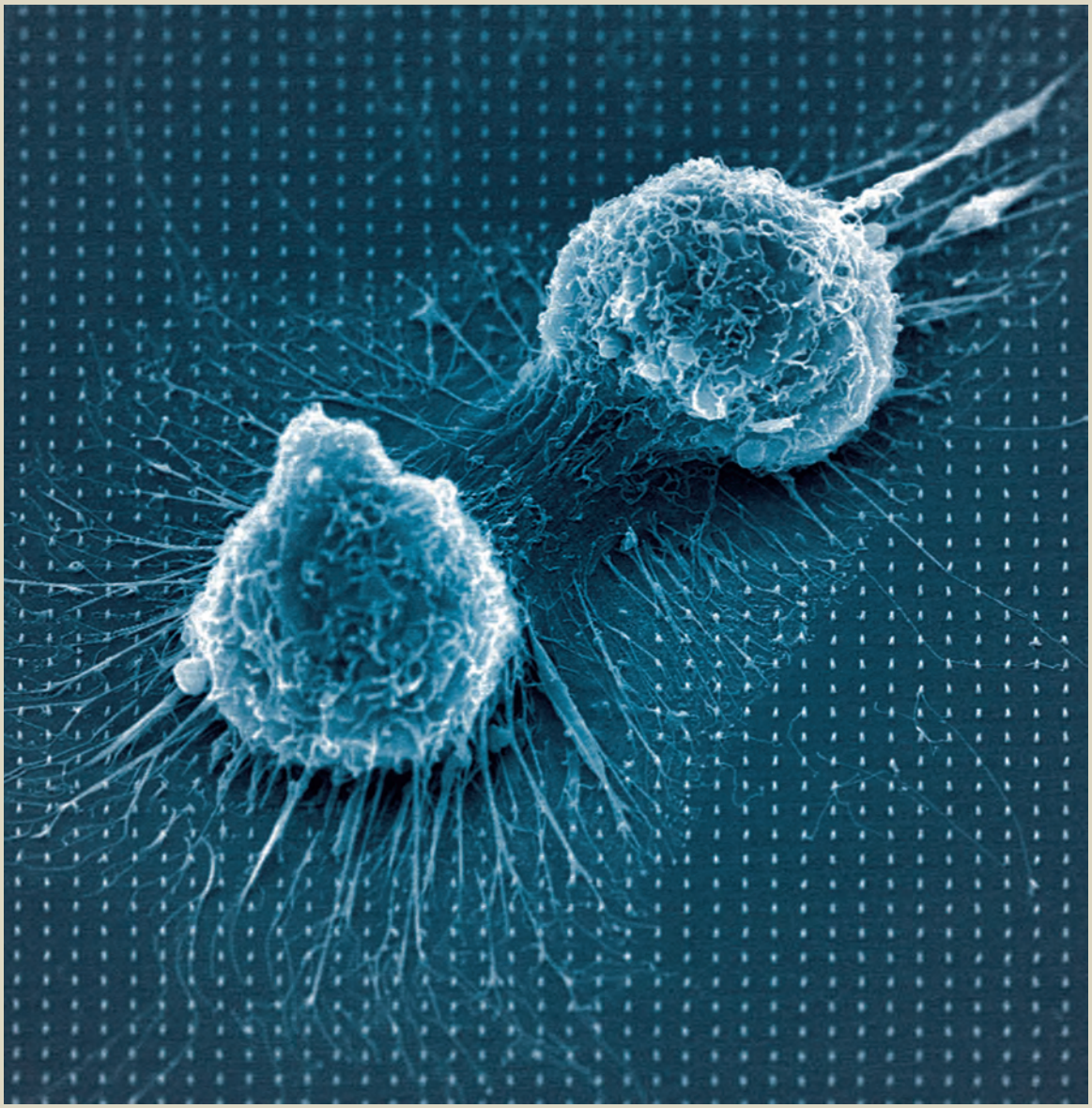
# Department of Physics

Annual Report 2013



NTNU
Norwegian University of Science and Technology

# DEPARTMENT OF PHYSICS, NTNU

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**COVER PAGE:**

Tekst:
Nanopatterned surfaces offer novel possibilities to influence and study cells. Here a HeLa cell is dividing on a surface decorated with epoxy nanopillars.

The picture is taken by **Kai Sandvold Beckwith**, using a scanning electron microscope at NTNU NanoLab, as part of his PhD-project entitled: “Nanostructured devices for cell studies”.

# LEADER FUNCTIONS

| | Spring | Autumn |
|---|---|---|
| **Head of the Department** | Professor<br>Asle Sudbø | Professor<br>Mikael Lindgren |
| **Deputy Head of the Department (education)** | Associate professor<br>Jon Andreas Støvneng | Associate professor<br>Jon Andreas Støvneng |
| **Deputy Head of the Department (research)** | | Associate professor<br>Erik Wahlström |
| **Head of Administration** | Head of office<br>Aud Lise Kulseth | Head of office<br>Aud Lise Kulseth |
| **Head of Technical Staff** | Senior engineer<br>Per Magne Lillebekken | Senior engineer<br>Per Magne Lillebekken |

## Departmental Board

| | | |
|---|---|---|
| **Head of the Department** | Professor<br>Asle Sudbø | Professor<br>Mikael Lindgren |
| **Representing the permanent scientific staff** | Associate professor<br>Dag Werner Breiby | Associate professor<br>Dag Werner Breiby |
| **Representing the temporary scientific staff** | Research scientist<br>Henrik Enoksen | Research scientist<br>Marianne Daae |
| **Representing the technical / administrative staff** | Senior engineer<br>Per Magne Lillebekken | Senior engineer<br>Per Magne Lillebekken |
| **Representing the students of the Department** | Student<br>Lars Rikard Stavrum | Student<br>Lars Rikard Stavrum |
| | Student<br>Simen Mikkelsen | Student<br>Simen Mikkelsen |
| **Appointed external members** | Research manager<br>Jostein Mårdalen,<br>SINTEF Petroleum Research | Head of office<br>Morten Sylvester, NTNU<br>Department of Public Outreach<br>and Exhibitions, University Museum |
| | Professor<br>Lisa Lorentzen, NTNU<br>Department of<br>Mathematical Sciences | Professor<br>Lisa Lorentzen, NTNU<br>Department of<br>Mathematical Sciences |

# DEPARTMENT OF PHYSICS, NTNU

www.ntnu.no/fysikk

# CONTENTS



**Edited by:**

Eli Ljøkelsøy Monsøy, Peder Kristian Brenne, Aud Lise Kulseth og Mikael Lindgren

The Annual report is also available on the internet address:
www.ntnu.no/fysikk/arsrapport

# A glance at 2013

The Department of Physics has a tradition of being one of the most scientifically outstanding and productive departments of NTNU. In 2013 we again ranked among the highest in publication ratio with papers in prestigious scientific journals. We have also educated more than 3400 students at various levels of physics every year, about 1350 of them in other study programs not directly related to physics. Over a 4 year period (2009-2013) the gross production of study-points has increased by almost 15%. In conclusion, The Department of Physics is still standing strong within its major duties: research and education.

For the department, 2013 was a year of many changes that came on top of a 5-year period with many retirements as well as new appointments. This has led to approximately 1/3 of the scientific staff being changed in a few years, resulting in new challenges to our research and teaching portfolios. There are also major changes on the horizon in the way things are to be carried out around us. The university is discussing new budget models and strives to finance more of our research from external funding, especially from the EU. The research council puts more money into large projects and national consortia, making it more difficult to get financing for free basic research in the traditional way. Another demand for all universities in Norway is to decrease the total number of study programs and sharpen the courses and their quality. These many changes are to be implemented in the near future.

The excellence of a department is in some sense the sum of all contributions from our excellent individuals carrying out their daily work. One example is Ingjald Øverbø who was awarded the Faculty of Natural Science and Technologys' (NT) Students Best Lecturer prize. Judging from all the students who were awarded prizes at NT and NTNU level, there are many more outstanding researchers and teachers that have been good advisors and teaching supervisors. For 2013 I would like to emphasize the prize for innovative presentation presented to Research Fellow Armen Julukian; Eskil Aursand received the prize for best graduate student 2012; the best thesis at the NT Faculty in Realfag was awarded to Jonas Rylund Glesaaen; and finally, Iver Bakken Sperstad received the Exxon Mobil award for the best PhD at NTNU.

When it comes to production and excellence at the Department of Physics, 2013 was indeed a good year.

Mikael Lindgren

Head of Department

# STAFF

***Head of Department***
Professor Asle Sudbø/Professor Mikael Lindgren

***Deputy Head of Department***
Associate professor Jon Andreas Støvneng
Associate professor Erik Wahlstrøm

## SCIENTIFIC STAFF

***Professors***
Jens Oluf Andersen, Anne Borg, Arne Brataas, Dag Werner Breiby, Catharina de Lange Davies, Patrick Joseph Espy, Jon Otto Fossum, Ursula Gibson, Alex Hansen, Robert Edward Hibbins, Randi Holmestad, Johan Skule Høye, Michael Kachelriess, Morten Kildemo, Jacob Linder, Tore Lindmo, Ragnvald Mathiesen, Arne Mikkelsen, Jan Myrheim, Kalbe Razi Naqvi, Kåre Olaussen, Steinar Raaen, Pawel Tadeusz Sikorski, Ingve Simonsen, Bo-Sture Skagerstam, Irina Sorokina, Bjørn Torger Stokke.

***Associate professors***
Peter Berg, Berit Bungum, Rita de Sousa Dias, John Ove Fjærestad, Pål Erik Goa, Antonius van Helvoort, Magnus Borstad Lilledahl, Anne Beate Langeland Marthinsen, Rolf Jonas Persson, Marit Sletmoen, Turid Worren Reenaas, Justin Wells, Ingjald Øverbø.

***Adjunct professors***
Pietro Ballone, Kenneth Dahl Knudsen, Roger Sollie, John Walmsley, Per Erik Wullum.

***Postdocs***
Mercy Afadzi, David Barriet, David Basset, Ruben Bjørge, Vladislav Dvoyrin, Yanjie Gan, Kamila Gawel, Zahra Ghadyani, Kjetil Magne Dørheim Hals, Kristin Høydalsvik, Eric Andrew Karhu, Jérôme Maria, Yrr Asbjørg Mørch, Sergey Ostapchenko, Alireza Qaiumzadeh, Zbigniew Rozynek, Ragnhild Sæterli, Nikolai Tolstik, Dung Trung Tran, Johanna van Wamel, Xiaodong Yang, Andreas Åslund.

***Research scientists***
Flemming Ehlers, Sylvie Lélu, Wajira Mirihanage, Katarzyna Maria Psonka-Antonczyk, Santanu Sinha, Linn Sofie Snipstad, Corrine Straub.

***Doctoral students***
Mohammad Alidoust, Arturo Amador, Nina Bjørk Arnfinnsdottir, Habib Baghirov, Jean-Philippe Banon, Kai Muller Beckwith, Sindre Bjørnøy, Troels Arnfred Bojesen, Teferi Dejene Demissie, Marianne Daae, Siv Eggen, Pål Gunnar Ellingsen, Henrik Enoksen, Martin Ervik, Bjørn-Tore Esjeholm, Camilla Espedal, Morteza Esmaeili, Ken Vidar Falch, Mari Helene Farstad, Vidar Tonaas Fauske, Vasco Rafael Povoa Fernandes, Andreas Finnøy, Vegard Flovik, Jostein Bø Fløystad, Peder Notto Galteland, Ming Gao, Amund Gjerde Gjendem, Knut Skogstrand Gjerden, Håvard Granlund, Arne Løhre Grimsmo, Morten Grøva, Elisabeth Lindbo Hansen, Leif Ove Hansen, Yngve Hofstad Hansen, Kristin Haugstad, Øyvind Storesund Hetland, Jon Holmestad, Sigmund Mongstad Hope, Lars Husdal, Armend Gazmeno Håti, Armen Julukian, André Kapelrud, Hanne Kauko, Nora Kleinknecht, Dmitry Klimentov, Jacob Berent Kryvi, Iryna Kulagina, Rajesh Kumar, Fredrik Aleksander Martinsen, Federico Mazzola, Maryam Gholami Mayani, Hanne Mehli, Magnus Strøm Mellingsæter, Leander Michels, Alexander Mikkelsen, Shamil Mirkhanov, Astrid Marie Muggerud, Eva Mørtsell, William Naylor, Mohammadreza Nematollahi, Torstein Nesse, Magnus Nord, Tor Nordam, Anna Maria Padol, Neelam Panjwani, Stanislav Polyakov, Srvani Keerthi Ramisetty, Andreas Lønning Reiten, Stefan Rex, Jonas Myren Ribe, Elisabeth Inge Romijn, Severin Sadjina, Takeshi Saito, Isha Savani, Tatyana Sherstova, Hans Langva Skarsvåg, Eirik Torbjørn Bakken Skjønsfjell, Arne Stormo, Morten Stornes, Daniele Toniolo, Erlend Grytli Tveten, Asle Heide Vaskinn, Maryam Vatanparast, Sigurd Wenner, Rosmarie Johanna de Wit, Lars Martin Sandvik Aas.

***Emeriti***
Johannes Falnes, Kristian Fossheim, Eivind Hiis Hauge, Per Christian Hemmer, Ola Hunderi, Anders Johnsson, Jørgen Løvseth, Tore Høe Løvaas, Thor Bernt Melø, Frode Mo, Kjell Mork, Emil J. Samuelsen, Svein Sigmond, Helge Redvald Skullerud, Arne Valberg.

## ADMINISTRATIVE AND TECHNICAL STAFF

***Head of Administration***
Aud Lise Kulseth

***Administrative staff***
Peder Kristian Brenne, Julie Lange Hansen, Inger Synøve Kosberg, Inger Johanne Bjørnerud Lian, Eli Ljøkelsøy Monsøy, Magni Rise Stølen.

***Head of Technical staff***
Per Magne Lillebekken

***Technical staff***
Irene Aspli, Astrid Bjørkøy, Ole Tore Buset, Knut Reidar Gjervan, Oddbjørn Grandum, Tor Jakobsen, Dagfinn Johnsen, Erling Kristiansen, Lise Kvaløy, Gjertrud Maurstad, Arne Moholdt, Jon Normann Ramlo, Inge Sandaunet, Daniel Skåre, Bjørn Gunnar Soleim, Bertil Olaf Staven, Kristin Grendstad Sæterbø.

# Economy

| | 2011 | 2012 | 2013 |
|---|---|---|---|
| Public funding | 137 351 | 117 035 | 113 474 |
| EU funding | 1 655 | 3 644 | 4 539 |
| **Sum income** | **139 006** | **120 679** | **118 013** |
| | | | |
| Wages | 91 935 | 96 087 | 92 890 |
| Operating expenses | 44 443 | 29 926 | 32 022 |
| **Sum expenses** | **136 378** | **126 013** | **124 912** |
| | | | |
| **Result** | **2 628** | **-5 334** | **-6 899** |

# AWARDS

**PhD candidate Armen Julukian awarded for innovative presentation.**

PhD candidate Armen Julukian at the Department of Physics was awarded for the most innovative presentation at the conference Nordic Drying Conference - NDC 2013. The conference took place in Copenhagen, June 5-7 2013.

**Associate professor Ingjald Øverbø awarded as best lecturer**

Associate professor Ingjald Øverbø at the Department of Physics, received the Faculty of Natural Sciences and Technology's prize for Best Lecturer in 2013. Øverbø received the prize at the annual Graduation Ceremony.

**MSc Jonas Rylund Glesaaen awarded at the Faculty Graduation Ceremony**

The Faculty of Natural Sciences and Technology award for best MSc in Natural Sciences went to Jonas Rylund Glesaaen at the program Master of Science in Physics. Glesaaen's supervisor was Professor Jens Oluf Andersen at the Division of Theoretical Physics.

**PhD Iver Bakken Sperstad awarded**

The award for best PhD at the Faculty of Natural Sciences and Technology, and the Exxon Mobile Research Prize 2013, went to Iver Bakken Sperstad for his dissertation “Dissipative quantum phase transtions and high-temperature superconductors”. Sperstad was supervised by Asle Sudbø at the Division of Theoretical Physics.

**Nanotechnology student awarded**

In June 2013 Eskil Aursand at the Nanotechnology program was awarded for best graduating candidate. Aursand accomplished his master's thesis at the Department of Physics, supervised by Professor Ingve Simonsen. The thesis discusses calculations of small nanoparticles in response to electromagnetic radiation.

# RESEARCH DIVISIONS

## APPLIED PHYSICS

***Head of Section***
Professor Patrick Joseph Espy (spring)
Associate professor Turid Worren Reenaas (autumn)

***Staff***
Professor Ursula Gibson
Professor Alex Hansen
Professor Robert Edward Hibbins
Professor Morten Kildemo
Professor Mikael Lindgren
Professor Ingve Simonsen
Professor Irina Sorokina
Associate professor Berit Bungum
Associate professor Rolf Jonas Persson
Postdoc. Vladislav Dvoyrin
Postdoc. Zahra Ghadyani
Postdoc. Eric Karhu
Postdoc. Jérôme Maria
Postdoc. Nikolai Tolstik
Postdoc. Xiaodong Yang
Research scientist Santanu Sinha
Research scientist Corrine Straub

### *Overview*

The Division of Applied Physics and Didactic Physics consists of several research teams carrying out research within the fields of *applied optics and laser physics; atmospheric, energy and environmental physics; computational physics; as well as physics education ("didactic physics").*

The applied optics group carries out advanced laser spectroscopy and imaging of molecular systems in biology and materials sciences *(Lindgren)*. The optics group also develops optical instrumentation prototypes in polarimetry *(Kildemo, Lindgren)* and theoretical modelling of optical properties of materials and surface reliefs *(Simonsen)*. The laser physics group works with femtosecond lasers based on optical fibers *(Sorokina)*.

Atmospheric, energy and environmental physics includes studies of climate processes, including atmospheric dynamics, composition and UV-irradiance, as well as the influence of solar radiation and energetic particles on the atmosphere (*Espy, Hibbins and Kjeldstad*). It also includes research in solar energy such as intermediate band solar cells, as well as new absorber materials and new concepts (*Reenaas and Gibson*).

Research in physics education (*Bungum, Persson*) involves research in physics and technology education in schools as well as at university level. The section also co-ordinates the Nordic research network NorSEd, with grants from NordForsk.

For 2013 we have chosen to give a more thorough account of two specific research projects carried out in Energy and Environmental research and Computational Physics.

### *Survey of research activities*

**Optical Materials**
(*U. Gibson, T.W. Reenaas, I. Sorokina, E. Karhu, F. Martinsen*)

There are two main topics of research in this area – transition-metal doped ZnS films for intermediate band solar cells and mid-IR lasers, and silicon-core fibers for solar cells.

Transition metal doping of II-VI semiconductors results in the formation of energy levels within the energy gap, which can be pumped for broad-band laser emission in the mid infrared, and are being explored to increase the efficiency of solar cells. We are using ultra-high vacuum deposition to deposit high purity thin films of these materials.

Silicon-core microfibers are being drawn at NTNU and in collaboration with J. Ballato at Clemson University, using an interface modifier technique developed here. A CaO layer forms a eutectic near the freezing point of the silicon, accommodating strain, while also serving as a sink for impurities. This allows us to use impure silicon as a starting material and still form microwires of sufficient purity for use in radial junction solar cells. The CaO etches preferentially after fiber formation and slicing. Figure 1 shows the cross-section of a wire after etching to expose the core. The cone-like structure can be used to direct incoming radiation to the core, increasing efficiency without increasing the fill-fraction of silicon.

