics II (incl. lab)	34
Mechanical Physics (incl. lab)	36
Electricity and Magnetism (incl. lab)	19
Quantum Physics and Statistical Physics (incl. lab)	21
Dynamics (incl. lab)	1
System Dynamics (incl. lab)	1
Energy and Environmental Physics (incl. lab)	11
Biophysics I (incl. lab)	16
Introduction to Quantum Mechanics	16
Space Technology I	25
Astrophysics	44

M.Sc.

Didactic in Physics (incl. lab)	6
Measuring Sensors and Transducers (incl. lab)	10
Signal Analysis (incl. lab)	17
Optics (incl. lab)	6
Atmospheric Physics (incl. lab)	6
Subatomic Physics	7
Particle Physics	1
Relativistic Quantum Mechanics	3
Light, vision, colour (incl. lab)	5
Applied electronics (incl. lab)	1

PhD.

Mesoscopic Physics	6
Critical Phenonomens	6
Non-ionizing Radiation Biology	2
Superconductivity	3
Symmetry in Physics	11
Nanoparticle Polymer Physics	2
Quantum Optics	12
Quantum Field Theory	4



THESES - GRADUATE STUDIES

Engineering (siv. ing. / M. sc. tech.)

Bakke, Jan Øistein Haavig: *A Numerical Study of the Roughness Exponent for Central Force Lattices.*
Supervisor: Alex Hansen

Benjaminsen, Ilana Christin: *Detection of hypoxia in tumors by use of dynamic contrast-enhanced magnetic resonance imaging.*
Supervisor: Einar K. Rofstad

Bjelland, Johannes: *Monte Carlo Simulation of Temperature Programmed Desorption.*
Supervisor: Steinar Raaen

Blakely, Pål David: *Radiance distribution of ultraviolet radiation from the sky. Instrument testing and calibration.*
Supervisor: Berit Johanne Kjeldstad

Breivik, Gøril Margrethe: *Modelling of acoustic wave propagation based on the method of normal modes tested on beamformers and compared to sea trial recordings.*
Supervisor: Hans Magne Pedersen

Børkje, Kjetil: *Pair production of neutrinos in intense electromagnetic fields?*
Supervisor: Kåre Olaussen

Dahl, Øystein: *Nanoscale Structuring of SrRuO3; A Scanning Tunneling Microscopy Approach.*
Supervisor: Anne Borg

Foros, Jørn: *The dependence of the enhanced Gilbert damping in Au/Pd/Fe/GaAs(001) films on temperature and on the thickness of the Pd layer.*
Supervisor: Arne Brataas

Giskeødegård, Nils Håvard: *Simulating of Speckle Effects in Optical Coherence Tomography.*
Supervisor: Hans Magne Pedersen

Grønnevik, Arve: *Quantitative NMR-investigations of water distribution in plant root media to be used in the International Space Station.*
Supervisor: Anders Johnsson

Grønsleth, Martin Sigurd: *Metastability og Coexistence of Ferromegnetism and Superconductivity.*
Supervisor: Asle Sudbø

Hallanger, Aslak: *Non-linear deformations of liquid-liquid interfaces induced by electromagnetic radiation pressure.*
Supervisor: Johan Skule Høye

Hansen, Henning Frydenlund: *A stochastic model of stock markets.*
Supervisor: Alex Hansen

Heggem, Britt: *Electrically stressed drop dynamics and electrocoalescence.*
Supervisor: Tore Høe Løvaas

Helleseng, Knut Olav: *Influence of TEM sample preparation on high resolution studies of perovskite thin films.*
Supervisor: Randi Holmestad

Herfjord, Erik: *Gust Factor Analysis. Wind Measurement and data quality control.*
Supervisor: Jørgen Løvseth

Hestad, Øystein Leif: *Charge injection in transformer oil.*
Supervisor: Tore Høe Løvaas