These fibers are also being investigated for use in infrared optical transmission; to date the best multimode fibers have transmission losses of ~2dB/cm at 1.55 microns.

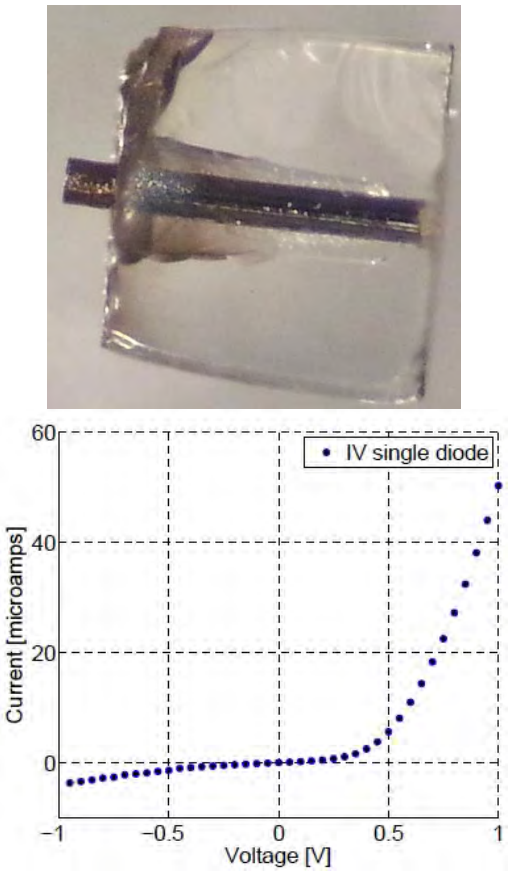


**Figure 1. Cross-section of etched fiber (top) and diode characteristics from a p-n junction made from a fiber (bottom).**

## Fluctuating Lines and Fiber Bundles

*(A. Hansen, K. Skogstrand Gjerden and A. Stormo)*

Since the beginning of the nineties, we have been a small group of physicists around the globe that has pondered the geometry of fracture surfaces. Fracture surfaces are rough. However, they are more than just rough. They show scaling. That is, changing the length scale we consider in the fracture plane by a factor $\lambda$ and the length scale in the direction orthogonal to the fracture plane by a factor $\lambda^H$, the fracture surface remains statistically unchanged. Moreover, the value of the roughness exponent H seemed not to depend on the material that had fractured. It was the discovery of this property that triggered our interest 25 years ago. On the theoretical side, we now see the fracture surface as the footprint of a fracture process which is operating in a critical state – hence the insensitivity of the roughness exponent to the material used.

In 1997, a fundamental experiment was performed by Schmittbuhl and Måløy at the University of Oslo. By sintering together two sandblasted Plexiglas plates and then plying them apart slowly, a rough crack front could be observed and measured as the process proceeded. It turns out that there are two roughness exponents describing the scaling properties of the fracture front: one on small scales and another on large scales.

A model based on a Langevin equation for an elastic line moving through a disordered landscape that pins it, turned out to give an excellent description of the large-scale scaling regime. However, the small-scale scaling regime remained unexplained, even though many attempts have been made to find an explanation. The Langevin approach – usually referred to as the Fluctuating Line Model - is a top-down approach which can be derived from linear elastic fracture mechanics.

PhD candidates Knut Skogstrand Gjerden and Arne Stormo have with Alex Hansen developed a bottom-up approach based on the fiber bundle model which reproduces all the results of the fluctuating line model on large scales but which also reproduce the small scale scaling regime. We call this approach the Soft Clamp Fiber Bundle Model.

# BIOPHYSICS AND MEDICAL TECHNOLOGY

***Head of Section***
Professor Tore Lindmo (spring)
Professor Catharina de Lange Davies (autumn)

***Staff***
Professor Kalbe Razi Naqvi
Professor Pawel Tadeusz Sikorski
Professor Bjørn Torger Stokke
Associate professor Rita de Sousa Dias
Associate professor Pål Erik Goa
Associate professor Magnus Borstad Lilledahl
Associate professor Anne Beate L. Marthinsen
Associate professor Marit Sletmoen
Postdoc. Mercy Afadzi
Postdoc. David Barriet
Postdoc. David Bassett
Postdoc. Kamila Gawel
Postdoc. Yrr Asbjørg Mørch
Postdoc. Johanna van Wamel
Postdoc. Andreas Åslund
Research scientist Sylvie Lélu
Research Scientist Katarzyna Psonka-Antonczyk
Research Scientist Linn Sofie Snipstad

## *Overview*

The section performs research on the length scale from single molecules to bacteria and cells, and to tissue and whole animals. A variety of imaging techniques such as atomic force microscopy, electron microscopy and focused ion beam-imaging, confocal laser scanning and multiphoton microscopy, and magnetic resonance imaging (MRI), are used together with other experimental methods such as optical tweezers, flow cytometry, and molecular techniques. Instrumentation and clean room available at NTNU Nanolab are also important infrastructure for our research. We combine experimental research with simulations and mathematical modelling. The research activity is divided into Medical physics and technology, Biopolymer and bionanotechnology, and Photo-biophysics.

## *Survey of research activities*

Medical physics and technology
http://www.ntnu.edu/physics/medphys

**Delivery of nanoparticles in tumour tissue and cells**
*(C. de Lange Davies, S. Lelu, M. Afadzi, S. Eggen, S. Hak, H. Baghirov, A. Åslund, R.Hansen, S.Mørch, W. Glomm, Y. Mørch)*

Multifunctional nanoparticles (NP) combining contrast agents for imaging and therapeutic agents have opened new possibilities in cancer diagnostics and therapy. Due to the leaky blood vessels in tumour tissue, there is a higher accumulation of the therapeutic agent in tumour tissue than in normal tissue. However, the tumour uptake is low and the distribution heterogeneous. The aim of our research is to study the mechanism and improve the delivery of nanoparticles.

**The behaviour of nanoparticles circulating in mice: Binding to endothelial cells and nano-particle dissociation.**

Nanoemulsion containing the MRI contrast agents gadolinium was labelled with a ligand binding to the receptor αvβ3 on endothelial cells. The data showed that it is possible to obtain quantitative information on receptor binding, internalization and recycling binding using dynamic contrast enhanced MRI. The binding to endothelial cells was verified with intravital microscopy (Fig1).
Intravital confocal laser scanning microscopy and dorsal window chambers on the back of mice was also used to study the dissociation of lipidic NP using Förster resonance energy transfer (FRET) of the NP circulating in blood.

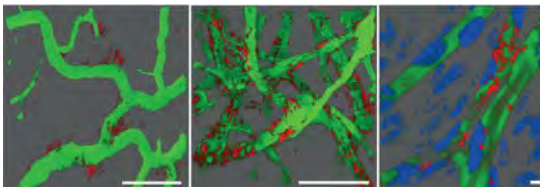

**Figure 1: Intravital microscopy of blood vessels (green), nanoemulsion (red) and cells (blue). Non-targeting nano-emulsion (left) and targeting nanoemulsion (middle and right). Image: Sjoerd Hak**

**Ultrasound-mediated drug delivery to tumour cells.**

Novel polymeric NPs of poly(butylcyanoacrylate) (PBCA) were developed and characterized. These NPs have the ability to stabilize gas bubbles thereby forming particles to be used for ultrasound imaging and delivery of therapeutic agents. Acoustic and mechanic properties of the gas bubbles were measured. The kinetics of the cellular uptake of the NP and encapsulated model drug (nile red) were studied. In prostate tumours growing in athymic mice, focused ultrasound was found to enhance extravasation and improve the penetration of the NP through the extracellular matrix, although the effect on extravasation was most prominent.

**Ultrasound-mediated penetration of nanoparticles across the blood-brain barrier**

One of the major challenges in treating diseases in the central nervous system (CNS) is the delivery of drugs to the brain. The access of molecules to the CNS is strictly controlled by the tight capillary endothelium that constitutes the blood-brain barrier (BBB). Focused ultrasound in the presence of microbubbles has been reported to temporarily open the BBB. We have demonstrated that focused ultrasound made the BBB in rats permeable for our PBCA-microbubbles. Efflux pumps pumping out drug from the endothelial cells forming the BBB also protects the brain tissue from drugs. Functionalizing gold-iron NP with siRNA silencing the P-gp efflux pump, we showed successful silencing of the pump and the drugs remained in the endothelial cells forming a BBB layer in vitro.

**Magnetic Resonance Imaging**
*(P.E. Goa, S. Hak)*

Magnetic Resonance Imaging is a highly interdisciplinary field, and our research is performed in close collaboration with the Department of Circulation and Medical Imaging at NTNU, as well as the Clinic of Radiology and Nuclear Medicine at St.Olavs Hospital HF. Examples of current projects are:
*Accelerated 3D-EPI for functional MRI applications at high magnetic fields*
(J. Ladstein, A. Kristoffersen, A.K. Håberg, P.E.Goa)
*Transverse relaxivity of iron oxide nanocrystals clustered in nanoemulsions*
(S. Hak, P.E. Goa, S. Stenmark, F.F. Bjerkholt, O. Haraldseth)
*Advanced Diffusion weighted MRI for Breast Cancer Tumor Classification*
(J. Teruel, P.E. Goa, H. Fjøsne, A. Østlie, T.F. Bathen)

**Clinical applications of multiphoton microscopy**
*(M. Lilledahl, R.h Kumar, E. Romijn, A. Finnøy)*

Multiphoton microscopy is an ideal tool for studying many biological molecules. Many important molecules like collagen, elastin and many lipids can be imaged without any exogenous stains, thereby simplifying in vivo imaging and the potential for clinical applications. Our research aims to identify such clinical applications, develop the necessary analysis tools, and understand the biological relevance of the data to develop multiphoton microscopy as a clinical tool.

**Stromal changes in breast cancer**
*(A. Braband, I. Kariuki, A. Bofin, M. Lilledahl)*

The cellular component has naturally been the target for most cancer research. In tumor diagnosis, the number, size and shape of the cells are often used for diagnosis. Recently it has been shown that the stromal component plays a major role in the development of the disease. Primarily has a diagnostic marker, as cancer with different degrees of malignancies likely will change their surrounding stroma differently. By using second harmonic generation to image collagen fibers in different areas of the tumor we have shown that the structure of the stromal component can easily be used to differentiate cancer tissue from normal tissue.

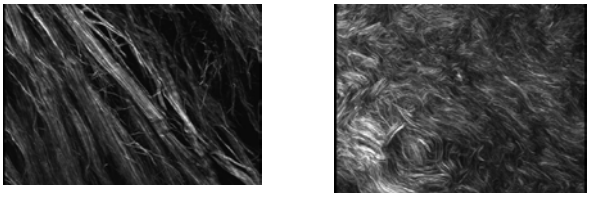

**Figure 2: Intratumoral collagen fibers (left) and extra-tumoral collagen fibers (right)**

***3D quantitative imaging of collagen structure***
*(E. Romijn, M. Lilledahl)*

In biomechanical models of tissue, the collagen component is an integral part as it imparts the primary stiffness to the tissue. To have accurate models, accurate input parameters regarding collagen structure are needed. Second harmonic generation is an ideal tool for characterizing this structure as it gives a 3D image of the collagen structure without endogenous staining. However, due to an anisotropic point spread function, quantitative analysis is difficult. We have developed an algorithm based on Fourier analysis which quantifies the structure of these fibers based and removes the effect of the point spread function. Using this, we can extract quantitative 3D information which is utilized in biomechanical models.

**Tissue engineered cartilage**
*(M. Olderøy, M. Lilledahl, J.E. Brinchman)*

During osteoarthritis, the cartilage covering articular joints are degraded leading to painful and debilitating conditions. Several surgical repair techniques have been developed but as of yet there are no accepted long term solutions to the problem. An attractive technique is using stem cells which are seeded in an alginate gel where they differentiate into chondrocytes and starts to produce the matrix components which make up cartilage. However, to produce fully functional tissue, the resulting structure is very important. We have been using second harmonic generation to characterize the structure of matrix and correlate this with different culturing conditions. This will let us optimize the conditions to achieve the optimum tissue structure.

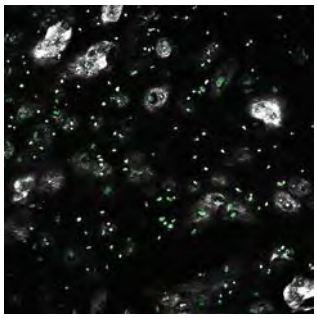

**Figure 3: Stem cells (stained with DAPI-green) secrete collagen fibers which align in fibrils, imaged with second harmonic generation (white)**

**Optical analysis of osteoarthritis**
*(R. Kumar, Jon Olav Drogset, Kirsten Marie Grønhaug, Jostein Halgunset, Magnus Lilledahl)*

Understanding the development of osteoarthritis is of vital importance in assigning appropriate treatment as well as developing. We are collaborating with surgeons at the Hospital in Levanger where we have studied cartilage samples which have been excised during total knee replacement surgery. These samples have been studied with an array of optical techniques which included nonlinear microscopy, Raman microscopy, and immunohistochemistry. By analyzing this data we hope to be able to further understand the progression of osteoarthritis.

## Biopolymers and bionanotechnology

**DNA condensation; Experimental and Monte Carlo studies**

**DNA condensation and decondensation using mixed cationic agents**
*(R.S. Dias, A.F. Jorge, A.A.C.C. Pais)*

Efficient DNA condensation and decondensation, as well as low toxicity, are required for an efficient gene delivery system. Polyethyleneimine (PEI) is a popular condensing agents but its large toxicity is a drawback for *in vivo* applications. We have explored the possibility of replacing some of the PEI by Fe(III) ions, believed to be less toxic to the cells. We have seen the presence of the metal ions significantly reduces the amount of PEI necessary to condense DNA, and that this strategy makes DNA decompaction by heparin easier, starting from similar degrees of condensation. Furthermore, a lower toxicity of DNA-PEI-Fe(III) complexes was observed, when compared to native DNA-PEI complexes with the same degree of condensation and values of zeta potential. It was also found, using Monte Carlo simulations, that the improved effect of the multivalent ions is related to the preferred position of the trivalent ions in the DNA areas less populated by the PEI chains, which facilitates the overall condensation.

**DNA condensation in model bacterial cells**
*(R.S. Dias, S.K. Ramisetti)*

In 2013 we have started a new project, having as main focus the study of DNA condensation in bacteria. In eukaryotic cells (e.g. humans), DNA compaction is promoted by the organized wrapping of the DNA around proteins called histones. Histones do not exist in bacteria. Instead, there are a few other types of proteins that modulate the DNA by inducing, for example, its bending and bridging. In addition, and contrary to eukaryotic cells, bacteria have no nuclear membrane and the large concentration of macromolecules (RNA and proteins) on the cytoplasm is believed to help DNA condensation, by molecular crowding effect.
We employ a range of techniques to evaluate the conformation of DNA in bacteria cell.

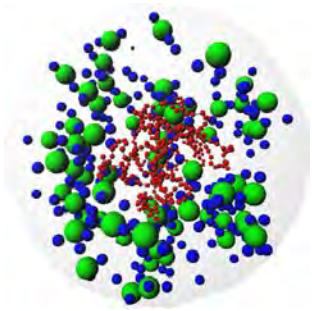

**Figure 4: Snapshot of a model bacterial cell with the DNA in red and crowding molecules in green and blue.**

## Bionanotechnology

http://www.ntnu.edu/physics/bionano

*(P. Sikorski, D. Bassett, K.M. Beckwith, S.H. Bjørnøy)*

The group is working the field of biomaterials and the application of nanotechnology and nanostructured surfaces for biophysics and cell biology research. In our research we extensively use the NTNU Nanolab, both for the characterisation of biomaterials, as well as for the development of new nanotechnology based devices. What sets our approach apart from other studies in the field is a focus on robust, inexpensive and high throughput fabrication methods, as cell biology research often requires large area, single use devices. We work on several research topics, which are briefly summarized below.

### Application of focused ion beam/scanning electron microscopy (FIB/SEM) for the characterization of cells, tissues and biomaterials.

A successive series of FIB/SEM images is collected after nm-thin sections of the samples have been milled away using the ion beam, which are then used to create 3D reconstructions of tissue organization with nm-resolution.

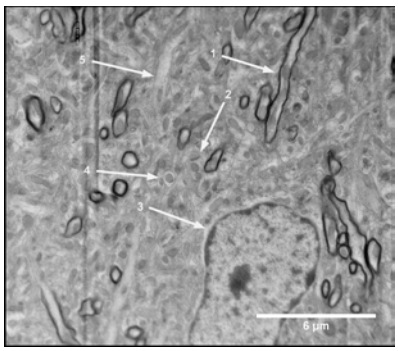


**Figure 5: Image of epoxy embedded and contrasted brain tissue collected using SEM in the FIB/SEM instrument. The arrows point to details in the tissue. 1: Myelin-coated axone, 2: Synapse, 3: Cell, 4: Cross section of a dendrite, 5: Also cross section of a dendrite, but along the long axis. Image Marianne Sandvold**

### Cell arrays and cell nanostructure interactions.

Co-culture of two different cell populations, organized by control of cell adhesion to a surface. Here, small cell adherent patterns have been printed on a surface to which cells can not adhere. The green cell population could only adhere to this printed pattern. In the 2nd step, the surrounding area was re-activated allowing the 2nd cell population to adhere. This type of technology can be used to study cell-cell interactions and develop enchanced tools for cell biology research.

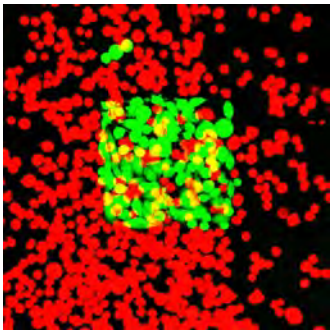

**Figure 6: Coculture of cells in green and red adhering to different pattern. Image: Kai M. Beckwith**

### Design and fabrication of mineralized hydrogel materials for biomedical applications.

In this work we focus on controlled incorporation of mineral phases into hydrogels, to understand the interplay between organic and inorganic phases and to create new types of materials for biomedical applications with a particular focus on bone tissue engineering.

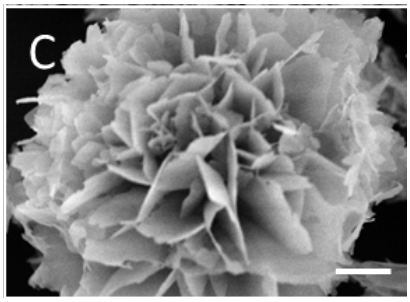


**Figure 7: This SEM image shows a copper phosphate crystal prepared as a part of research into biomineralization of alginate based hydrogels. Image: David Bassett**

**Biopolymer mesoscale structural organization and interactions**

http://home.phys.ntnu.no/brukdef/prosjekter/biopolymerphysics/

*(B. T. Stokke, K. Psonka-Antonczyk, K. Gawel, A. Padol, M. Gao, T. Sherstova, J.M. Ribe, A.G. Håti)*

Our research focuses on mesoscale structure formation and interactions within biological macromolecules. This research field includes the internal and collective organisation of biological polymers that is crucial for life, and the knowledge obtained forms a basis for various technological exploitations. We are currently pursuing research topics as e.g., polyelectrolyte complexation, bio-polymer multilayers and gels, (1,3)-β-D-glucans and their interactions with polynucleotides, physics of enzymatic mode of action, responsive gels as biospecific signal transducers, and nanoscale studies of macromolecular interactions. In addition to classical ensemble averaging techniques, application of single-molecule techniques is a distinctive facet of our approach to tackle core issues within these topics. See the website for further information.

In 2013 we reported on nanoscopic studies of amyloids, a water soluble, bioactive beta-glucan from yeast cell wall, and cell wall structures from apples following extraction of various components. Correlative atomic force microscopy and hyperspectral imaging using conformation sensitive fluorescence probe of artificial generated amyloids led the basis for the use of fluorescence emission profiles as probe for amyloid maturation in animal models. The correlation between higher order structures of beta-glucans and their bioactive form, e.g. biological response modifier, is a long standing research issue. Our 2013 publication of the yeast cell wall derived beta-glucan indicates that this is also a triplex structure. This is despite that this is a long chain branched sequence at variance with the regular comblike nature of other beta-glucans adopting the triplex structure.

An interferometric platform capable of monitoring changes in hydrogel swelling with 2 nanometer resolution led the basis for the following 2013 reports. In the first example, a polyanion hydrogel exposed to cationic surfactant and subsequent to cyclodextrins was characterized. The changes in the equilibrium swelling as function of concentrations of surfactants and cyclodextrins revealed changes dependent ability to form micelles and capacities to perturb interactions involved in the equilibrium conditions. Cholesterol modified pullulan was used as the basic polymer network building block in the second example investigated. The cholesterol groups forms nanoscopic domains in aqueous solution and thereby induce collapse of the hydrogels. An increase in the hydrogel swelling was observed associated with increasing concentrations of cyclodextrin, in a way that reflected the interaction strength between the cyclodextrins and the cholesterol groups. The interferometric readout providing superior resolution compared to e.g. diffraction limited optical imaging, yielded high resolution data of triggered dimensional changes by external stimuli. In the third example, we determined the mechanical properties of a thin layer of polymer impregnation of an ionic gel surface by its constraining effect on electrostatic determined swelling.

The 50$^{th}$ anniversary issue of Biopolymers focusing on Glycopolymers was published in 2013. In this context, we were invited to review features of biological, non-crystalline polymers important for their molecular understanding. Topics included effect of duplex and triplex structures within polysaccharides, control of sequence in binary co-polysaccharides, and polyelectrolyte complexation and multilayer formation. In particular, the overview of impact of duplex and triplex organization of the polysaccharides xanthan and beta-glucans on their ability to enhance their stability, including also the release of the oligomers, has offered new insights into these materials.

**Immobilization of single bacteria in predefined patterns using microcontact printing.**

*(M. Sletmoen, K.E. Haugstad, N. B. Arnfinnsdottir, J. Nilsen-Nygaard)*

Application of single molecule tools based on atomic force (AFM) or optical tweezers (OT) for determination of molecular interactions are central in our activity. Additionally, we have activity related to the immobilization of single bacteria in predefined patterns using microcontact printing. This work is motivated by the knowledge that the behavior of individual bacteria often differs from

that of the average population both with respect to growth rates and gene expression. Furthermore, individual bacteria may adopt rare phenotypes and display oscillatory behaviors that are not synchronized across the population. High-resolution, time-lapse microscopy of single bacteria immobilized onto a solid support is a powerful method for studying such natural heterogeneity in bacterial behavior, of which much is still to be discovered. We explore application of soft lithography for preparation of patterned supports designed for monitoring of bacterial populations at the individual bacterial level.

Surfaces with arrays of circular spots (diameter 0.8 – 5 μm) of bacterial adhering chemicals surrounded by chemicals that resist bacterial adhesion are obtained using micro contact printing. The master used to make the PDMS stamp needed for the micro contact printing was prepared by photo-lithography at NTNU Nanolab. In order to achieve immobilization of single cells onto these spots, we have optimized the surface chemistry in respect to both maximizing the probability for bacterial adhesion on the functionalized spot, as well as simplicity of array production. The design of the chemical patterns has also been optimized with respect to size of and separation distance between the bacterial adhering islands. The identification of optimal parameter choices for the array production is based on array inspection using both bright field and confocal microscopy as well as image analysis. The arrays obtained showed the immobilization of either single or multiple bacteria onto the spots on the microcontact printed array, with a correlation between spot size and bacteria multiplicity. Based on these arrays the optimal spot size for immobilization of single bacteria was identified, and arrays showing a high probability for immobilization of single bacteria have been obtained (Fig 8).

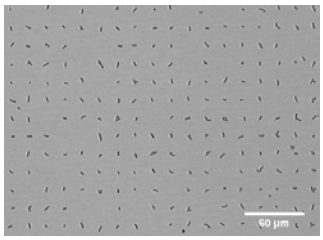


**Figure 8: Bacterial microarrays observed using confocal microscopy. Photo: Vegar Ottesen**

## Photobiophysics

*(K. R. Naqvi)*

### Photoprotection in light-harvesting complexes

When plants are exposed to a light level higher than the optimum, chlorophyll (Chl) molecules in the long-lived triplet state ($^3$Chl) are formed, which are capable of sensitizing singlet oxygen ($^1O_2$), a species detrimental to the photosynthetic apparatus of plants. In order to sustain the photosynthetic activities, plants have evolved multiple photoprotective mechanisms based on quenching $^3$Chl as well as $^1O_2$. The lumenal loop of light-harvesting chlorophyll a/b complex of photosystem II (LHCII) plays important roles in regulating the pigment conformation and energy dissipation. Site-directed mutagenesis analysis was applied to investigate triplet–triplet energy transfer and quenching of $^3$Chl in LHCII. The amino acid at site 123 located in this region was mutated to Gly, Pro, Gln, Thr and Tyr, respectively, and fluorescence excitation spectra, triplet-minus-singlet (TmS) spectra and kinetics of carotenoid triplet decay were recorded (for wild type and all the mutants). A red-shift was evident in the TmS spectra of the mutants S123T and S123P, and all the mutants except S123Y showed a decrease in the triplet energy transfer efficiency. On the basis of these data and the available structural information, it has been proposed that the observed changes are related to the involvement, due to conformational changes in the lumenal region, of a long-wavelength lutein (Lut2) involved in quenching $^3$Chl.

### Photoprotection in riboflavin-containing beverages

Milk and other riboflavin-containing beverages are vulnerable to photodamage, because riboflavin absorbs strongly in the visible region, and triplet riboflavin ($^3$Rib) sensitizes $^1O_2$. Previous claims to the effect that the lifetime of $^3$Rib is rather short (ca. 15 μs) and that crocin, a highly water-soluble naturally occurring carotenoid, is unable to quench $^3$Rib have been shown to be incorrect. Crocin and other hydrophilic carotenoids (Car) have been found to quench at a rate close to that of a diffusion-controlled reaction, and quenching occurs both by triplet-triplet energy transfer and electron transfer (from $^3$Rib to Car).

### Conjugated polymers

The electroluminescence and photovoltaic properties of conjugated polymers attracted much interest because these materials are seen as cheaper alternatives to inorganic optoelectronic devices. The underlying physics behind the properties of

conjugated polymers is rather complex and may involve solvent relaxation, intra or inter chain energy transfer and conformational relaxation of the polymer backbone. Since the exciton is not delocalized over the entire chain but remains confined to just a few segments of the main backbone, the use of oligomers as model compounds enables us to disentangle several of the above mentioned photophysical processes. The problem of conformational relaxation in nonpolar solvents was analyzed in the preceding year in terms of a stochastic model based on a mechanochemical analog that includes the participation of the oligomer side chains in storing and dissipating the stresses induced by photoexcitation. The model was applied to a series of PPV (poly-phenylenevinylene) trimers to predict the relaxation rate constants over a wide range of solvent viscosities as well as its temperature dependence. By treating transport properties as local quantities, the model allows prediction of viscosity in the nano-volume surrounding the oligomer. This year the model was extended to new systems, in particular those which are predicted to relax in the sub-ps timeframe such has PPV's without (or very small) side chains and/or P3HT's (3,4',4''-trihexyl-2,2':5',2''-terthiophene) poly-thiophenes which have a considerably smaller number of side chains than the previously reported systems. Since nonpolar solvents such as chloroform are widely used to solubilize polymer films, an extension of the earlier viscosity model to polar solvents was also undertaken.

**Other projects**

A new pulsed-source phosphorimeter has been constructed, and it has been demonstrated that a specially wired ungated photomultiplier tube (PMT) slightly outperforms a gated Hamamatsu PMT that has recently become commercially available. Room-temperature delayed fluorescence of riboflavin in aqueous solutions, unreported previously, has been used for investigating triplet-state kinetics.

A quantitative analysis of screening hypochromism of red blood cells has been carried out and short-comings of previous attempts have been identified.

# COMPLEX MATERIALS

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Professor Steinar Raaen (autumn)

***Staff***
Professor Jon Otto Fossum
Professor Bo-Sture Skagerstam
Associate professor Peter Berg
Adjunct professor Pietro Ballone
Adjunct professor Kenneth Dahl Knudsen
Postdoc. Zbigniew Rozynek

## *Overview*

The division carries out research within *physics of soft and complex materials*. The phenomena studied include: Nanostructured surface alloys, clay-containing systems, spontaneous and guided self-assembly of nanoparticles of various kinds, diffusion properties in nanoporous media, anomalous diffusion processes and mechanical properties of granular media, multiphase flow in porous media, and nonlinear, electro-kinetic flows in porous media.

The research comprises the use of experimental, computational and theoretical methods.

The list of the *experimental instruments* and facilities situated at the department is long: X-ray photoelectron spectroscopy (XPS); ultraviolet photoelectron spectroscopy (UPS); low energy electron diffraction (LEED); photoemission electron microscopy (PEEM); temperature programmed desorption (TPD) spectroscopy; a range of UHV sample preparation techniques; wide- and small-angle X-ray scattering; static and dynamic light scattering; light microscopy; measurements of dynamic viscoelastic properties of soft materials (rheology); microcalorimetry; thermo-gravimetry; dynamic electro-optic properties of molecules in solution; circular dichroism.

Using *computational methods* we study various complex phenomena including reactive, electro-kinetic flows in rigid and soft porous media.

The *theoretical studies* are mainly on condensed matter physics, statistical physics and quantum optics.

## *Survey of research activities*

**Electro-kinetic flow phenomena at the micro- and nanoscale**
(*P. Berg*)

Our group studies the dynamics of electrolytes and, in particular, whether continuum models can be applied to describe their properties, both at thermodynamic equilibrium and in non-equilibrium settings.

Recent advances in the development of electrochemical energy devices such as fuel cells, batteries and super-capacitors, have led to a renewed interest in such mean-field models. These can be especially useful when capturing the corresponding flow phenomena of electrolyte solutions in micro- and nanopores, and relating these to data which has been collected experimentally.

The main focus lies on electro-diffusion in polymer electrolyte membranes (PEM) and catalyst layers, as used in PEM fuel cells. Both reactive and non-reactive flows are of interest, including their interplay with the pore morphology. Lately, the research efforts have been expanded to explore nanobubble dynamics in water electrolysis and nanofluidic diodes, as well as stochastic models for the oxygen reduction reaction.

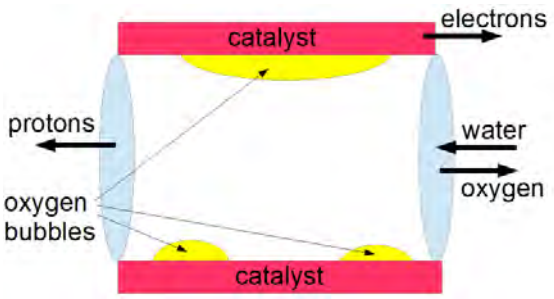


**Figure 1. Nanobubble formation inside an anode electrode pore during water electrolysis: the pore liquid (water) contains protons and oxygen, the bubbles contain oxygen and vapour.**

Apart from classical mean-field theory, theoretical approaches also comprise random pore networks, lattice models, simplified two-phase flow models and stochastic simulation algorithms (SSA).

Research is conducted in collaboration with Professor Michael Eikerling at Simon Fraser University in Canada, Dr. Markus Schmuck at Heriot-Watt University in the UK, Dr. Juergen Fuhrmann at WIAS in Germany and Dr. Andre Leier at OIST in Japan.

**Experimental investigations of soft and complex matter: From nano to macro.**
(*J.O. Fossum*)

The research group has during several years focused on basic understanding of problems within soft and complex materials, in particular physical phenomena in soft matter using synthetic nanolayered silicates (clays), as physical complex model systems. Main physical phenomena studied in these systems include flow and diffusion processes, intercalation processes, spontaneous self-organization into liquid crystalline phases in systems of nanoplatelets, and guided self-organization into electro-rheological and magneto-rheological systems with smart material properties. The most important experimental methods used at NTNU include standard microscopy, as well as AFM and STM; rheometry in external applied fields (magnetic or electric); visible light scattering; and wide- and small-angle X-ray scattering. Synchrotron X-ray scattering is performed at ESRF in Grenoble, France, LNLS in Campinas Sao Paulo, Brazil, PAL in Pohang, South Korea, Maxlab Lund University in Sweden. Small-angle-neutron-scattering (SANS) studies are performed at IFE, Kjeller. Magnetic resonance-spectroscopy and -imaging are performed in collaboration with Universidade Federal de Pernambuco, Recife, Brazil. Other international collaboration with University Paris7, ESPCI-ParisTech, University Rennes1 in France, University of Amsterdam, University of Havana Cuba, and not the least Universidade de Brasilia, Pontifica Universidade Catolica do Rio de Janeiro (PUC- Rio) and others in Brazil.

**Publication highlights from 2013:**

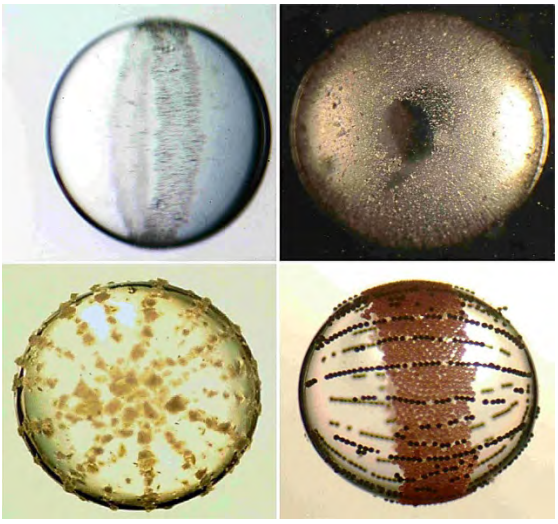

**Figure 2.** ***Active structuring of colloidal armour on liquid drops*****, P. Dommersnes, Z. Rozynek, A. Mikkelsen, R. Castberg, K. Kjerstad, K. Hersvik and J.O. Fossum, Nature Communications, DOI: 10.1038/ncomms3066 (2013).**

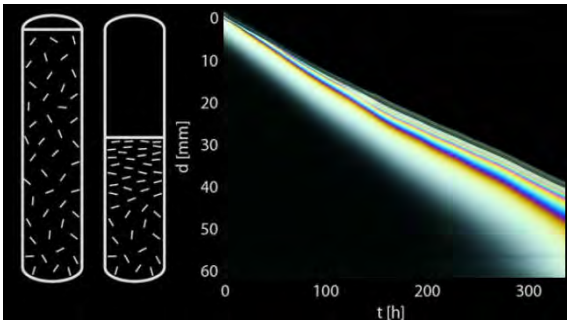


**Figure 3.** ***Orientational order in a glass of charged platelets with a concentration gradient*****, E.L. Hansen, S. Jabbari-Farouji, H. Mauroy, T.S. Plivelic, D. Bonn, J. O. Fossum, Soft Matter, 9, 9999-10004, DOI: 10.1039/C3SM52103F (2013).**

The article referred to in Fig.2, that was published in *Nature Communications, 4, 2066 (2013) DOI: 10.1038/ncomms3066*, is concerned with adsorption and assembly of colloidal particles at the surface of liquid droplets, which are at the base of particle-stabilized emulsions and templating. We reported that electro-hydrodynamic and electro-rheological effects in leaky-dielectric liquid drops can be used to structure and dynamically control colloidal particle assemblies at drop surfaces, including electric-field-assisted convective assembly of jammed colloidal 'ribbons', electro-rheological colloidal chains confined to a two-dimensional surface and spinning colloidal domains on that surface. In addition, we demonstrated the size control of 'pupil'-like openings in clay colloidal shells. We anticipate that electric field manipulation of colloids in leaky dielectrics can lead to new routes of colloidosome assembly and design for 'smart armoured' droplets.

*The article referred to in Fig. 3, was published in Soft Matter, 9, 9999-1000 (2013), DOI: 10.1039/C3SM52103F,* and is concerned with colloidal dispersions of anisometric particles which can display dynamical arrest and ordering involving both translational and rotational degrees of freedom. We show that orientational order can develop in glassy colloidal dispersions of charged platelets when a concentration gradient is imposed through solvent evaporation. Our model system of Laponite clay (LRD) platelets in deionized water has been extensively studied for its ergodic to non-ergodic transitions, and the existence of an underlying isotropic–nematic phase transition has been a subject of debate. We used small-angle X-ray scattering, dynamical light scattering and birefringence to show that the orientational order we observe does not result from an underlying, uniquely determined equilibrium state with orientational order, but from plastic deformation of the colloidal glass.

**Polymer-nanoparticle systems**
(*K.D. Knudsen*)

The research has recently been focused on nanoparticle-polymer systems, where particles are embedded at low concentrations into the polymer matrix in order to modify the properties of the material. The particles used are generally clay-based, thus highly asymmetric (disk-shaped), and can be oriented inside the matrix by external stimuli such as electric fields. They are typically surface treated with organic molecules in order to be properly integrated into the polymer matrix and maintain an individual, non-aggregated state. The latter is an important factor with respect to the mechanical properties of the polymer, as well as to the high-temperature resilience. We have recently shown how also the intrinsic surface charge - that varies between different types of clay nanoparticles - has a significant effect on the final properties of the material.

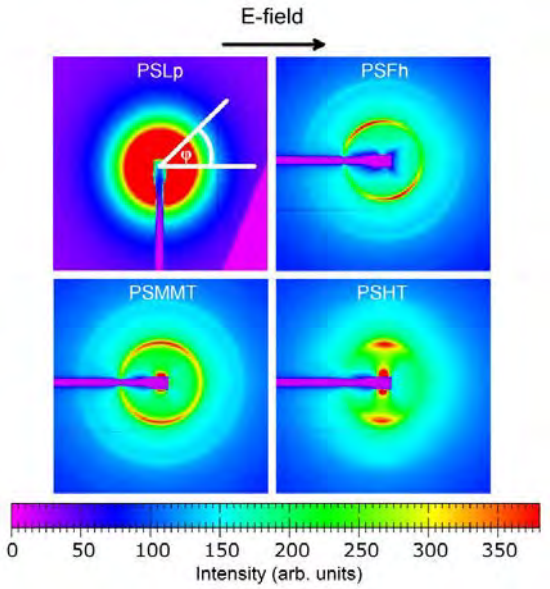


**Figure 4. 2D scattering patterns of four 3 wt% polystyrene-clay nanocomposites polymerized inside an E-field and probed normal to the E-field direction. (H. Mauroy)**

In order to gain information on the nanostructure of these materials, we rely heavily on various scattering methods, using mainly neutrons and high-intensity X-rays as probes. Via the collaboration with the Institute for Energy Technology (IFE) we have unique access to specialized instrumentation, particularly small-angle neutron scattering. This method is especially useful for the study of soft and light materials, such as polymers, due to the negligible radiation damage and selective interaction for neutrons compared to X-rays.

**Dynamic electro-optic measurements of biopolymers and clay particles**
(*A. Mikkelsen*)

The rotational diffusion properties of macromolecules in solution are measured using electrically induced transient birefringence. A primary goal is a deeper understanding of the interplay between functions and structural dynamics of e.g. clay particles. The experimental setup has been built at our laboratory and is continuously being improved.