Hoff, Ronny: *Resonance-tuned heaving buoy: Experimental investigation of hydrodynamic parameters.*
Supervisor: Jørgen Løvseth

Høyer-Hansen, Martin: *Magnetic properties in underdoped* $La_{2-x}\,Sr_x\,CuO_4$.
Supervisor: Kristian Fossheim

Håland, Endre Berntsen: *Pulse generator for mobility measurement of ions.*
Supervisor: Helge Redvald Skullerud

Jamroz, Piotr: *Ultrathin Organic films.*
Supervisor: Ola Hunderi

Klaveness, Arne: *Diode pumped 2 μm lasers.*
Supervisor: Ola Hunderi

Malde, Ole André: *Optical Coherence Tomography measurements of the attenuation coefficient in agar-gel samples containing absorbing Phthalocyanine dye and scattering Intralipid.*
Supervisor: Ole Johan Løkberg

Morten, Jan Petter; *Spin and Charge Transport in Dirty Superconductors.*
Supervisor: Arne Brataas

Nordmark, Heidi; *TEM studies of phase transformation β''-β'/U in Al-Mg-Si alloys.*
Supervisor: Randi Holmestad

Ommundsen, Karen; *Microarray analysis of the gene expression profile of human melanoma cells in culture: Effects of low extracellular pH and radiation sensitivity.*
Supervisor: Einar K Rofstad

Osvaag, Bjørn Øivind; *A stochastic model of the stock market.*
Supervisor: Alex Hansen

Ramstad, Thomas; *Determining the density of states in continuous classical spin models using a generalized Wang-Landau algorithm.*
Supervisor: Alex Hansen

Ruud, Else-Beate; *Effects of irradiation on blood flow in human melanoma xenografts measured by dynamic contrast-enhanced magnetic resonance imaging.*
Supervisor: Einar K Rofstad

Saur, Sigrun; *Characterization of ferrous sulphate gel as a radiation dosimeter.*
Supervisor: Tore Lindmo

Sivertsvik, Kenneth; *Wavelet as an analytical tool in an FMCW radar.*
Supervisor: Anders Johnsson

Skogholt, Peter; *Normal tissue complication probability and target coverage with different techniques for irradiation of breast cancer.*
Supervisor: Tore Lindmo

Stranden, Torunn; *Numerical model for static friction between rough elastic surfaces.*
Supervisor: Alex Hansen

Søndenå, Rune; *Atomistic modelling of precipitates in Al-Mg-Si alloys.*
Supervisor: Randi Holmestad

Thuen, Marte Øvreås; *Effect of ionizing radiation on fluctuations in oxygen tension in human melanoma xenografts.*
Supervisor: Einar K Rofstad

Tjervåg, Ragnhild; *Spin tunneling between ferromagnetic superconductors.*
Supervisor: Asle Sudbø

Woldene, Anne Stine; *Direct solar ultraviolet radiation measurements. Spectroradiometer testing and calibration.*
Supervisor: Berit Johanne Kjeldstad

You, Chang Chuan; *Superconducting Properties of Lead Thin Films and Array of Lines.*
Supervisor: Kristian Fossheim

Ødegård, Agnar; *Traces of Gamma-Ray Bursts.*
Supervisor: Bo-Sture Skagerstam

Aakervik, Odd Marius; *Computerization of a Gravitational Pendulum Viscoelastometer.*
Supervisor: Arne Mikkelsen

Cand. Scient.:

Auran, Hege:
Masse-overføring til svarte hull i Binær-systemer"
Supervisor: Hans Kolbenstvedt

Berre, Lodve:
Develpment of software for 4 Hz Ultrasonic Wind Sensor
Supervisor: Jørgen Løvseth

Fagerjord, Are Skjalg:
Gammaglimt
Supervisor: Jan Myrheim

Grøva, Morten:
Renormaliseringsteori
Supervisor: Kjell Mork

Johnsen, Sverre Gullikstad:
Towards optical quantum computing
Supervisor: Bo-Sture Skagerstam