In 2013 a project on the electrically induced transient birefringence of colloidal laponite clay particles was initiated. The results have so far revealed some extremely interesting anomalous effects that are pursued next year.

**Growth of metal nanostructures on graphite**
*(S. Raaen)*

The research activity is focused on studying properties of surfaces that have been modified by doping or nanostructured adsorption layers. The experimental techniques include photoelectron spectroscopy (XPS and UPS), low energy electron diffraction (LEED), temperature programmed desorption (TPD), as well as several in-situ sample preparation techniques. In addition, SEM images are obtained in collaboration with other groups at NTNU.

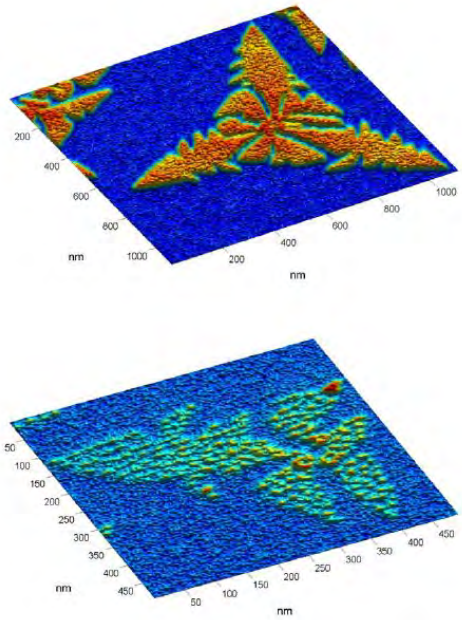


**Figure 5. SEM image of Au/C-nanostructures. The bottom image show nanodots formed by ion sputtering.**

The adsorption properties of supported metal nanostructures differ from those of the solid surface. The catalytic activity of small gold particles represents an interesting example, since low-index gold surfaces are known to be noble and inactive towards most molecules. The fundamental question is therefore which size-related properties make the gold nanoparticles catalytically active. Nano-particles of gold can, for instance, catalyze CO oxidation at room temperature and below, which is much lower than the temperatures needed for traditional supported metal catalysts. In addition to possessing the catalytic properties of the single crystalline substrate from the same material, a metal nanoparticle array contains new degrees of freedom which influence the reaction output. These are particle size and shape, and the interface between the particles and the support, which typically is a non-metallic surface on which the particles are dispersed.

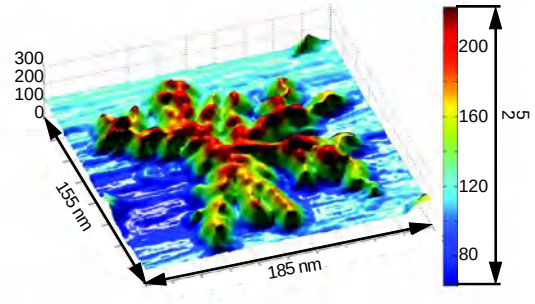


**Figure 6. AFM image of a Pt/C nanostructure.**

Growth of the structures is performed by evaporation of the metal on the substrate at well-defined temperature. The deposition rate was varied to obtain different structures. Gold on graphite nanostructures are shown in Figure 5; platinum on graphite nanostructures are shown in Figure 6. Surface structures may be refined by low energy ion beam sputtering (IBS). We find that IBS can be used as a shaping tool of self-assembled nanostructures by reducing the size down to 2 nm in a controllable manner. Ion-induced formation of nanostructures of unique shapes was correlated to ion-induced island diffusion on weakly interacting substrates.

Electronic properties and composition of the surfaces are probed by photoemission and the reactivity of the samples is studied by adsorption and desorption of simple gases to obtain information on size effects in the nanometer regime.

**Diffusion in granular/traffic flows and quantum optics**
(*B.-S. Skagerstam*)

We have focused our attention on the large-time statistical properties of granular flows. In this study use has been made of properties of stochastic differential equations. Some features of the large-time behavior can be interpreted as anomalous diffusion. We have shown that anomalous diffusion processes can be described in terms of a conventional memory function in contrast to the sometimes used method of fractional derivatives. We have also studied the appearance of anomalous diffusion and solitary waves in some non-linear systems. In addition, some features of Levy flights in simple quantum-mechanical system have been studied analytically as well be means of Monte-Carlo simulations (in collaboration with A.L. Grimsmo and J.F. Klauder (Univ. of Florida) )

In the field of cavity quantum electrodynamics we have studied the Purcell effect for atoms close to superconducting bodies. We have suggested that the low-frequency dielectric properties of super-conducting bodies, which to a large extent is poorly understood, can be investigated by means of spontaneous emission of atoms. Deviation from exponential decay at small and large times has also been investigated in great detail mainly in terms of numerical simulations (in collaboration with A.L. Grimsmo, P.K. Rekdal (Univ. College of Molde) and A. Vaskinn). A quantum-optics derivation of interference effects in a Michelson-Morley setup for general quantum states has been worked out (in collaboration with Ø. Langangen (Univ. of Oslo) and A. Vaskinn). Various aspects of quantum information theory and open system quantum dynamics and, in particular, quantum-feedback systems have also been investigated (in collaboration with A. Grimsmo and A.S. Parkins (Univ. of Auckland)). The research project on the human eye as a quantum-mechanical detector of photons has continued. Various features of a predictive model for the response of the human eye on low intensity (quantum) light have been investigated.

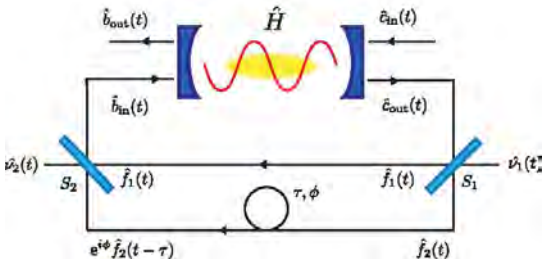


**Figure 7. A time-delay auto-synchronization quantum-feedback control system adapted to a recently experimentally implemented quantum gas experiment.**

# CONDENSED MATTER PHYSICS

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Professor Randi Holmestad (autumn)

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Professor Ragnvald Mathiesen
Associate professor Antonius van Helvoort
Associate professor Justin Wells
Adjunct professor John Walmsley
Adjunct associate professor Per Erik Vullum
Postdoc. Ruben Bjørge
Postdoc. Yanjie Gan
Postdoc. Kristin Høydalsvik
Postdoc. Ragnhild Sæterli
Postdoc. Dung Trung Tran
Research scientist Flemming Ehlers
Research scientist Wajira Mirihanage

## *Overview*

The research activities are within experimental condensed matter physics, with particular emphasis on understanding physical properties of materials and material structures through advanced scattering and imaging methods. The division consists of the transmission electron microscopy (TEM), X-ray, and nanophysics groups. The two former groups host national resource facilities (RECX and NORTEM). A large fraction of the research is focused on nanoscale structure studies and the connection to macroscopic physical properties. An increasing part of the activities is directed towards numerical simulations and modelling, giving a better understanding of both the materials systems studied and the performance of the experimental equipment. Here, a brief survey of the three research groups is given. At the end an example of a current research project is described in more detail.

## *Survey of research activities*

**Transmission electron microscopy (TEM)**
*(R. Holmestad, A.T.J. van Helvoort, J. Walmsley, P-E Vullum, B.G. Soleim, R. Bjørge, F.J.H. Ehlers, Y. Gan, R. Sæterli, T. Tran)*

The transmission electron microscopy (TEM) research group is active in a broad range projects including nanoscale structural studies and the connection to macroscopic physical properties, within the field of materials physics. The group has at the end of 2013 eight PhD students and three post-docs, and works in close collaboration with SINTEF through the TEM Gemini centre (see http://www.ntnu.edu/geminicentre/tem).

In 2013 the TEM Gemini centre was involved in 41 journal publications, of which 34 with at least one co-author from the Division of Condensed Matter. One PhD, Hanne Kauko, defended her PhD in 2013 (Quantitative HAADF STEM, see research example next page). Two new PhD project (aluminium alloys and QD solar cells) started up in 2013. Three Master students finished their degree successfully within TEM. The group offered an intensive TEM introduction course with 20 participants with hands-on labs. The event was supported by TSO Materialer. Organized group meetings took place almost every week, and the group has given many guided tours for high school students to the microscopes as well as contributed to Researchers Night. The microscope were also used in courses given by the Department.

In 2013 three new TEMs were installed in Kjemiblokk 1 in Gløshaugen as part of the NORTEM project. The partners with NTNU in this nationally coordinated project are UiO and SINTEF. In Trondheim the investment is ca. 40 MNOK and includes i) a state-of-the-art double corrected instrument with cold field emission source, ii) a modern field emission TEM and iii) an easy-accessible TEM with a thermionic source.

The first machine was taken in use August 2013 and has already > 20 users. Results from this TEM are already published. The top machine was accepted in October and sub-Angstrom imaging is now routinely done within the group. The third TEM was accepted December 2013 and has a complementary set-up to the first two TEMs, focusing on tomography and orientational imaging. In addition, the group kept one of the two older TEMs in use.


**Figure 1. The double-corrected JEOL ARM200CF. This is one of the best equipped TEM/STEMs currently in Europe. Photo: Ole Morten Melgård.**

The group has for many years worked with SINTEF and Hydro on alloy development and nucleation of precipitates in aluminium alloys, including structure determination of metastable hardening phases by combining experiments (high resolution TEM, scanning TEM, quantitative diffraction and atom probe) and modelling (density functional theory). In addition, there is a broad range of research activities on other materials, with a common emphasis on nano/microstructure, understanding of properties and advanced microscopy techniques. Examples are:

- Multicrystalline silicon solar cell materials-defects and impurity influence on efficiency
- Functional perovskite materials - ferroelectric thin films and nanorods
- Nanoparticles and support in catalyst materials – electron tomography and in situ techniques
- Nanowires of III-V semiconductors
- Intermediate band solar cell materials
- TEM/STEM image simulations and quantification.

**Nanophysics**
*(E. Wahlström, J. Wells)*

In the current trend of continued downscaling of electronics and data storage, we enter a new, and mostly unexplored, realm where quantum mechanics dominates over classical physics. This presents several challenges to technological progress, but it also opens up a new playground of possibilities.

**Nanomagnetics**
*(E. Wahlström)*

The research focus of the group is to understand the physics of charge and spin flow in low dimensional systems and magnetic structures at the nanoscale. In particular STM-based transport characterisation in combination with ferromagnetic resonance measurements is used to understand how charge and spin currents and low energy excitations can be controlled in model systems. Topics of current research are: weak localization and quantum fluctuations in low-dimensional systems as well as magnon dissipation and magnonics of structured and unstructured thin films (metals and oxides) and multilayer systems. During 2013 we have worked on the following topics:

- Magnetodynamic properties of lanthanum strontium oxide (LSMO) thin films with focus on structure effects on resonance modes.
- Spin-pumping into antiferromagnetic interfaces, effects on damping and exchange bias. Preliminary studies of both Mn based alloys and Cr based films.
- Eddy current effects in FMR.
- RF adsorption in and point contact spectroscopy of magnetic nanoparticles.
- Magnetoresistance of point contacts in low dimensional materials (graphite)
- Development of instrumentation for uniform field broadband FMR investigations.

**Nanoelectronics**
*(J. Wells)*

Our work is based on a broad range of materials and techniques, and experimental studied are mostly conducted at synchrotron facilities. In 2013 we carried out experiments at synchrotron sources in Switzerland, Sweden, Denmark and Australia. A main focus of our recent work has been connected to silicon based quantum computer architectures. We have demonstrated that it is possible to measure the electronic structure of single atom thick dopant layers on which quantum devices are based. We have also demonstrated that it is possible to measure the confinement and the many-body interactions in such structures.

Also in 2013, we have worked on understanding highly unusual phonon interactions in graphene and bismuth, unusual spin textures in heavy element crystals and dichalcogenides - the latter being important for emergent spintronic devices. We have also studied organic self-assembled structures as a route to fabricating quantum storage devices with tunable properties, and started to look into graphene interactions in medical applications.

In 2014 we will continue these activities, in strong collaboration with a number of partners around the world. We will also strengthen activities in NanoLab and with the Australian centre for Quantum Computation and Communication Technology.

**Surface science**
*(A. Borg)*

The surface science include investigations of oxidation and reduction behaviour of Pd-based single crystal alloy surfaces, an activity run in close collaboration with Department of Chemical Engineering (Prof. H. J. Venvik) at NTNU and Div. of Synchrotron Radiation Research at Lund University (Prof. E. Lundgren and assoc. prof. J. Gustafson). Another main topic has been to understand the adsorption behaviour and interaction of selected adsorbates with ordered $TiO_2$ surfaces as well growth behaviour of chemical vapour deposited $TiO_x$ thin films on metal substrates, where we collaborate closely with Dept. of Physics and Astronomy at Uppsala University (Prof. A. Sandell) and Dept. Chemical Physics at Lund University (Prof. P. Uvdal).

Specific projects have been:

- Oxidation and reduction behaviour of (100)-oriented single crystal surfaces of PdAg and PdCu.
- Near ambient pressure XPS studies of Pd-based catalytic model systems.
- Adsorption and dissociation behaviour of water on rutile surfaces.
- Formation of thin $TiO_x$ films by chemical vapour deposition on gold single crystal surfaces and their interaction with water and atomic hydrogen.

**X-ray scattering, diffraction and imaging**
*(D.W. Breiby, R.H. Mathiesen, O.T. Buset, K. Høydalsvik, W. Mirihanage)*

The X-ray group is active in applying and further developing X-ray scattering and imaging methods for studying materials ranging from functional polymers for organic electronics, via oxides and metallic nano- and microstructured materials. In 2013 the group has continued and expanded its activities within national and European research projects, and enjoys close collaboration with several world-leading groups both in X-ray physics and in materials science. The group currently has two post docs, four PhD students and several project and master students.

Two candidates, Morteza Esmaeili and Håvard Granlund, both supervised by Prof. Breiby, obtained their PhD degrees in 2013. Five MSc students obtained their degree. In total, the X-ray group had 10 journal publications in 2013.

Significant upgrades have been done in the X-ray laboratory, in connection with its new status as a national resource centre, RECX. Presently, the laboratory contains four set ups, two of which are used for X-ray scattering and diffraction experiments, and a third is dedicated to microradiographic imaging. The fourth instrument, a versatile tomography instrument from Nikon for 3D imaging, was installed in March 2013. The laboratory is generic, covering a large variety of experiments ranging from imaging and tomography, via reflectivity and grazing incidence measurements to traditional wide- and small angle X-ray scattering (WAXS/SAXS). A significant part of the experimental activities of the X-ray group is carried out at synchrotron radiation facilities, mainly at ESRF (Grenoble), HASYLAB (Hamburg) and SLS (Zurich).
Current research activities include:

- Coherent X-ray diffractive imaging, carried out in close collaboration with the Swiss Light Source. We are involved in both methods development and material physics experiments on samples ranging from nanoparticles to organic fibres.
- Raster scanning WAXS and SAXS measurements of thin films and fibres.
- Studies of catalytic nanoparticles under working conditions by small-angle X-ray scattering (SAXS)
- Grazing-incidence small- and wide angle X-ray scattering (GISAXS / GIWAXS), with a special emphasis on modelling (in-house software developments *SimDiffraction*). We employ these techniques mainly for clarifying structure-property relations in conjugated polymers and liquid crystals, mainly for organic electronics.
- Micro- and mesoscale transport during unconstrained dendritic growth
- Pattern selection and interfacial instabilities in regular eutectic solidification microstructures
- Microstructure formation and chemical modification in irregular eutectic systems

- Convective-diffusive interaction during non-equilibrium transport in metal solidification processes.
- Recrystallization kinetics in ultra-fine grained metals.

**Research example:**

**Quantitative Scanning Transmission Electron Microscopy**
*(H. Kauko, R. Holmestad and A.T.J. van Helvoort)*

In modern scanning transmission electron microscopes (STEM), the electron probe can be as small as 0.6 Å using correction for spherical aberrations in the probe forming lens system. If such a fine probe is scanned over a specimen and the transmitted electrons that have been scattered to wide angles (> 50 mrad) are collected, an incoherent image with atomic resolution can be obtained. This method is referred to as high-angle annular dark field (HAADF) STEM. The contrast in HAADF STEM images is strongly dependent on the atomic number.

In this PhD project we explored how the intensities in HAADF STEM images can be used to quantify the composition in semiconductor specimens. The desired output is a high-resolution compositional map of the specimen. Compared to spectroscopic mapping techniques as for example energy dispersive X-ray spectroscopy, a lower electron dose is needed and a higher accuracy can be obtained. To get a compositional map from a HAADF STEM image, the experimental image intensities are compared with simulated intensities. To enable this comparison, the intensities were normalized to the incident beam intensity. The image simulations were performed using the so-called frozen-lattice multislice approach.

We chose to apply this quantitative HAADF STEM approach to a novel semiconductor material based on heterostructured GaAs type nanowires (NWs) grown with molecular beam epitaxy (MBE) at NTNU. These NWs are promising building blocks for future optoelectronic devices, such as solar cells and light emitting diodes. Quantitative HAADF STEM was applied to study Sb concentration variations in axial $GaAs_{1-y}Sb_y$ inserts (50-150 nm long) within GaAs NWs and in $GaAs_{1-y}Sb_y$ NWs. Both axial and radial composition could be measured and related to the optical and the electronic properties of these NWs. In addition, Al concentration variations in $Al_xGa_{1-x}As$ shell in GaAs/AlGaAs core-shell NWs could be quantified (see Fig. 2).

International partners in the project were Monash Centre for Electron Microscopy, Austrialia (Prof. J. Etheridge) and the Institut für Festkörperphysik, Universität Bremen, Germany (Prof. A. Rosenauer). NTNU partners were profs. Helge Weman and Bjørn Ove Fimland at Department of Electronics and Telecommunication.

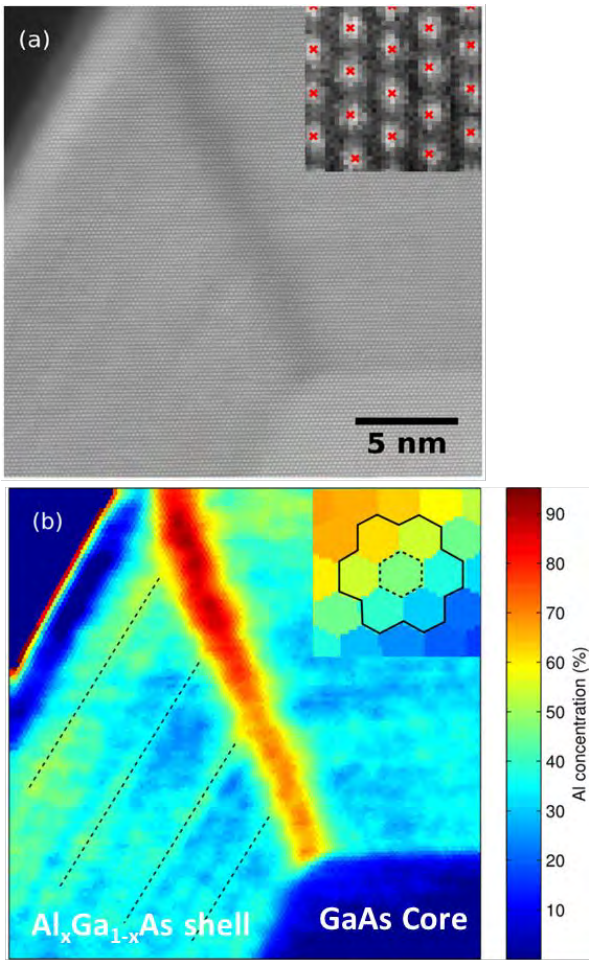


**Figure 2: (a) High-resolution HAADF STEM image of a cross-sectioned GaAs/AlGaAs core shell nanowire (b) corresponding Al composition map based on HAADF STEM image intensity. Inserts in (a) and (b) show finding the atomic columns and the unit cell intensity averaging routine used, respectively. Kauko *et al.*, APL, 232111 (2013).**

# THEORETICAL PHYSICS

***Head of Section***
Professor Johan Skule Høye (spring)
Professor Jens Oluf Andersen (autumn)

***Staff***
Professor Arne Brataas
Professor Michael Kachelriess
Professor Jacob Linder
Professor Jan Myrheim
Professor Kåre Olaussen
Professor Asle Sudbø
Associate professor John Ove Fjærestad
Associate professor Jon Andreas Støvneng
Associate professor Ingjald Øverbø
Adjunct professor Roger Sollie
Postdoc. Kjetil Magne Dørheim Hals
Postdoc. Sergey Ostapchenko
Postdoc. Alireza Qaiumzadeh

## *Overview*

The research is mainly carried out within the broad fields of condensed matter physics, statistical physics, quantum physics, and astroparticle physics. These contain several subfields with a large variety of topics for research. An overview is given below.

## *Survey of research activities*

**Casimir friction**
*(J.S. Høye, I. Brevik)*

We have continued our study of Casimir friction between dielectric parallel plates that move parallel to each other without direct contact. Again our basis is the statistical mechanical method combined with the Kubo formalism for the response due to a perturbing interaction. As before, for small velocities, the friction vanishes at zero temperature. At finite temperatures we find a noticeable friction when including eigenfrequencies of the plates down to zero frequency (frequency spectrum of damped oscillators). Further we have extended our investigations to the non-linear regime of higher velocities. Then a friction a proportional to the third power of velocity is found at zero temperature. We have compared our results for metal plates with those obtained by others, and we find both agreement and small deviations. Those results have been obtained by quite different methods, and the situation in the field has been rather unclear.

**Critical properties of D-dimensional spins**
*(E. Lomba, J.S. Høye)*

Earlier we analysed the critical properties of the HRT (hierarchical reference theory) in view of the SCOZA (self-consistent Ornstein-Zernike approximation). With support of numerical solution of the HRT equation we found simple rational numbers for the critical indices.

We have extended the analysis of the HRT for supercritical temperatures to $D$-dimensional spins, i.e. spin dimensionality is $D$ while spatial dimension is still 3. Again we find that the dominating scaling function is linked to two subdominating parts, one of which is connected to the mean field behaviour away from the critical region. Due to this connection simple rational numbers, independent of $D$ ($<\infty$) are found for the HRT critical indices. Supported by numerical work we found $\alpha=0$, $\beta=1/3$, $\gamma=4/3$, $\eta=0$, and $\nu=2/3$ independent of $D$. Our results contrast earlier results based upon $1/D$ expansions from renormalization group theory. Thus a previous numerical evaluation of HRT by others gave an apparent $D$-dependence when fitting is made to a single exponent in a standard way. Our results show instead that variation with $D$ is connected to relative magnitudes of leading and subleading scaling functions such that the one in middle vanishes in the mean spherical model limit $D=\infty$. According to previous arguments by one of us it is not ruled out that these indices except for logarithmic type corrections are the exact ones for fluids, lattice gases, and the Ising model and now also for $D$-dimensional spins.

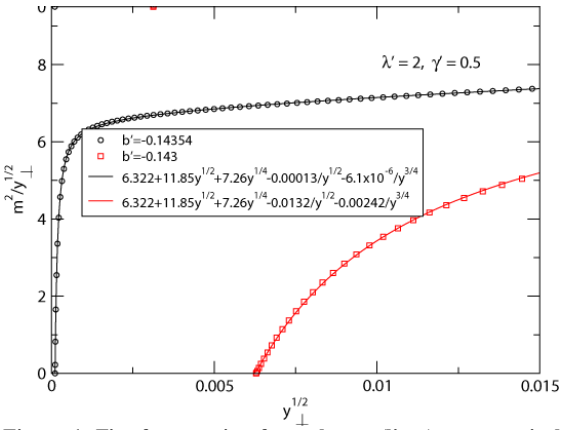


**Figure 1. Fit of expression from theory (lines) to numerical solution (symbols) of the HRT equation for $D=3.24$ ($\gamma'=0.5$). The $b'$ is temperature parameter, $m$ is magnetization, and $y$ is transverse inverse suscepti-bility.**

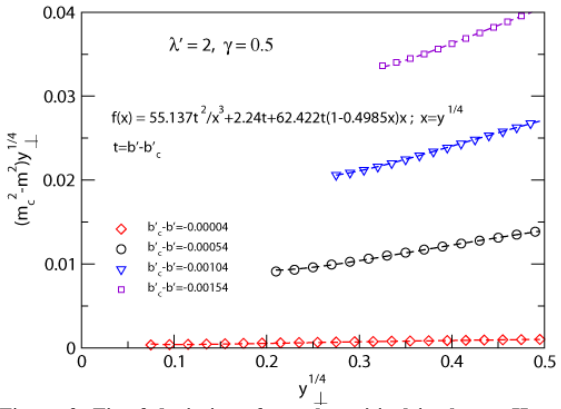


**Figure 2. Fit of deviations from the critical isotherm. Here $b_c$' is critical temperature parameter, and $m_c$ is the critical isotherm.**

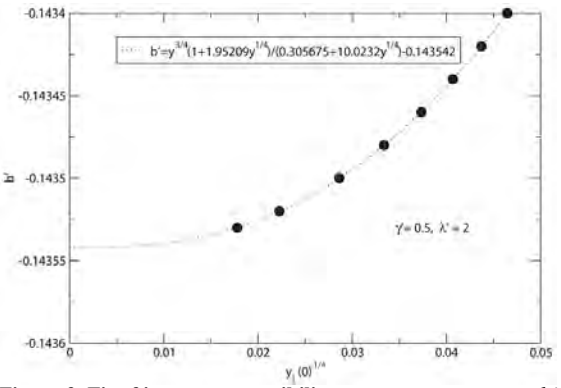


**Figure 3. Fit of inverse susceptibility $y$ versus temperature $b$' for magnetization $m=0$. The critical index $\gamma$ follows from $y \sim \Delta b'^{\gamma}$, i.e. $\gamma=4/3$**

## Quantum transport and magnetization dynamics

(*J. Linder, M. Alidoust, I. Kulagina, D. Toniolo, H. Enoksen, A. Sudbø*)

During 2013 we published 6 papers in Physical Review B, including 2 papers as Rapid Communnications, and 1 paper in Physical Review Letters. The primary research focus has been to investigate the quantum transport of spin and charge in hybrid systems featuring multiple broken symmetries. A main goal in this context is to find ways to exert experimental control over the generation, manipulation, and detection of spin- and charge-currents, including magnetic domain wall motion. This is interesting both from a fundamental physics point of view and in terms of possible applications. Some research highlights from the above publications include:

(1) The prediction of anomalous domain wall velocity and Walker breakdown in magnetic systems with anisotropic exchange

(2)¨Spin-controlled superconductivity in graphene sheets
(3) Ultrasensitive magnetometers based on spin-triplet superconductivity

(4) A study of how to optimize chiral domain wall motion via the topology of magnetization textures

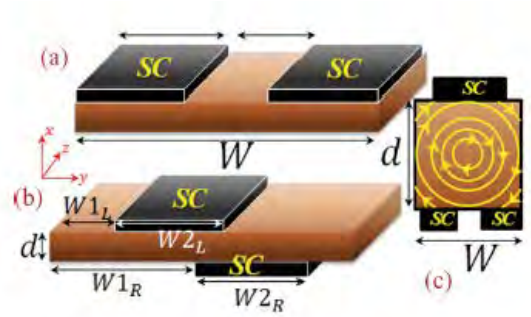


**Figure 4: Prediction of a \phi-Josephson junction where the ground-state phase difference can take arbitrary values**

## Viscosity in cosmology

*(L. Husdal and K. Olaussen)*

The viscosity of matter can be modelled in cosmology by an extra pressure term in the Friedmann equations. The introduction of such a term may lead to mathematical solutions with surprising behavior, since it simply acts as an exotic form of matter with zero energy density and negative pressure.
We are investigating the magnitude of viscosity of real matter, mostly during the lepton era, computed from the Chapman-Enskog expansion of the relativistic Boltzmann equation. We don't find that viscosity can have any observable effect on the expansion history in that era.
The equations show that neutrino interactions is the dominant contribution to viscosity, increasing as the interaction gets weaker with lower temperature, thus becoming infinite when the neutrinos don't interact at all! This artifact of extending equations beyond their range of validity leads to an interesting problem of how to introduce decoupling in a smooth and physically reasonable fashion.

## Higher order symplectic integrators for the Hamilton equations

*(A. Mushtaq and K. Olaussen)*

We are continuing to promote our proposed algorithms, and explore how they can be efficiently implemented for interesting physical problems. In particular for well-structured problems with many degrees of freedom.

**Methods from statistical mechanics of fluids applied to quantum field theories**
*(A. Amador, J.S. Høye, and K. Olaussen)*

The quantum field theories describing nature have long been formulated on a lattice, for Monte-Carlo simulations of properties which are difficult or impossible to obtain by analytic methods. For realistic modelling of continuum field theories the lattice models must be close to a critical point, where correlations are very much larger than the lattice spacing. There are limits to how well this can be achieved in current simulations; there are also cases where simulations are difficult due to lack of a positive Monte-Carlo measure.
An alternative numerical approach is to apply integral equation methods of statistical mechanics which have proven to work well for fluids or fluid-like systems. We have made preliminary investigations of how the so-called MSA-method can be implemented, with the conclusion that bosonic and fermionic systems at (optionaly) finite temperature and chemical potential can be approached. Non-abelian lattice gauge theories look difficult to implement, but non-compact abelian (i.e. with gauge group R instead of U(1)) models seem possible.
We have implemented the method for the multi-component $\varphi^4$-model on the lattice, with encouraging results wrt. location of the critical region.

**Very-high-precision solutions of eigenvalue problems**
*(A. Noreen, K. Olaussen)*

We are investigating if our previous algorithms for solving one-dimensional Schrödinger type eigenvalue problems can be extended non-separable problems in higher dimensions. Preliminary investigations and coding indicate that extensions to two dimensions is possible in some cases.

**QCD Phase Diagram**
*(J. O. Andersen and W. Naylor)*

Quantum chromodynamics is generally accepted as the theory that describes the strong interactions among the quarks and gluons. Due to a remarkable property of nonabelian gauge theories called confinement, free quarks are never observed. All quarks are confined inside the hadrons. Hadrons are the bound states of a quark and an antiquark (e.g. pions and kaons), and three quarks (e.g. protons and neutrons). If hadronic matter is heated, it is expected to undergo a phase transition to a new state of matter called the quark-gluon plasma. In this state of matter, the quarks and gluons are no longer confined but are free to move around large distances. The quark-gluon plasma is similar to an ordinary electromagnetic plasma, but is more complicated due to the nonabelian aspects of QCD.

The quark-gluon plasma existed in the early universe and so understanding its properties is essential in cosmology. In order to study the properties of the plasma, large experimental efforts at CERN and Brookhaven are made to create it in heavy-ion collisions. Strongly interacting matter also behaves in a highly nontrivial manner if one increases the density. If the density becomes sufficiently high, there is a phase transition to quark matter, which might be in color superconducting state if the temperature is low enough and the baryon density is high enough. This part of the phase diagram (see Fig. 5) is relevant in astrophysics as compact stars are the only known candidate for containing quark matter in its interior.

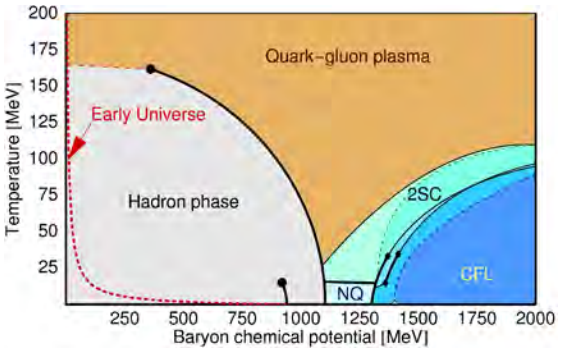


**Figure 5. QCD phase diagram as function of baryon chemical potential and temperature.**

We are currently investigating the chiral and deconfinement transitions in very strong magnetic field. This is a part of the ongoing research done in our group to unravel the properties of strongly interacting matter in extreme conditions. Matter in very strong magnetic field is relevant in a number of situations. For example, strong magnetic fields are present in certain neutron and quark stars. The equation of state is strongly affected by the presence of strong B field and hence the properties of the stars as well. Strong B fields are also present in noncentral heavy collisions and so it is important to investigate the properties of matter in this context. Finally, we started a project with international collaborators to calculate quark susceptibilities for hot matter. This is of great interest to the lattice community in order to determine the equation of state at finite baryon chemical potential. The group has published three papers, one in JHEP, and two in Physical Review D, and has two preprints.

**Cosmic ray physics**
*(M. Kachelriess, S. Ostapchenko et al.)*

Our research has concentrated on Galactic cosmic ray physics. We have continued to study the propagation of high energy cosmic rays, calculating the trajectories of individual cosmic rays in recent models of the regular and turbulent Galactic magnetic field. We determined a model that can explain the "cosmic ray knee" entirely by cosmic ray leakage from the Milky Way and is consistent with determinations of the average grammage X(E) traversed by cosmic rays at low energies.
We have also studied the limitations on the contribution of single sources to the observed cosmic ray flux, both from bounds on the flux and the anisotropy.

In collaboration with members of the Fermi-LAT experiment, we have examined how the measured photon flux at high Galactic latitudes can be correlated with the intensity of Galactic cosmic rays and the production cross section for photons in proton gas collisions.

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***(Total: 18 )***

**Afadzi, Merci**
*"Delivery of Encapsulated Drugs to Cancer Cells and Tissue: The Impact of Ultrasound"*
ISBN: 978-82-471-4210-3
Supervisor: Catharina de Lange Davies

**Alidoust, Mohammad**
*"Proximity Effects and Transport Properties of Nano-Scale Systems with Multiple Broken Symmetries"*
ISBN: 978-82-471-4866-2
Supervisor: Jacob Linder

**Demissie, Teferi Dejene**
*"The vertical structure and source regions of large and small scale waves in the middle atmosphere"*
ISBN: 978-82-471-4673-6
Supervisor: Patrick Joseph Espy

**Enoksen, Henrik**
*"Quantum Transport in Hybrid Structures"*
ISBN: 978-82-471-4581-4
Supervisors: Asle Sudbø

**Esjeholm, Bjørn-Tore**
*"Technological Knowledge displayed in D&T classrooms. A video study of the realisation of design and technology education in Norwegian schools"*
ISBN: 978-82-471-4481-7
Supervisor: Berit Bungum

**Esmaeili, Morteza**
*"X-ray Diffraction and Tomography Studies of Functional Organic Fibres"*
ISBN: 978-82-471-4245-5
Supervisor: Dag Werner Breiby

**Gao, Ming**
*"High resolution characterization of responsive hydrogels for biomedical application"*
ISBN: 978-82-471-4241-7
Supervisor: Bjørn Torger Stokke

**Gjerden, Knut Skogrand**
*"Role of quenched disorder in fracture front propagation"*
ISBN: 978-82-471-4261-5
Supervisor: Alex Hansen

**Granlund, Håvard**
*"Scanning X-ray Scattering Studies of Mechanically Processed Polymers"*
ISBN: 978-82-471-4786-3
Supervisor: Dag Werner Breiby

**Grøva, Morten**
*Two-phase Flow in Porous Media*
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Supervisor: Alex Hansen

**Hansen, Elisabeth Lindbo**
*"Soft Matter Physics of Clays and Clay Suspensions: structural arrest, ordering, and host-guest interactions"*
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Supervisor: Jon Otto Fossum

**Julukian, Armen**
*"Nanofabrication and Properties of Gold and Platinum Nanostructures on Graphite"*
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Supervisor: Steinar Raaen

**Kauko, Hanne**
*"Quantitative scanning transmission electron microscopy studies on heterostructured GaAs nanowires"*
ISBN: 978-82-471-4890-7
Supervisor: Ton van Helvoort

**Nordam, Tor**
*"Scattering of light form weakly rough surfaces"*
ISBN: 978-82-471-4188-5
Supervisor: Ingve Simonsen

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*"Spin-Orbit-Induced Transport in Metals and Superconductors"*
ISBN: 978-82-471-4324-7
Supervisor: Arne Brataas

**Stormo, Arne**
*"Brittle to Quiasi-Brittle Transitions in the Soft Clamp Fiber Bundle Model"*
ISBN: 978-82-471-4748-1
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**Vaskinn, Asle**
*"Cavity Quantum Electrodynamics"*
ISBN: 978-82-471-4694-1
Supervisor: Bo-Sture Skagerstam

**Aas, Lars Martin Sandvik**
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Supervisor: Morten Kildemo

# CONFERENCES AND TALKS

## SCIENTIFIC TALKS
***(Total: 130)***

**Ahtapodov, Lyubomir; Todorovic, Jelena; Reinertsen, Johannes F; Dasa Lakshmi Narayana, Dheeraj; Munshi, Abdul Mazid; Van Helvoort, Antonius; Fimland, Bjørn-Ove; Weman, Helge.**
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**Alves-Filho, Odilio; Julukian, Armen; Raaen, Steinar.**
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**Andersen, Jens Oluf.**
A guided tour in the phase diagram of QCD. Seminar; 2013-04-18 - 2013-04-18

**Andersen, Jens Oluf.**
Equation of state for hot and dense QCD. Resummed perturbation theory confronts lattice data. Theory seminar; 2013-10-28 - 2013-10-28

**Andersen, Jens Oluf.**
QCD in extreme conditions. Passion for physics (symposium); 2013-03-08 - 2013-03-08

**Andersen, Jens Oluf.**
The chiral transition in strong magnetic fields: finite density effects.. Workshop; 2013-03-18 - 2013-03-21

**Bassett, David.**
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**Beckwith, Kai Muller; Nord, Magnus Kristofer; Fauske, Vidar Tonaas; Van Helvoort, Antonius.**
Nanotools - A Lab Course Based on Modern Characterization Tools. Scandem 2013; 2013-06-10 - 2013-06-14

**Beckwith, Kai Sandvold; Sikorski, Pawel.**
Cell interfaces with arrays of vertically aligned nanowires. E-MRS Spring Meeting; 2013-05-27 - 2013-05-31

**Beckwith, Kai Sandvold; Sikorski, Pawel.**
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**Beckwith, Kai Sandvold; Sikorski, Pawel.**
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**Berg, Peter.**
Analytical model of a dead spot inside a PEM fuel cell anode. Hydrogen and Fuel Cells in the Nordic Countries 2013, Oslo, Norway; 2013-11-01

**Berg, Peter.**
Capital substitution in an industrial revolution. Lunch seminar, Dept. of Economics, NTNU; 2013-03-07

**Berg, Peter.**
Homogenization of periodic catalyst layers in PEM fuel cells. Chemistry seminar, Simon Fraser University, Canada; 2013-08-08

**Berg, Peter.**
Mean-field models in PEM nanopores. European Fuel Cell Forum 2013, Lucerne, Switzerland; 2013-07-04

**Berg, Peter.**
Modelling periodic catalyst layers in PEM fuel cells. Lunch seminar, Dept. of Chemistry, NTNU; 2013-01-18