Kjeldsberg, Ronny: *Nøytrionemisjoner fra nøytron-stjerners indre*
Supervisor: Sigmund Waldenstrøm

Kolstø, Morten Ivar: *"Hvite dverger"*
Supervisor: Jan Myrheim og Ingjald Øverbø

Langangen, Øystein Ole:
Non-Perturbative series in Quantum Field Theory
Supervisor: Bo-Sture Skagerstam

Lorentzen, Mona Methi:*Delbruk spredning*
Supervisor: Kjell Mork og Ingjald Øverbø

Sivertsen, Guri: *Hvordan evalueres elevene gjennom lærergitte prøver i naturfag og fysikk i videregående skole*
Supervisor: Per Morten Kind

Størvold, Bjørn:
Resonant AC Høyspenningsforsyning for elektrisk feltsonde. Utvikling og prototypfremstilling
Supervisor: Reidar Svein Sigmond

Master of Science

Mageto, Maxwell Joel
TEM study of microstructure in relation to hardness and ductility in Al-Mg-Si (6xxx) Alloys
Supervisor: Randi Holmestad

Melaku, Zinaye
Concentrating Solar Energy System for High Temperature Heat Production and their Potential in Ethiopia
Supervisor: Jørgen Løvseth

Menang, Kaah Promise;
Direct and Global Solar Radiation – Measurement and its use to Describe The Clear Sky Condition in Trondheim
Supervisor: Berit Kjeldstad

Yankson, Herbert Gustav:
Flow properties of laponite clay
Supervisor: Jon Otto Fossum

THESES - DOCTORAL STUDIES

Breiby, Dag Werner:
Ordering and Preferred Orientation in Films of Polymeric Semiconductors
Supervisor: Emil J. Samuelsen

Bruzell, Ellen:
Photoherapy of newborns suffering from hyperbilirubinaemia. An experimental study
Supervisor: Terje Christensen and Anders Johnsson

Bungum, Berit:
Perception of Technology Education
Supervisor: Per Morten Kind

Friis, Jesper:
Quantitative Convergent Beam Electron Diffraction and Charge Density Studies
Supervisor: Randi Holmestad

Frøseth, Anders:
Atomistic Modeling of the Al-Mg-Si Alloy System
Supervisor: Ragnvald Høier and Randi Holmestad

Holvik, Egil:
Betti designature and elastic demultiple of multi-component seismic data
Supervisor: Johan Høye

Ramstad, Ståle:
Effects of Electromagnetic Fields on Biological Systems
Supervisor: Anders Johnsson

Wittje, Roland:
Acoustics, Atom Smashing and Amateur Radio
Dr. philos. degree

Ådland, Hans Magne:
Rotational diffusion processes in segmented polymers. Theory and computer simulations
Supervisor: Arne Mikkelsen

ACTIVITIES TO PROMOTE "PHYSICS"

PRESENTATIONS THROUGH THE MEDIA

Fossheim, Kristian: *Johannes Haarklou - Ein av norsk musikks mest allsidige komponistar*
P2-Akademiet, NRK, NRK P2-Akademiet, 2003-01-30

Fossheim, Kristian: *Matematikken får sin Abel-pris* Firda 2003-06-05.

Fossheim, Kristian: *Åndens triumf får sin pris* Adresseavisen, kronikk 2003-03-28.

Samuelsen, Emil J.: *Rare ord og deira røter* "Menneske og miljø i Nord-Troms", Samuelsberg: Nord-Troms Historielag, 2003. 93-95 s.

Samuelsen, Emil J.: *Humbug om laser mot smerte og sus.* To innlegg i Malvikbladet, 2003-05-31 og 2003-06-28.