**Berg, Peter.**
Modified PNP-Stokes equations for electro-kinetic flow in PEM nanopores. ModVal 10, Bad Boll, Germany; 2013-03-20

**Berg, Peter.**
Morphology and functionality of polymer electrolyte membranes. Seminar - Current problems in theoretical physics, Univ. Duisburg-Essen, Germany; 2013-04-24

**Berg, Peter.**
Water Phenomena in PEM. International Workshop, Chairman and Organiser, NTNU, Norway; 2013-10-03 - 2013-10-04

**Borg, Anne.**
Pd based alloys - From membranes to model systems. Invited talk at Linköping University; 2013-06-25

**Brabrand, Anders; Kariuki, Ian; Dyrnes, Linda Anita; Engstrøm, Monica J; Haugen, Olav Anton; Lilledahl, Magnus Borstad; Bofin, Anna M..**
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**Brabrand, Anders; Kariuki, Ian; Dyrnes, Linda Anita; Lilledahl, Magnus Borstad; Bofin, Anna M..**
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**Breiby, Dag Werner.**
Depth-resolved GISAXS models. Seminar at Université du Maine, Le Mans; 2013-02-21

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**Breiby, Dag Werner.**
In situ ptychography of organic materials. MAX IV imaging workshop; 2013-05-14 - 2013-05-15

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**Ellingsen, Pål Gunnar.**
How to engage your listeners. STRATLED group seminar; 2013-05-13 - 2013-05-13

**Ellingsen, Pål Gunnar.**
Hyperspectral fluorescence microscopy. Optik og Fotonik i Sverige 2013; 2013-10-22 - 2013-10-23

**Ellingsen, Pål Gunnar; Aas, Lars Martin Sandvik; Hagen, Vegard Stenhjem; Gustafsson, Håkan; Lilledahl, Magnus Borstad; Kildemo, Morten; Lindgren, Mikael.**
Mueller Matrix imaging of biomedical samples - collagen fibers, ligament and atherosclerotic plaques. 6th International Conference on Spectroscopic Ellipsometry; 2013-05-26 - 2013-05-31

**Espy, Patrick Joseph; Demissie, Teferi Dejene; Hatlen, Morten; Hibbins, Robert; De Wit, Rosmarie Johanna; Swenson, Gary; Vargas, Fabio.**
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**Farstad, Mari Helene; Ragazzon, Davide; Walle, Lars Erik; Schaefer, Andreas; Sandell, Anders; Borg, Anne.**
TiOx Thin Films on Au(111): Water dissociation properties. AVS 60th International Symposium and Exhibition; 2013-10-27 - 2013-11-01

**Fauske, Vidar Tonaas; KIM, DONG CHUL; Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; Fimland, Bjørn-Ove; Weman, Helge; Van Helvoort, Antonius.**
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**Fauske, Vidar Tonaas; KIM, DONG CHUL; Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; Fimland, Bjørn-Ove; Weman, Helge; Van Helvoort, Antonius.**
Mechanical and electrical characterization of nanowire-substrate interfaces. 4th Annual Nanonetwork Workshop; 2013-06-17 - 2013-06-19

**Fløystad, Jostein Bø; Esmaeili, Morteza; Diaz, Ana; Guizar-Sicairos, Manuel; Andreasen, Jens Wenzel; Breiby, Dag Werner.**
Lensless X-Ray Microscopy at the Nanoscale. Nordic Physics Days 2013; 2013-06-12 - 2013-06-14

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In situ Materials Science Studies with X-ray Ptychography. International Congress on X-Ray Optics and Microanalysis (ICXOM); 2013-09-02 - 2013-09-06

**Fossheim, Kristian Johan.**
Superconductivity: Three Giants. Vortex VIII-konferansen; 2013-09-21 - 2013-09-26

**Fossum, Jon Otto.**
Complex Physics in Clays. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Fossum, Jon Otto.**
Why clays? and Recent observations regarding possible mechanisms responsible for CO2- or drug molecules- vs. H2O- intercalation in smectite clay interlayers. 1st NTNU-PAN workshop on Soft and Complex Matter Physics; 2013-04-26 - 2013-04-26

**Fossum, Jon Otto; Dommersnes, Paul; Rozynek, Zbigniew Jerzy; Mikkelsen, Alexander.**
Active structuring of colloidal shells on drops by electric fields. in 9th Ibero-American Workshop on Complex Fluids and 2nd Italian-Brazilian Workshop on Liquid Crystals; 2013-10-14 - 2013-10-18

**Fossum, Jon Otto; Dommersnes, Paul; Rozynek, Zbigniew; Mikkelsen, Alexander.**
Active structuring of colloidal armor on liquid drops, extensions. Bi-annual meeting of the Norwegian Physical Society; 2013-08-07 - 2013-08-10

**Fossum, Jon Otto; Hansen, Elisabeth Lindbo; Rozynek, Zbigniew; Michels, Leander Edward; Hemmen, Henrik; Rustenberg, Karin Hveding; Fonseca, Davi de Miranda; Knudsen, Kenneth; Plivelic, Tomás S.; Rivera, Aramis; Altshuler, Ernesto.**
Recent observations regarding possible mechanisms responsible for CO2- or drug molecules- vs. H2O-intercalation in smectite clay interlayers. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Fossum, Jon Otto; Rozynek, Zbigniew Jerzy; Dommersnes, Paul; Mikkelsen, Alexander.**
Active Structuring of Colloidal Microparticles on Liquid Drops. MRS Fall Meeting 2013 Symposium WW: Self-Organization and Nanoscale Pattern Formation; 2013-12-01 - 2013-12-06

**Gao, Ming; Toita, Sayaka; Sawada, Shinichi; Akiyoshi, Kazunari; Prot, Victorien Emile; Gawel, Kamila; Skallerud, Bjørn Helge; Stokke, Bjørn Torger.**
Changes in swelling volume of stimuli responsive hydrogels at high resolution. Nordic Physics Days; 2013-06-11 - 2013-06-14

**Gederaas, Odrun; Mettra, Bastien; Hauge, Anette; Siksjø, Monica; Ellingsen, Pål Gunnar; Høgset, Anders; Egeberg, Kjartan Wøllo; Lindgren, Mikael; Monnereau, Cyrille; Andraud, Chantal.**
Localization and photodynamic therapy of chromophores targeted for cancer cells. 2nd International Workshop on Nano and Bio-Photonics; 3-8 Nov 2013, Biarritz (FRANCE); 2013-11-03 - 2013-11-08

**Gibson, Ursula; Dibbs, Andrew; Eraker, Andreas Juvkam; Hawkins, Thomas A.; Ballato, John.**
Alkaline oxide modifiers for the production of semiconductor fibers. 3rd Workshop on Specialty Optical Fibers; 2013-08-28 - 2013-08-30

**Hallsteinsen, Ingrid; Folven, Erik; Chopdekar, Rajesh V.; Nord, Magnus Kristofer; Christiansen, Emil; Vullum, Per Erik; Holmestad, Randi; Takamura, Y; Grepstad, Jostein; Tybell, Thomas.**
Magnetic switching of epitaxial (111)-oriented La0.7Sr0.3MnO3 /SrTiO3 thin films. 8th NTNU NanoLab symposium; 2013-11-12 - 2013-11-12

**Hansen, Alex.**
Constrained Crack Growth: Scaling and Dynamics. ICF13; 2013-06-16 - 2013-06-21

**Hansen, Alex.**
Effective rheology of immiscible two-phase flow in porous media. Gjesteforelesning; 2013-12-12 - 2013-12-12

**Hansen, Alex.**
Newtonian and Non-Newtonial Flow in Fractures. Multidimensional Aspects of Statistical Physics; 2013-01-14 - 2013-01-17

**Hansen, Alex.**
The fiber bundle: modeling failure in materials. Fracmeet 2013; 2013-01-21 - 2013-01-24

**Hansen, Alex.**
The fiber bundle: modeling failure in materials. 5th Warsaw School of Statistical Physics; 2013-06-22 - 2013-06-29

**Hansen, Elisabeth Lindbo; Fossum, Jon Otto.**
An orientationally ordered glass of soft colloidal platelets. 1st NTNU-PAN workshop on Soft and Complex Matter Physics; 2013-04-26 - 2013-04-26

**Hansen, Elisabeth Lindbo; Fossum, Jon Otto.**
An orientationally ordered glass of soft colloidal platelets. Nordsoft International workshop on Soft Matter Physics and Biomembranes; 2013-05-21 - 2013-05-24

**Hansen, Elisabeth Lindbo; Hemmen, Henrik; Fonseca, Davi de Miranda; Coutant, C.; Knudsen, Kenneth; Plivelic, Tomás S.; Bonn, Daniel; Fossum, Jon Otto.**
Swelling transition of a clay induced by heating. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Hansen, Elisabeth Lindbo; Jabbari-Farouji, Sara; Mauroy, Henrik; Plivelic, Tomás S.; Bonn, Daniel; Fossum, Jon Otto.**
Orientational order in a glass of charged platelets with a concentration gradient. International Mini-Workshop on Multi-Component Soft and Complex Fluids; 2013-07-15 - 2013-07-16

**Hansen, Elisabeth Lindbo; Plivelic, Tomás S.; Fossum, Jon Otto.**
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**Haugstad, Kristin E.; Gerken, Thomas; Stokke, Bjørn Torger; Dam, Tarun K.; Brewer, Fred; Sletmoen, Marit.**
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**Holmestad, Randi.**
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**Holmestad, Randi; Klaus, Leifer.**
TEM- Why, how and where?. NorFab-MyFab user meeting; 2013-04-17 - 2013-04-18

**Holmestad, Randi; Marioara, Calin Daniel; Friis, Jesper.**
Highlights from activities within NTNU and SINTEF on 6xxx Al alloy development. Hydro Research division seminar; 2013-06-30 - 2013-06-30

**Holmestad, Randi; Van Helvoort, Antonius; Walmsley, John.**
TEM instrumentation and activities at NTNU. Texas-Norway seminar and workshop on Nanoscience and -technology; 2013-10-14 - 2013-10-17

**Holmestad, Randi; Walmsley, John; Soleim, Bjørn Gunnar; Vullum, Per Erik; Van Helvoort, Antonius.**
NORTEM - new possibilities for atomic scale structure characterization. 8th Nanolab usermeeting; 2013-11-12 - 2013-11-12

**Hope, Sigmund Mongstad.**
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**Huh, Junghwan; KIM, DONG CHUL; Yun, H.; Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; Kauko, Hanne; Van Helvoort, Antonius; Lee, S.W.; Fimland, Bjørn-Ove; Weman, Helge.**
Electrical Characteristics of Individual GaAsSb Nanowires Grown by Molecular Beam Epitaxy. 8th Nanolab usermeeting; 2013-11-12 - 2013-11-12

**Huh, Junghwan; Kim, Dong-Chul; Yun, H.; Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; Kauko, Hanne; Van Helvoort, Antonius; Lee, S.W.; Fimland, Bjørn-Ove; Weman, Helge.**
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**Høydalsvik, Kristin; Aas, Lars Martin Sandvik; Kildemo, Morten; Breiby, Dag Werner.**
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In situ coherent X-ray diffractive imaging of CO2-storing nanoparticles. Norwegian PhD Network on Nanotechnology for Microsystems; 4th annual workshop; 2013-06-17 - 2013-06-19

**Jorge, Andreia F.; Dias, Rita de Sousa; Pais, Alberto A. C. C..**
Enhanced Condensation and Facilitated Release of DNA Using Mixed Cationic Agents: A Combined Experimental and Monte Carlo Study. Nordic Physics Days 2013; 2013-06-12 - 2013-06-14

**Kildemo, Morten; Maria, Jerome; Aas, Lars Martin Sandvik.**
Mueller Matrix Scattering Ellipsometry of rough as-cut Mc-Si. The 6th International Conference on Spectroscopic Ellipsometry; 2013-05-26 - 2013-05-31

**Mathiesen, Ragnvald.**
New opportunities in material science - Fast kinetics and mesoscale structure dynamics seen with a new source. ESRF User Meeting - Work Shop Material Science and Chemistry; 2013-02-04 - 2013-02-06

**Mathiesen, Ragnvald.**
Synchrotron X-ray imaging for the study of solidification in metallic alloys. The II International Baltic School on Methods and Instruments of the X-ray investigation; 2013-10-03 - 2013-10-07

**Mathiesen, Ragnvald.**
Time-resolved X-ray diffraction and imaging studies of liquid->solid phase transformation. Instituttseminar; 2013-11-14 - 2013-11-14

**Meheust, Y; Khaldoun, A.; Moller, P; Fall, A; Hansen, Elisabeth Lindbo; Wegdam, G; de Leeuw, B.; Fossum, Jon Otto; Bonn, Daniel.**
Mudslides of clayey soils. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Meheust, Y; Parmar, Kanak Pal Singh; Fonseca, Davi de Miranda; Hemmen, Henrik; Knudsen, Kenneth; Måløy, Knut Jørgen; Fossum, Jon Otto.**
Self-organization in complex fluids of smectite clay. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Mellingsæter, Magnus Strøm; Bungum, Berit.**
Engineering students' use of the interactive whiteboard during physics group work. ESERA konferansen 2013; 2013-09-02 - 2013-09-07

**Michels, Leander Edward; Hemmen, Henrik; Rozynek, Zbigniew; Droppa, Roosevelt; da Silva, Gerlado Jose; Fossum, Jon Otto.**
Dynamics of humidity uptake by meso-, and nano-porous clay. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Mikkelsen, Alexander; Rozynek, Zbigniew; Dommersnes, Paul; Castberg, Rene; Mauroy, Henrik; Knudsen, Kenneth; Fossum, Jon Otto.**
Electric-field manipulation of clay particles: an overview. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Mikkelsen, Alexander; Rozynek, Zbigniew; Dommersnes, Paul; Fossum, Jon Otto.**
A new approach to fabricating Janus and Patchy particles. 1st NTNU-PAN workshop on Soft and Complex Matter Physics; 2013-04-26 - 2013-04-26

**Mikkelsen, Alexander; Rozynek, Zbigniew Jerzy; Dommersnes, Paul; Fossum, Jon Otto.**
A New Approach for Fabricating Janus and Patchy Shells. MRS Fall Meeting 2013 Symposium WW: Self-Organization and Nanoscale Pattern Formation; 2013-12-01 - 2013-12-06

**Monnereau, Cyrille; Mettra, Bastien; Micouin, Guillaume; Baldeck, Patrice L.; Appaix, Florence; VanDerSanden, Boudewijn; Marotte, Sopie; Leverrier, Yann; Lindgren, Mikael; Gederaas, Odrun; Andraud, Chantal.**
Polymeric vectors for chromophores biocompatibilization: a general approach towards in vivo applications in biophotonics.. 2nd International Workshop on Nano and Bio-Photonics; 3-8 Nov 2013, Biarritz (FRANCE); 2013-11-03 - 2013-11-08

**Mørch, Ýrr Asbjørg; Stenstad, Per Martin; Schmid, Ruth; Davies, Catharina De Lange; Eggen, Siv; Åslund, Andreas; Snipstad, Sofie.**
Characterization of nanoparticles and microbubbles. Nanobiotechnology International Workshop, EC Joint Research Centre; 2013-12-03 - 2013-12-05

**Mørk, Atle; Barrio, Maria; Buddensiek, Maike-Liselotte; Grimstad, Alv-Arne; Lindeberg, Erik Gøsta Brun; Bakk, Audun; Rendall, Hans; Ruden, Fridtjov.**
CO2FieldLab:Field experience with monitoring and safety assessment of CO2 migrating in shallow subsurface. Vinterkonferansen 2013; 2013-01-08 - 2013-01-10

**Naylor, William.**
A model of chiral symmetry and deconfinement within QCD. Department Theory series; 2013-09-09 - 2013-09-09

**Nematollahi, Mohammadreza; Yang, Xiaodong; Gibson, Ursula; Reenaas, Turid Worren.**
PLD of Cr-doped ZnS for intermediate band solar cells. Norwegian Solar Cell Conference; 2013-03-13

**Nord, Magnus Kristofer; Boschker, Jos Emiel; Vullum, Per Erik; Tybell, Thomas; Holmestad, Randi.**
Study of electronic reconstruction in La0.7Sr0.3MnO3/SrTiO3 thin film interface using Transmission Electron Microscopy. 4th annual workshop arranged by the Norwegian PhD Network on Nanotechnology for Microsystems; 2013-06-17 - 2013-06-19

**Panjwani, Neelam; Bungum, Berit.**
Teachers' views on inquiry based science teaching. ESERA konferanse 2013; 2013-09-02 - 2013-09-07

**Prot, Victorien Emile; Sveinsson, Hrafn Mar; Gawel, Kamila; Gao, Ming; Skallerud, Bjørn Helge; Stokke, Bjørn Torger.**
Ionic strength induced swelling for determination of thin polymer film elastic properties. Nordic Seminar for Computational Mechanics; 2013-10-23 - 2013-10-25

**Ribe, Jonas Myren; Barriet, David; Stokke, Bjørn Torger.**
A Versatile Method for Transferring Patterned Metals to Poly(dimethylsiloxane). 8th NTNU NanoLab Symposium; 2013-11-12 - 2013-11-12

**Romijn, Elisabeth Inge; Lilledahl, Magnus Borstad.**
3D quantitative Fourier analysis of second harmonic generation microscopy images of collagen structure in cartilage. Photonics West; 2013-02-02 - 2013-02-07

**Rozynek, Zbigniew; Dommersnes, Paul; Kjerstad, Knut; Mikkelsen, Alexander; Castberg, Rene; Hersvik, Kjetil; Fossum, Jon Otto.**
Active structuring of clay colloidal armour on liquid drops. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Rozynek, Zbigniew; Dommersnes, Paul; Mikkelsen, Alexander; Castberg, Rene; Fossum, Jon Otto.**
Active structuring of colloidal microbeads on liquid drops (and new approach to fabricating patchy shells). International Mini-Workshop on Complex Drops and Emulsions; 2013-07-12 - 2013-07-12

**Rozynek, Zbigniew; Dommersnes, Paul; Mikkelsen, Alexander; Castberg, Rene; Fossum, Jon Otto.**
Clay-based active eye pupil-like structure. International Mini-Workshop on Multi-Component Soft and Complex Fluids; 2013-07-15

**Rozynek, Zbigniew; Dommersnes, Paul; Mikkelsen, Alexander; Castberg, Rene; Fossum, Jon Otto.**
Structuring of colloidal particles on liquid drops. 1st NTNU-PAN workshop on Soft and Complex Matter Physics; 2013-04-26 - 2013-04-26

**Rozynek, Zbigniew; Fossum, Jon Otto; Hemmen, Henrik; Plivelic, Tomás S.; Rustenberg, Karin Hveding; Michels, Leander Edward; Johnsrud, Emilie Lund.**
Intercalation and Retention of Carbon Dioxide in Synthetic Fluorohectorite Clay at near-ambient Conditions. 10th Nordic Workshop on Scattering from Soft Matter; 2013-01-17 - 2013-01-18

**Rozynek, Zbigniew; Silva, S.M.L.; Mauroy, Henrik; de Azevedo, Eduardo; da Silva, G.J.; Fossum, Jon Otto; Plivelic, Tomás S..**
Polypropylene/organoclay nanocomposites in electric fields. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Rozynek, Zbigniew; Dommersnes, Paul; Mikkelsen, Alexander; Castberg, Rene; Kjerstad, Knut; Hersvik, Kjetil; Fossum, Jon Otto.**
Structuring of colloidal particles on liquid drops. Nordsoft International workshop on Soft Matter Physics and Biomembranes; 2013-05-21 - 2013-05-24

**Rønning, Magnus; Voronov, Alexey; Tsakoumis, Nikolaos; Voss, Georg; van Beek, Wouter; Høydalsvik, Kristin; Fløystad, Jostein Bø; Breiby, Dag Werner; Andreasen, Jens W.; Urakawa, Atsushi; Holmen, Anders.**
Multi-technique characterisation of Fischer-Tropsch catalysts at industrially relevant conditions. E-MRS Spring Meeting 2013 (The European Material Conference); 2013-05-27 - 2013-05-31

**Rønning, Magnus; Voronov, Alexey; Tsakoumis, Nikolaos; Voss, Georg; Van Beek, Wouter; Høydalsvik, Kristin; Fløystad, Jostein Bø; Breiby, Dag Werner; Urakawa, Atsushi.**
In situ characterisation of cobalt-based Fischer-Tropsch synthesis catalysts: Strategies to improve (surface) sensitivity of bulk techniques. Norwegian Catalysis Symposium 2013; 2013-12-02 - 2013-12-03

**Rønning, Snorre Stavik; Bakken, Marianne; Birkeland, Roger; Espy, Patrick Joseph; Hibbins, Robert.**
OPTIMIZING AN INFRARED CAMERA FOR OBSERVATION OF ATMOSPHERIC GRAVITY WAVES FROM A CUBESAT PLATFORM. 64th International Astronautical Congress; 2013-09-23 - 2013-09-28

**Saito, Takeshi.**
Effect of trace elements (Cu and Zn) on 6xxx series aluminum alloys. BILAT meeting in Toyama 2013; 2013-06-04 - 2013-06-07

**Saito, Takeshi; Lefebvre, Williams; Marioara, Calin D.; Andersen, Sigmund J.; Holmestad, Randi.**
Investigation of Cu and Zn atomic columns on the precipitates in Al-Mg-Si alloys by aberration-corrected scanning electron microscope. EMAG 2013; 2013-09-03 - 2013-09-06

**Schmid, Ruth; Mørch, Yrr Asbjørg; Stenstad, Per Martin; Hansen, Rune; Hansen, Yngve Hofstad; Afadzi, Mercy; Eggen, Siv; Davies, Catharina De Lange.**
Multifunctional Nanoparticles for Ultrasound-mediated Diagnosis and Therapy. BioNanoMed 2013; 2013-03-13 - 2013-03-15

**Siksjø, Monica; Mettra, Bastien; Hauge, Anette; Ellingsen, Pål; Høgset, Anders; Egeberg, Kjartan Wøllo; Lindgren, Mikael; Monnereau, Cyrille; Andraud, Chantal; Gederaas, Odrun.**
Localization and photodynamic therapy of chromophores targeted for cancer cells. Scientific and annual meeting.The Norwegian Society for Photobiology and Photomedicine.The 30 years Jubilee of NOFFOF; 2013-11-08 - 2013-11-08

**Singh, Gurvinder; Van Helvoort, Antonius; Bandyopadhyay, Sulalit; Volden, Sondre; Andreassen, Jens-Petter; Glomm, Wilhelm.**
Shape and Size Controlled Synthesis of Metal Nanostructures. 8th Nanolab usermeeting; 2013-11-12 - 2013-11-12

**Solem, Susanne; Aursand, Peder; Flåtten, Tore.**
On the dispersive wave-dynamics of two-phase flow models. SIAM Conference on Computational Science and Engineering; 2013-02-24 - 2013-03-01

**Sorokin, Evgeni; Tolstik, Nikolai; Sorokina, Irina T.**
Enhancement and shape control of weak molecular absorption signal with chirped-pulse mid-IR lasers. Conference on Lasers and Electro-optics/Europe; 2013-05-12 - 2013-05-16

**Sorokin, Evgeni; Tolstik, Nikolai; Sorokina, Irina T.**
Few-cycle mid-IR oscillators. International Conference on Lasers, Applications and Technologies (ICONO/LAT 2013); 2013-06-18 - 2013-06-22

**Stokke, Bjørn Torger.**
Emerging possibilities of scanning probe microscopy applications in life sciences. CMIC Core facility seminar; 2013-02-14 - 2013-02-14

**Stokke, Bjørn Torger.**
Hydrogels as specific signal transducing materials applied in biosensors. Invitert gjesteforelesning; 2013-01-25 - 2013-01-25

**Sudbø, Asle.**
Phase transitions in Multi-component condensates. Zlatko Tesanovic Memorial Symposium; 2013-03-23 - 2013-03-24

**Taklo, Maaike Margrete Visser; Vardøy, Astrid-Sofie Borge; De Wolf, Ingrid; Simons, Veerle; van de Wiel, H. J.; van der Waal, Adri; Lapadatu, Adriana; Martinsen, Stian; Wunderle, Bernhard.**
Residual stress in silicon caused by Cu-Sn wafer-level packaging. InterPACK2013-73317; 2013-07-16 - 2013-07-18

**Thaulow, Christian; Bjørnøy, Sindre Hove; vebner, marius.**
Mechanical testing of diatoms. 5th International Conference on Mechanics of Biomaterials and Tissues 2013; 2013-12-08 - 2013-12-12

**Tolstik, Nikolai; Sorokin, Evgeni; Sorokina, Irina T.**
High-energy Mid-Infrared Cr:ZnS Chirped-pulse oscillator. Conference on Lasers and Electro-optics/Europe; 2013-05-12 - 2013-05-16

**Tolstik, Nikolai; Sorokina, Irina T; Sorokin, Evgeni.**
Watt-level Kerr-lens Mode-locked Cr:ZnS laser at 2.4 mm. CLEO: 2013; 2013-06-09 - 2013-06-14

**van de Wiel, H. J.; Vardøy, Astrid-Sofie Borge; Hayes, G.; Kouters, M.H.M.; van der Waal, Adri; Erinc, M.; Lapadatu, Adriana; Martinsen, Stian; Taklo, Maaike Margrete Visser; Fischer, H.R..**
Systematic characterization of key parameters of hermetic waferlevel Cu-Sn SLID bonding. European Microelectronics and Packaging Conference; 2013-09-09 - 2013-09-12

**Vicinanza, Nicla; Næss, Linda Normann; Svenum, Ingeborg-Helene; Peters, Thijs; Bredesen, Rune; Borg, Anne; Venvik, Hilde Johnsen.**
Basic properties of thin, self-supported Pd77%Ag23% membranes. 8th International Membrane Science & Technology Conference; 2013-11-25 - 2013-11-29

**Vicinanza, Nicla; Næss, Linda Normann; Svenum, Ingeborg-Helene; Peters, Thijs; Bredesen, Rune; Borg, Anne; Venvik, Hilde Johnsen.**
Permeation properties of thin, self-supported Pd77%Ag23% membranes. 23rd Annual Meeting North American Membrane Society; 2013-06-08 - 2013-06-12

**Voss, Georg; Voronov, Alexey; Fløystad, Jostein Bø; Rønning, Magnus.**
The state of promotors (Ni, Re) in Co Fischer Tropsch Catalysts. 10th Natural Gas Conversion Symposium (NGCS 10); 2013-03-01 - 2013-03-06

**Wells, Justin W.**
Materials for quantum computation applications; an experimental approach. Invited Guest Lecture; 2013-03-19 - 2013-03-19

**Wells, Justin W.**
Materials for quantum computation applications; an experimental approach. Invited Guest Lecture; 2013-03-20 - 2013-03-20

**Wells, Justin W.**
Understanding charge and spin transport phenomena: an experimental approach. General Physics Colloquium; 2013-02-01 - 2013-02-01

**Wenner, Sigurd; Marioara, Calin Daniel; Røyset, Jostein; Holmestad, Randi.**
Transmission electron microscopy and muon spin relaxation studies of precipitation in Al–Mg–Si alloys. BILAT meeting 2013; 2013-06-04 - 2013-06-07

**Zha, Min; Li, Yanjun; Mathiesen, Ragnvald; Bjørge, Ruben; Roven, Hans Jørgen.**
Development of an Al-7Mg alloy with a high strength and good ductility by ECAP. 5th International Conference on Recrystallization & Grain Growth 2013; 2013-05-05 - 2013-05-10

**Aas, Lars Martin Sandvik; Kildemo, Morten.**
Optical properties of biaxial nanopatterned gold plasmonic nanowired grid polarizer. The 6th International Conference on Spectroscopic Ellipsometry; 2013-05-26 - 2013-05-31

**Åslund, Andreas; Berg, Sigrid; Mørch, Ýrr Asbjørg; Lelu, Sylvie; Habib, Baghirov; Glomm, Wilhelm; Stenstad, Per Martin; Sandvig, Axel; Widerøe, Marius; Hansen, Rune; Davies, Catharina De Lange.**
Multifunctional nanoparticles for drug delivery across the blood-brain barrier. MedIm - Norwegian Research School in Medical Imaging; 2013-10-01 - 2013-10-03

## SCIENTIFIC POSTERS
***(Total: 72)***

**Ahtapodov, Lyubomir; Kauko, Hanne; Munshi, Abdul Mazid; Fimland, Bjørn-Ove; Van Helvoort, Antonius; Weman, Helge.**
Optical properties of self-catalyzed GaAs Nanowires with axial GaAsSb inserts. Nanowires-2013; 2013-11-12 - 2013-11-15

**Altoe, M; Grassi, G.; Fonseca, C.L.S.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto.**
Dynamics of Humidity in Iron Fluorohectorite. Soft Matter Confinement, Geilo School; 2013-03-11 - 2013-03-21

**Altoe, M; Grassi, G.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto; da Silva, G.J..**
Swelling clay dependent on certain physical parameters. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Beckwith, Kai Sandvold; Sikorski, Pawel.**
Patterning and co-culturing cells in a polydopamine/ poly(vinyl alcohol) system. E-MRS Spring Meeting; 2013-05-27 - 2013-05-31

**Castberg, Rene; Rozynek, Zbigniew; Fossum, Jon Otto; Måløy, Knut Jørgen; Dommersnes, Paul.**
Clay particle rotation and alignment in electric fields. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Dasa Lakshmi Narayana, Dheeraj; Munshi, Abdul Mazid; Fauske, Vidar Tonaas; KIM, DONG CHUL; Van Helvoort, Antonius; Fimland, Bjørn-Ove; Weman, Helge.**
Epitaxial growth and characterization of vertical III-V semiconductor nanowires on graphene. 7th Nanowire Growth Workshop; 2013-06-10 - 2013-06-12

**Dasa Lakshmi Narayana, Dheeraj; Munshi, Abdul Mazid; Fauske, Vidar Tonaas; KIM, DONG CHUL; Van Helvoort, Antonius; Fimland, Bjørn-Ove; Weman, Helge.**
Epitaxial growth of vertical III-V semiconductor nanowires on graphene. Graphene2013; 2013-04-23 - 2013-04-26

**Davies, Catharina De Lange; Eggen, Siv; Fagerland, Stein-Martin Tilrum; Afadzi, Mercy; Hansen, Rune; Bøhn, Audun; Furu, Håkon; Angelsen, Bjørn Atle J.; Stenstad, Per Martin; Mørch, Ýrr Asbjørg.**
Ultrasound-mediated delivery of a novel nanoparticle-microbubble platform. 104th Annual Meeting American Association for Cancer Research; 2013-04-06 - 2013-04-10

**Davies, Catharina De Lange; Snipstad, Sofie; Westrum, Sara; Eggen, Siv; Søvik, Kishia Stojcevska; Andreas, Åslund; Stenstad, Per Martin; Mørch, Ýrr Asbjørg; Schmid, Ruth.**
Ultrasound-enhanced accumulation in fat and efficient cellular uptake of hydrophobic drugs using a novel nanoparticle- microbubble platform.. CostAction: TD1004 Theranostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery,; 2013-09-01 - 2013-09-03

**De Wit, Rosmarie Johanna; Hibbins, Robert; Espy, Patrick Joseph.**
Gravity wave momentum flux variability in the high latitude northern hemisphere winter mesosphere/lower thermosphere. European Geophysical Union; 2013-04-07 - 2013-04-12

**Eggen, Siv; Hansen, Rune; Fagerland, Stein-Martin Tilrum; Søvik, Kishia Stojcevska; Mørch, Ýrr Asbjørg; Berg, Sigrid; Furu, Håkon; Bøhn, Audun; Davies, Catharina De Lange.**
Improving the delivery of nanomedicine in cancer tissue by ultrasound. 5th National PhD Conference in Medical Imaging 2013; 2013-10-02 - 2013-10-03

**Ellingsen, Pål Gunnar; Aas, Lars Martin Sandvik; Hagen, Vegard Stenhjem; Kumar, Rajesh; Gustafsson, Håkan; Lilledahl, Magnus Borstad; Kildemo, Morten; Lindgren, Mikael.**
Mueller Matrix imaging on biomedical samples - collagen fibers and atherosclerotic plaques. 6th International Conference on Spectroscopic Ellipsometry; 2013-05-26 - 2013-05-31

**Fauske, Vidar Tonaas; Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; KIM, DONG CHUL; Fimland, Bjørn-Ove; Weman, Helge; Van Helvoort, Antonius.**
Site-specific, cross-sectional TEM samples of as-grown nanowires by FIB. NorfFab/MyFab user meeting; 2013-04-17 - 2013-04-18

**Fløystad, Jostein Bø; Esmaeili, Morteza; Diaz, Ana; Guizar-Sicairos, Manuel; Høydalsvik, Kristin; Andreasen, Jens Wenzel; Breiby, Dag Werner.**
Materials Science Studies with in situ Ptychography. Ptycho2013; 2013-05-04 - 2013-05-07

**Fonseca, C.L.S.; Grassi, G.; Altoe, M; da Silva, G.J.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto.**
Synchrotron X-ray Scattering Studies in Cooper-Fluorohectorite. XXXVI Encontro Nacional de Fisica da Materia Condensada; 2013-05-13 - 2013-05-17

**Fonseca, C.L.S.; Grassi, G.; Altoe, M; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto; da Silva, G.J..**
Synchrotron X-ray scattering studies in Cu-fluorohectorite. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Gederaas, Odrun; Hauge, Anette; Nesbakken, Mari; Ellingsen, Pål Gunnar; Manandhar, Rojlina; Høgset, Anders; Lindgren, Mikael.**
Hyperspectral imaging and cell survival of rat bladder and glioma cancer cell lines after TPCS2a – PDT, a part. NanoPDT meeting, Gøteborg, 11th -12th 2013.; 2013-04-11 - 2013-04-12

**Grassi, G.; Michels, Leander Edward; Droppa, R; da Silva, G.J.; Fossum, Jon Otto.**
Humidity Intercalation Processes in Synthetic Nanosilicates by Synchrotron X-ray Scattering. Soft Matter Confinement, Geilo School; 2013-03-11 - 2013-03-21

**Grassi, G.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto; Da Silva, G.J..**
Hendricks-Teller-types peaks in clay. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Grassi, G.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto; da Silva, G.J..**
Hydration Transitions: High order analysis by synchrotron x-ray scattering. Third annual Niels Bohr International Academy workshop on ESS science: crossing space and time domains with SAS and QENS; 2013-06-24 - 2013-06-28

**Grassi, G.; Michels, Leander Edward; Droppa, R; Fossum, Jon Otto; da Silva, G.J..**
Water intercalation in clay. 15th International Clay Conference; 2013-07-15 - 2013-07-20

**Haaland, Stein; Mulligan, Frank J.; Hibbins, Robert; Foerster, Matthias; Hall, Chris; Kleinknecht, Nora.**
On the electromagnetic forcing of atmospheric neutral winds.. AGU Fall 2013; 2013-12-09 - 2013-12-13

**Haaland, Stein; Mulligan, Frank J.; Hibbins, Robert; Foerster, Matthias; Hall, Chris; Kleinknecht, Nora.**
On the electromagnetic forcing of the thermospheric neutral wind. Cluster Tromsoe 2013; 2013-09-16 - 2013-09-20

**Hansen, Elisabeth Lindbo; Jabbari-Farouji, Sara; Mauroy, Henrik; Plivelic, Tomás S.; Bonn, Daniel; Fossum, Jon Otto.**
Orientational Order in a Glass of Charged Platelets with a Concentration Gradient. MRS Fall Meeting 2013 Symposium WW: Self-Organization and Nanoscale Pattern Formation; 2013-12-01 - 2014-12-06

**Haugstad, Kristin E.; Gerken, Thomas; Stokke, Bjørn Torger; Dam, Tarun K.; Brewer, Fred; Sletmoen, Marit.**
Single molecular study of mucin possessing different carbohydrate side chains containing the T and Tn cancer antigen using force probes with picoNewton sensitivity. Mucins in Health and Disease (12th International Workshop on Carcinoma-associated Mucins); 2013-07-27 - 2013-07-31

**Hemmen, Henrik; Rustenberg, Karin Hveding; Michels, Leander Edward; Rozynek, Zbigniew; Plivelic, Tomás S.; Fossum, Jon Otto.**
Intercalation and retention of carbon dioxide in synthetic fluorohectorite clay at near-ambient conditions. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Hibbins, Robert; De Wit, Rosmarie Johanna; Espy, Patrick Joseph; Kolnes, Nils Henrik; Svennevik, Magnus; Swenson, Gary; Vargas, Fabio.**
Comparison of gravity wave momentum flux observed by meteor radar and airglow imager. European Geophysical Union; 2013-04-07 - 2013-04-12

**Hope, Sigmund Mongstad.**
Topology of fracture networks. CLIMIT & BIGCCS PhD Seminar 2013; 2013-10-17 - 2013-10-18

**Kauko, Hanne; Munshi, Abdul Mazid; Lim, Cheng Guan; KIM, DONG CHUL; Dasa Lakshmi Narayana, Dheeraj; Fimland, Bjørn-Ove; Van Helvoort, Antonius; Weman, Helge.**
GaAs/AlGaAs core-shell nanowires for novel solar cell applications. Nanokonferansen 2013; 2013-03-18 - 2013-03-18

**Kauko, Hanne; Munshi, Abdul Mazid; Lim, Cheng Guan; KIM, DONG CHUL; Dasa Lakshmi Narayana, Dheeraj; Fimland, Bjørn-Ove; Van Helvoort, Antonius; Weman, Helge.**
GaAs/AlGaAs core-shell nanowires for novel solar cell applications. Norwegian Solar Cell Conferance 2013; 2013-03-13 - 2013-03-15

**Kauko, Hanne; Munshi, Abdul Mazid; Lim, Cheng Guan; KIM, DONG CHUL; Dasa Lakshmi Narayana, Dheeraj; Fimland, Bjørn-Ove; Van Helvoort, Antonius; Weman, Helge.**
Novel solar cells based on GaAs/AlGaAs core-shell nanowires. 4th annual Nanonetwork workshop; 2013-06-17 - 2013-06-19

**Kildemo, Morten; Maria, Jerome; Aas, Lars Martin Sandvik.**
Mueller matrix scattering ellipsometry of pyramidal structured c-Si. The 6th International Conference on Spectroscopic Ellipsometry; 2013-05-26 - 2013-05-31

**Mauroy, Henrik; Hansen, Elisabeth Lindbo; Rozynek, Zbigniew; Plivelic, Tomás S.; Fossum, Jon Otto; Helgesen, Geir; Knudsen, Kenneth.**
Polystyrene-clay nanocomposites: the effect of clay surface charge. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Mauroy, Henrik; Knudsen, Kenneth; Fossum, Jon Otto.**
Diffusion through layered clay monitored by small angle neutron scattering. Soft Matter Confinement, Geilo School; 2013-03-11 - 2013-03-21

**Mauroy, Henrik; Rozynek, Zbigniew; Plivelic, Tomás S.; Fossum, Jon Otto; Helgesen, Geir; Knudsen, Kenneth.**
Phase segregation in PNIPAAM-laponite hydrogels: the effect of dissolved oxygen. 15th International Clay Conference; 2013-07-07 - 2013-07-11