Svare, Ivar: *Magnekyl-tull!* Debattinnlegg i Adresseavisen 2003-01-06

Sudbø, Asle: *Nobelprisen i fysikk 2003* "Verdt å vite", P2 Norsk Rikskringkasting 2003-10-10

Sudbø, Asle: *Nobelprisen i fysikk 2003.* Kronikk i Aftenposten 2003-10-12

Sudbø, Asle: *Nobelprisen i fysikk 2003* Norsk Telegrambyrå 2003-10-10

Sudbø, Asle: *Nobelprisen i fysikk 2003* Kronikk i Adresseavisen 2003-10-11

PARTICIPATION IN EVALUATION COMMITTEES

Evaluation committee work

Borg, A.:
* PhD committee at University of Eindhoven, January 2003

Johnsson, A.:
* Sensor hovedfagseksamen ved NLH
* Sakkyndig prof II-stilling i Narvik

Mo, F.:
* Sensor ved eksamen i fysikk ved Høgskolen i Gjøvik

Holmestad, R.:
* 2. opponent, dr,scient, University of Oslo (J.P. Mæhlen)
* Evaluation committee, dr.ing. NTNU (I.L. Tangen)

Samuelsen, E. J.:
*Expert evaluation (January 2003) of ESF project 1244 EUROCORES 02-PE-SONS-130 'Nanoscale Electrical Transport in Self-Organized Molecular Assemblies' (NETSOMA). Participating labs: Eindhoven, Cambridge, Risø, Zürich
*Expert evaluation (May 2003) of professor position at Linköping University

Arrangements

Brattaas, A.:
* Organiser NorFa Meeting, August 2003, Røst

Fossheim, K.:
* Member, program committee, 3rd European Conference on Vortex Matter in Superconductors, Crete 20-28 September 2003
* Member, international advisory committee, M2S HTSC, the World Conference in Superconductivity, Rio de Janeiro, 25-30 May 2003
* Member, international advisory committee: ISS'03 International Superconductivity Seminar, Tsukuba Japan, October 27-29, 2003
* Member, international advisory committee for the 24th Risø International Symposium on Materials Science Superconductivity and Magnetism: Materials Properties and Developments 10.13. September 2003

Fossum, J. O.:
* Convenor of "Fredagskollokviet i fysikk", spring and autumn 2003

Hunderi, O.:
* Chairman of the Norwegian Electrooptics Meeting, Flåm, May 2003
* Member of the organizing committee, 3rd International Conference on Ellipsometry, Wien, July 2003
* Member of the organizing committee, OSI-2003, Leon, Mexico, May 2003

Kjeldstad, B.:
* Member of the scientific committee of the 30th Annual European Meeting on Atmospheric Studies, Longyear-byen, August 13-17
* Convenor of "Fredagskollokviet i fysikk", spring and autumn 2003

Løkberg, O. J.:
* Member of the organizing committee, Speckle metrology 2003, International Conference, Trondheim, June 18-20, 2003

Pedersen, H.:
* Member of the organizing committee, Speckle metrology 2003, International Conference, Trondheim, June 18-20, 2003

AWARDS

Professor *Kristian Fossheim* received the ALLFORSK award for his continuous work to popularize science in mass media. The prize was presented by the University at its official Annual Meeting. Kristian Fossheim has over many years presented topics of science in TV, radio, daily newspapers and popular science journals. This has led to a focus on several fields of physics in mass media, e.g. the field of superconductivity and super strong magnets and on the history of Nobel prizes in physics. This award thus emphasizes that an important part of the work of University is to present scientific activities and results for a general audience.

Førsteamanuensis *Thorarinn Stefansson* received the award "Innsats for pedagogisk nybrottsarbeid" from Teknisk-vitenskapelig Forening for his continuous development of laboratory courses at the Department. The Department is proud of awards earned by its members, and finds it very satisfactory that it is publicly noticed that the staff has a very high level in the educational and teaching activities, additional to scientific achievements.

Research actitivites at the University sometimes give rise to industrially interesting products or developments. Both the Norwegian Science Research Council and the University are actively promoting such activities. In this context the Department would like to emphasize results achieved by professor *Tore Lindmo*, Section Biophysics and Medical Technology. His research in the field of flow cytometry has led to industrial contracts that were focussed on in 2003. Thanks to the work by Tore Lindmo the Department received an award to further stimulate activities in industrial and commercial direction.

A joint project between our Department and the Department of electronics and telecommunication has obtained a prize in a competition of product launching (Venture Cup) and has advanced also to participation in the national competion. The project is concerned with surface properties of perovskites based on specific optic reflection methods. The work on such reflection methods was originally initiated by Professor *Ola Hunderi*. Possible industrial production is presently under serious consideration.

PARTICIPATION IN INTERNATIONAL, NATIONAL, UNIVERSITY AND DEPARTMENTAL COMMITTEES

International commissions:

Borg, A.:
* Member of the ESF Nanotribology network, University of Basel, Switzerland
* Committee on Condensed Matter Physics, Swedish Research Council
* Member of "Beredningsgrupp før kondenserade materiens fysik" The Swedish Research Council

Falnes, J.:
* Member of the Steering Committee of ECOR (Engineering Committee on Oceanic Resources) Working Group on Wave Energy Conversion, 1997-2003

Fossheim, K.:
* Member, Steering Committee Vortex Matter Programme under European Science Foundation, 1999-2004

Hansen, A.:
* Secretary to the Board of European Physical Society's Computational Physics group
* Member of the prize committee for European Physical Society's Berni Alder Prize in Computational Physics
* Member of the International Union of Pure and Applied Physics (IUPAP), Commission of Statistical Physics (C3)

Holmestad, R.:
* Norwegian representative board member in the Scandinavian Electron Microscopy Society (SCANDEM)

Hunderi, O.:
* Topical Editor, Journal of the Optical Society of America 1999-
* Editorial Board, New Journal of Physics 2002-

Johnsson, A.:
* Consultant, Italian Space Research Council
* Member of Research Committee, Swedish Space Science Research Board

Kjeldstad, B.:
* Member, Advisory board for establishment of EU reference UV laboratory at Joint Research Centre in Ispra, Italy. (2001 – 2004)
* Member of World Meteorological Organisation, Scientific Advisory Group for Ultraviolet Radiation Measurements (WMO UVSAG)

Mo, F.:
* Associate editor - Crystallography Review (Taylor & Francis)

Mork, K.:
* Editor, Physica Scripta

Naqvi, K.R.
* Member, International Union of Pure and Applied Chemistry Task Group for updating and expanding "Glossary of Terms used in Photochemistry"

Samuelsen, E. J.:
* Norwegian representative in Council of European Synchrotron Radiation Facility ESRF, Grenoble
* Member of Nordsync, Nordic Consortium for Synchrotron Radiation (Denmark, Finland, Norway, Sweden)

Skagerstam, B.S.:
* NorFA, Nordic Guest Professor in Quantum Optics

Valberg, A.:
* Norwegian representative in Division I (Vision and Colour), Commission Internationale de l'Eclairage (CIE)
* Member of CIE international technical committee TC1-37, Physiological based system of colorimetry
* Member of the board and Deputy Secretary of the International Society for Low-Vision Research and Rehabilitation

National commissions:

Borg, A.:
* Vice President, Norwegian Physical Society

Brataas, A.:
* Member of council of the planned network of excellence in EU 6th programme "Fundamentals of nanoelectronics"

Hansen, A.:
* Member of Working Group on Nanotechnology, Norwegian Research Council

Hemmer, P.C.:
* Member, board of Vista
* Member representing NTNU in board of Nansenfondet

Johnsson, A.:
* Member "Forskningsutvalget", Department of Physics, University of Olso

Kjeldstad, B.:
* Member, board of KLIMAPRO, Programme for climate research in Norway, The Norwegian Research Council
* Member, educational committee for geophysical courses at University of Svalbard

Mo, F.:
* Member of the Committee for Synchrotron Research of Norsk Synkrotronforskning AS

Olaussen, K.:
* Member of "Fordelingsutvalget for tungregning" The Norwegian Research Council.

Stokke, B.:
* Member of UHR, Nasjonalt råd for teknologisk utdanning
*Member, member board of NANOMAT, The Norwegian Research Council
* Chairman, board of council in NORLIGHT

Sudbø, A.:
*Chairman, Norsk Fysikkråd
* Member, NORDITA Committee on Condensed Matter Physics/Biophysics.

Valberg, A.:
* Member of the committee for Science and Development at Tambartun National Center for the Visually Handicapped

University and Departmental commissions:

Borg, A.:
* Committee member, Engineering studies at NTNU
* Chairman of Division of Condensed Matter Physics (until August)
* Chairman of the Educational Committee at Department of Physics

Davies de Lange, C.:
* Chairman of Division of Biophysics and Medical Technology

Fossum, J.-O.:
* Chairman of Division of Complex Systems

Hansen, A.:
* Vice Head of the Department of Physics, NTNU

Hunderi, O.:
* Member of the Board, Department of Physics, NTNU
* Chairman, Study Programme for Physics and Mathematics.

Johnsson, A.:
* Head, Department of Physics, NTNU
* Chairman, board of Museum of Natural History and Archaeology (Vitenskapsmuseet), NTNU

Kjeldstad, B.:
* Member, Board of Department of Physics
* Substitute member, Board of the Faculty of Natural Science and Technology
* Substiute member, Board of University of Svalbard
* Substiute member, Board of Sør-Trøndelag University College, Faculty of Technology
* Chairman of Division of Applied and Didactic Physics

Lindmo, T.:
* Manager Strategic University Programme in Medical Technology
* Deputy Director Strategic Area of Medical Technology at NTNU
* External member of the Board, Department of Mathematical Sciences
* External member of the Board, Department of Cancer Research and Molecular Medicine

Olaussen, K.:
* Chairman of Division of theoretical Physics, Department of Physics

Samuelsen, E. J.:
* Chairman of Division of Condensed Matter Physics (from August)

Skullerud, H.R.:
* Member, Board of the Faculty of Natural Science and Technology

Stefansson, T.:
* Member, board of steering committee, School Laboratory for Mathematics, Natural Sciences and technology, NTNU

Stokke, B.:
* Vice Dean of the Faculty of Science and Technology
* Chairman of faculty education committee
* Chairman, committee for "Nanotechnology", NTNU
* Member, board of committee for Medical Technology at NTNU
* Substitute member, Board - Programme for Education of Teachers, NTNU
* Member, committee for new degree structure (UNG), NTNU
* Project Director, Thematic Area Materials at NTNU

GUEST LECTURES AT THE DEPARTMENT

Friday afternoon lectures on subjects of general interest. ("Fredagskollokviet i fysikk")
Convenor: Berit Kjelstad and Jon Otto Fossum

Programme – Spring term
10.01 Dr. Jon Kåre Hansen, NERA, Bergen: *Characterization of semiconductors by second and fourth harmonic generation: equipment, theory and measurements.*

24.01 Professor Kjell Mork, Institutt for fysikk, NTNU: *Nobelprisen i fysikk 2002.*

31.01 Professor Hans H. Faanes, Institutt for elkraftteknikk, NTNU: *Energiloven og kraftprisene*.

7.02 Medisinsk fysikar Anne Beate Marthinsen, Kreftavdelinga, St.Olavs Hospital, Trondheim *Stråleterapi av kreftpasientar - status og utfordringar.*

14.02 Teknisk direktør Svein Ellingsrud, Electromagnetic Geoservices AS, Trondheim: *Elektromagnetisk havbunnslogging.*

21.02 Post.doc Jens Oluf Andersen, NORDITA: *Bose-Einstein kondensasjon.*

28.02 Professor Signe Kjelstrup, Institutt for kjemi, NTNU: *Dissipative systems, an inspiration for research in physical chemistry*.

7.03 Forsker Ivar Brevik, Statoil, Forskningssenteret: *Is physics the future key science in oil and gas exploration?*

14.03 Professor Jakob Stamnes, Institutt for fysikk, Universitetet i Bergen og Professor Knut Stamnes, Stevens Institute of Technology, Hoboken, USA: *Optical remote sensing of lakes and coastal waters - challenges and opportunities.*

21.03 Dr. Lene Oddershede, The Niels Bohr Institute, Denmark: *Optical Tweezers studies of Nature's smallest machines.*

28.03 Professor Steinar Raaen, Institutt for fysikk, NTNU *Nano-structured surface alloys - electronic properties and chemical reactivity*.

4.04 Adm.direktør, siv.ing Nils Skutle, Rosenborg ballklubb: *Samhandling - veien til suksess*.

25.04 Professor Peter Hänggi, University of Augsburg, Germany: *Brownian Motors.*

Programme – Autumn term
22.08 Professor Janos Kertesz, Department of Theoretical Physics, Technical University of Budapest, Ungarn: *Complex Networks: Structures and processes.*

29.08 Professor Gunnar Stette, Institutt for teleteknikk, NTNU: *Nye radiosystemer for kommunikasjon og kringkasting.*

05.09 Professor Catharina Davies, Institutt for fysikk, NTNU: *Hvorfor kureres ikke kreft? Transport av terapeutiske makromolekyler i kreftvev.*

12.09 Professor Øyvind Grøn, Avdeling for ingeniørutdanning, Høgskolen i Oslo: *Hva kan temperaturvariasjonene i den kosmiske bakgrunnsstrålingen fortelle om universet.*

19.09 Forsker Erik Skjetne, Statoil forskningssenter: *R&D on Improved Oil Recovery in Statoil.*

26.09 Professor Annik Magerholm Fet, Institutt for industriell økonomi og teknologiledelse, NTNU: *Utfordringer til industrien vedrørende bærekraftig utvikling og rapportering.*

03.10 Daglig leder Atle Kjærvik, Vitensenteret, Trondheim: *Eksperimentets betydning i pedagogikken (les forskningsformidlingen)*.

10.10 Professor John Rekstad, Fysisk institutt, Universitetet i Oslo: *Solar energy, from research to commerce.*

17.10 Førsteamanuensis Ingvill Holden, Nasjonalt senter for matematikk i opplæring, NTNU: *Matematikk på alles lepper - hvordan klarte vi det?*

24.10 Førsteamanuensis Jørgen Løvseth, Institutt for fysikk, NTNU*: Wind power in the perspective of sustainable development and physics.*

31.10 Seniorforsker Johan Hauknes, STEP Senter for innovasjonsforskning, SINTEF Teknologiledelse: *Samfunnsøkonomi - dynamisk teori eller sosialvitenskap? Hva kan økonomi lære av fysikk - og hva kan fysikk lære av økonomi?*

07.11 Professor Eystein Jansen, Bjerknessenteret (Senter for fremragende forskning), Bergen: *Utfordringer for klimaforskningen, med perspektiv fra Bjerknessenteret.*

14.11 Professor Christian Skau, Institutt for matematiske fag, NTNU: *Niels Henrik Abels vei inn i matematikkhistorien - Fra Lemniskaten til addisjonsteoreme.*

21.11 Post.doc Paul Gunnar Dommersnes, L'Institut Curie, Paris: *Fluid membranes: From neurons to nanotubes.*

28.11 Professor Mogen Høgh Jensen, Niels Bohr Institutt, København: *Oscillating Gene Expressions in Regulatory Network*