**Mayani, Maryam Gholami; Thomassen, Sedsel Fretheim; Fimland, Bjørn-Ove; Reenaas, Turid Worren.**
Quantum dots for intermediate band solar cells. Norwegian Solar Cell Conference; 2013-03-13

**McDonagh, Birgitte Hjelmeland; Volden, Sondre; Lystvet, Sina Marie; Singh, Gurvinder; Ese, M-H; Sandvig, Ioanna; Sandvig, Axel; Lindgren, Mikael; Glomm, Wilhelm.**
Staining and cytotoxicity of transferrin gold nanoclusters on cancer cells. NorFab user meeting; 2013-04-17 - 2013-04-18

**Michels, Leander Edward; Grassi, G.; Hemmen, Henrik; Rozynek, Zbigniew; da Silva, G.J.; Fossum, Jon Otto; Droppa, R.**
Water intercalation and dynamics of humidity uptake by meso-, and nano-porous clay. Third annual Niels Bohr International Academy workshop on ESS science: crossing space and time domains with SAS and QENS; 2013-06-24 - 2013-06-28

**Michels, Leander Edward; Hemmen, Henrik; Rozynek, Zbigniew; Droppa, R; da Silva, G.J.; Fossum, Jon Otto.**
Dynamics of Humidity uptake by meso- and nano-porous clay. Soft Matter Confinement, Geilo School; 2013-03-11 - 2013-03-21

**Michels, Leander Edward; Hemmen, Henrik; Rozynek, Zbigniew; Grassi, G.; Droppa, R; Da Silva, G.J.; Fossum, Jon Otto.**
Water Intercalation and Dynamics of Humidity Uptake by Meso-, and Nano-porous Clay. International Soft Matter Conference; 2013-09-15 - 2013-09-19

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Ultrasound-mediated delivery of a novel nanoparticle-microbubble platform. Clinical Nanomedicine; 2013-06-23 - 2013-06-25

**Mørtsell, Eva Anne; Westermann, Ida; Marioara, Calin Daniel; Pedersen, Ketill Olav; Røyset, Jostein; Holmestad, Randi.**
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**Ribe, Jonas Myren; Barriet, David.**
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**Ribeiro, L.; Michels, Leander Edward; Mundim, Maria S.P; Sousa, M.; Fossum, Jon Otto; da Silva, G.J.; Mundim, Kleber C.**
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**Romijn, Elisabeth Inge; Lilledahl, Magnus Borstad.**
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**Skåre, Daniel; Aas, Lars Martin Sandvik; Ellingsen, Pål Gunnar; Letnes, Paul Anton; Kildemo, Morten.**
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## POPULAR SCIENTIFIC TALKS
***(Total: 9)***

**Ellingsen, Pål Gunnar.**
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**Fossheim, Kristian Johan.**
Bærekraftig utvikling: Korleis møter vi vår tids største globale utfordring?. Forelesing; 2013-09-11

**Hetland, Øyvind Storesund; Daae, Marianne; Kleinknecht, Nora; Ellingsen, Pål Gunnar.**
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**Holmestad, Randi.**
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**Holmestad, Randi; Van Helvoort, Antonius; Walmsley, John.**
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**Munshi, Abdul Mazid; Dasa Lakshmi Narayana, Dheeraj; KIM, DONG CHUL; Huh, Junghwan; Reinertsen, Johannes F; Ahtapodov, Lyubomir; Fimland, Bjørn-Ove; Weman, Helge; Fauske, Vidar Tonaas; Kauko, Hanne; Van Helvoort, Antonius; Lee, KD; heidari, B.**
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**Reenaas, Turid Worren.**
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**Stokke, Bjørn Torger.**
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**Wenner, Sigurd; Nord, Magnus Kristofer; Christiansen, Emil.**
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# PHYSICS PRESENTATION THROUGH MEDIA

***(Total: 28)***

**Beckwith, Kai Sandvold.**
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**Brataas, Arne.**
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**Brataas, Arne.**
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**Breiby, Dag Werner; Brandslet, Steinar.**
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**Fossum, Jon Otto.**
Laboratory for Soft and Complex Matter Studies.

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**Holmestad, Randi.**
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**Holmestad, Randi.**
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**Holmestad, Randi.**
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**Kauko, Hanne.**
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**Meland, Svein Inge; Eggen, Siv; Davies, Catharina De Lange.**
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**Reenaas, Turid Worren; Vold, Henrik Brattli.**
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**Samuelsen, Emil J.**
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**Sikorski, Pawel.**
Naturlig konstruert. Abc nyheter [Internett] 2013-06-09

**Sikorski, Pawel.**
Naturlig konstruert. Drammens Tidende [Avis] 2013-06-22

**Sikorski, Pawel.**
Naturlig konstruert. Haugesund Avis [Avis] 2013-06-08

**Sudbø, Asle; Weisser, Agnethe.**
NTNU-ere om nobelprisene: Kan takke Cern for resultatet.. Adresseavisen [Avis] 2013-10-10

**Sørumgård, Marit; Rossing, Nils Kristian; Sandbakk, Elin; Kulhawczuk, Martin; Lindø, Eili; Cyvin, Øylov Emma; Skjelbakken, Roger; Juberg, Even Hauge; Rødseth, Silje.**
Imaginary, interaktiv matematikk. [Kunstnerisk og museal presentasjon] Utstilling og matematikkverksted. NTNU Vitenskapsmuseet og Vitensenteret i Trondheim; Trondheim. 2013-11-15

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* Department of Physics, Uppsala University, Sweden, (Roland Mathieu, Per Nordblad, Olof Karis)
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## AMERICA

**Andersen, J.O.:**
* Kent State University (Michael Strickland)

**Berg, P.:**
* Simon Fraser University, Canada (M. Eikerling)

**Brataas, A.:**
* Harvard University, (Bertrand I. Halperin)
* UCLA, (Yaroslav Tserkovnyak) (USA)
* New York University, (Andrew D. Kent) (USA)

**Breiby, D.W.:**
* Georgia Institute of Technology, USA (prof. J.-L. Bredas, dr. C. Risko)
* UC Santa Barbara, USA (prof. M. Chabinyc)

**Davies, C.:**
* Harvard Medical School Boston, USA (R.K. Jain Y. Boucher)
* Mount Sinai School of Medicine New York, (W.Mulder)

**Espy, P.:**
* Hampton University, Center for Atmospheric Sciences (James M. Russell III), Virginia, USA

**Fossum, J.O.:**
* PUC Rio de Janeiro Brazil (prof. Marcio Carvalho)
* Universidade Federal de Pernambuco, UFPE, Recife, Brazil (prof. Wilson Barros)
* UFABC, Sao Paulo, Brazil (prof. Roosevelt Droppa Jr.)
* University of Brasilia, UnB, Brasilia, Brazil (prof. Geraldo Jose da Silva)
* University of Sao Paulo-USP (prof. Vera Constantino, prof. Antonio Figueiredo),
* University Havana, Cuba (Profs. Ernesto Altshuler, prof. Aramis Rivera)

**Gibson, U.:**
* Dartmouth College, Hanover NH USA (J. J. BelBruno)
* IBM Burlington, VT USA (M.L. Lipson)
* Univ. Mississippi (J. B. Cui)
* Clemson Univ., Clemson SC (J. Ballato)
* Rice Univ, Houston TX (D. Mittleman)

**Hansen, A.:**
* Univesidade Federal do Céara, Fortaleza, Brazil (Soares)

**Holmestad, R.**
* University of Illinois, Urbana-Champaign, USA (JM. Zuo)

**Høye, J.S.:**
* Oklahoma University, Norman, Oklahoma, USA (K. A. Milton), Theoretical Physics

**Lilledahl, M.B.:**
* Unviersity of Connecticut, US, (D. Pierce)

**Linder, J.:**
* Michelson Lab, Physics Division, Naval Air Warfare Center, China Lake, California

**Skagerstam, B.-S.:**
* Universidade Federal do Rio de Janeiro, Departamento de Fisica Matematica - Instituto de Fisica, Rio de Janeiro, Brazil (prof. Ruynet Lima de Matos Filho et al.)
* Universidade Federal do Ceará, Departamento de Física, Fortaleza, Brazil. (prof. José Soares de Andrade Junior)
* University of Florida, USA (J.R. Klauder)
* Syracuse University, N.Y., USA (A.P. Balachandran).
* Departamento de F´ısica, Universidade Federal do Cear´a, Brazil (R.N. Costa Filho)
* Universidade Estadual do Cear´a, Faculdade de Educa¸ Brazil (G Alencar)
* Centro Brasilero de Pesquisas Fisicas, Rio de Janeiro, Brazil (C. Tsallis)

**Stokke, B.T.**
* Albert Einstein College of Medicine, New York, USA (C F Brewer)
* Case Western Reserve University School of Medicine, Cleveland, Ohio, USA (T A Gerken)

**Sudbø, A.:**
* Department of physics, University of Massachussets at Amherst, Massachusetts, USA (prof. E. Babaev)
* Department of physics, University of California at Riverside, USA (prof. C. M. Varma).
* University of Colorado at Boulder, USA (profs. L. Radzihovsky and V. Gurarie)
* Kavli Institute of Theoretical Physics, University of California at Santa Barbara, USA (prof. C. Nayak)
* Station Q, Santa Barbara, USA (dr. P. Bonderson)

**Wahlström, E.:**
* New York University (prof. Andy Kent).
* Brookhaven National Laboratory (Dario Arena)

## ASIA

**Andersen, J.O.**
* Saha Institute (Munshi Mustafa and Najmul Haque).

**Berg, P.:**
* Okinawa Institute of Science and Technology, Japan (A. Leier)

**Brataas, A.:**
* Tohoku University, Sendai, Japan (Gerrit E. W. Bauer)

**Fossum, J.O.:**
* Gwangju Institute of Science and Technology, South Korea (prof. Do Young Noh)

**Hansen, A.:**
* Institute of Mathematical Sciences, Chennai, India (Ray)
* Saha Institute of Nuclear Physics, Kolkata, India (Chakrabarti).

**Holmestad, R.**
* Tokyo Technical University (T. Sato, S. Maraishi)
* Toyama University (K. Matsuda, S. Nishimura)

**Linder, J.:**
* Department of Physics, Tokyo Institute of Technology, Japan (T. Yokoyama)
* Department of Applied Physics, Nagoya University, Japan (Y. Tanaka)

**Lindgren, M.:**
* Riken Institute, Wako, Saitama, Japan (dr. Tamotsu Zako)

**Reenaas, T.W.:**
* Multimedia University, Malaysia (Teck Yong Tou, Seong Shan Yap)

**Sikorski, P.:**
* Department of Biomaterials Sciences, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan. (dr. M. Wada). Biophysics

**Skagerstam, B.-S.:**
* Centre for High Energy Physics, Indian Institute of Science, Bangalore, India (S. Vaidya).

**Stokke, B.T.:**
* Osaka Prefecture Univ., Osaka, Japan (S. Kitamura), Biophysics
* Department of Polymer Chemistry, Graduate School of Engineering, Kyoto University, Katsura Nishikyo-ku, Kyoto 615-8510 Japan (Kazunari Akiyoshi) Biophysics

**Sudbø, A:**
* Department of Applied Physics, Nagoya University, Japan.
* Department of physics, University of Tokyo, Japan (prof. N. Nagaosa).

## AUSTRALIA

**Davies, C.:**
* Cancer Biology Laboratory, Peter Mac Callum Cancer Centre, Melbourne (Robin Anderson)

**van Helvoort, A.T.J.:**
* Monash University, Melbourne, Australia (J. Etheridge)

**Holmestad, R.:**
* Monash University, Melbourne, Australia (J. Etheridge, M. Weyland, P. Nakashima)

## OSEANIA

**Skagerstam, B.-S.:**
* Department of Physics, University of Auckland, New Zealand (S. Parkins)

# EDUCATION

## SUBJECTS AND STUDENT ATTENDANCE

Some subjects were self-study courses in 2013

| *Subjects* | | *Student Attendance* |
|---|---|---|
| **MSc Technology 1st and 2nd year** | | |
| TFY4102 | Physics for Product Design Engineering, Earth Sciences and Petroleum Engineering (incl. lab) | 177 |
| TFY4104 | Physics for Product Design and Manufacturing, Marine Technology (incl. lab) | 290 |
| TFY4106 | Physics for Civil and Transport Engineering, Industrial Economics and Technology Management (incl. lab) | 228 |
| TFY4108 | Physics for Energy and Environmental Engineering (incl. lab) | 127 |
| TFY4115 | Physics for Electronics Engineering, Engineering Cybernetics, Nanotechnology (incl. lab) | 189 |
| TFY4120 | Physics for Chemical Engineering and Biotechnology, Materials Science and Engineering (incl. lab) | 107 |
| TFY4125 | Physics for Computer Science, Communication Technology | 230 |
| TFY4145 | Mechanical Physics (incl. lab) | 110 |
| TFY4155 | Electromagnetism (incl. lab) | 114 |
| TFY4160 | Wave Physics (incl. lab) | 108 |
| TFY4165 | Thermal Physics (incl. lab) | 98 |
| TFY4215 | Introduction to Quantum Physics | 97 |
| TFY4335 | Nano Life Science (incl. lab) | 20 |
| **MSc Technology 3rd year** | | |
| TFY4170 | Physics 2 for Electronics Engineering | 39 |
| TFY4185 | Measurement Techniques (incl. lab) | 103 |
| TFY4190 | Instrumentation (incl. lab) | 41 |
| TFY4195 | Optics (incl. lab) | 61 |
| TFY4205 | Quantum Mechanics II | 24 |
| TFY4230 | Statistical Physics | 68 |
| TFY4240 | Electromagnetic Theory | 52 |
| TFY4250 | Quantum Mechanics I | 53 |
| TFY4260 | Cell Biology and Cellular Biophysics (incl. lab) | 26 |
| TFY4330 | Nano Tools (incl. lab) | 6 |
| **MSc Technology 4th year** | | |
| TFY4200 | Optics, Advanced Course (incl. lab) | 6 |
| TFY4210 | Quantum Theory of Many-Particle Systems | 11 |
| TFY4220 | Solid State Physics (incl. lab) | 82 |
| TFY4225 | Nuclear and Radiation Physics (incl. lab) | 37 |
| TFY4235 | Computational Physics | 40 |
| TFY4245 | Solid State Physics, Advanced Course | 17 |
| TFY4255 | Materials Physics (incl. lab) | 8 |
| TFY4275 | Classical Transport Theory | 15 |
| TFY4280 | Signal Processing (incl. lab) | 34 |
| TFY4292 | Quantum Optics | 14 |
| TFY4300 | Energy and Environmental Physics | 56 |
| TFY4305 | Non-linear Dynamics | 17 |
| TFY4310 | Molecular Biophysics (incl. lab) | 15 |
| TFY4315 | Biophysics of Ionizing Radiation | 6 |
| TFY4320 | Medical Physics (incl. lab) | 12 |
| TFY4340 | Mesoscopic Physics | 8 |
| TFY4345 | Classical Mechanics | 37 |
| TFY485x | Experts in Team, Interdisciplinary Project | 17 |

**MSc Technology 5th year**

| | | |
|---|---|---|
| TFY4265 | Biophysical Micromethods (incl. lab) | 10 |
| TFY4500 | Biophysics, Specialization Project | 5 |
| TFY4505 | Biophysics, Specialization Course | 1 |
| TFY4510 | Physics, Specialization Project | 25 |
| TFY4515 | Physics, Specialization Course | 6 |
| TFY4520 | Nanotechnology, Specialization Project | 10 |
| TFY4525 | Bionanotechnology, Specialization Course | 7 |
| TFY4900 | Physics, Master's Thesis | 41 |
| TFY4905 | Nanotechnology, Master's Thesis | 11 |
| TFY4910 | Biophysics, Master's Thesis | 3 |

**BSc**

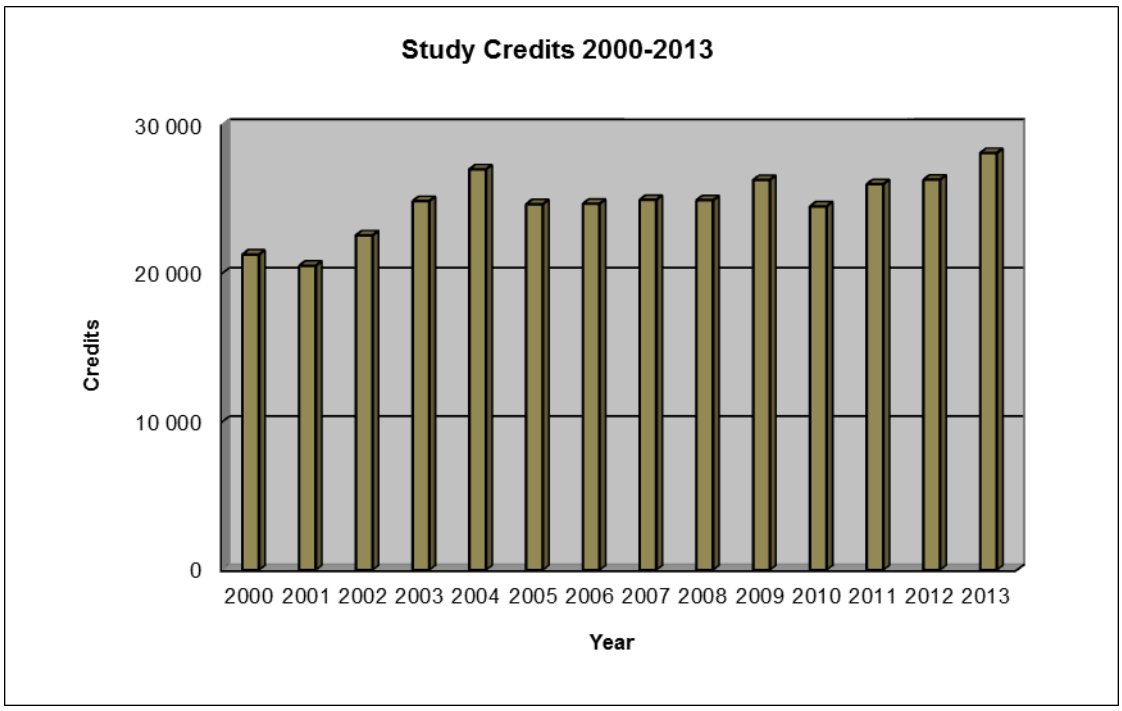
| | | |
|---|---|---|
| FY0001 | Service Course in Physics (incl. lab) | 43 |
| FY1001 | Mechanical Physics (incl. lab) | 60 |
| FY1002 | Wave Physics (incl. lab) | 49 |
| FY1003 | Electricity and Magnetism (incl. lab) | 48 |
| FY1005 | Thermal Physics (incl. lab) | 42 |
| FY1006 | Introduction to Quantum Physics | 38 |
| FY2045 | Quantum Mechanics I | 26 |
| FY2302 | Biophysics (incl. lab) | 6 |
| FY2450 | Astrophysics | 45 |

**MSc**

| | | |
|---|---|---|
| FY2290 | Energy Resources | 32 |
| FY3006 | Sensors and Transducers | 3 |
| FY3105 | Application of Symmetry Groups in Physics | 11 |
| FY3114 | Functional Materials | 11 |
| FY3201 | Atmospheric Physics and Climate Change | 17 |
| FY3402 | Subatomic Physics | 16 |
| FY3403 | Particle Physics | 25 |
| FY3452 | Gravitation and Cosmology | 25 |
| FY3464 | Quantum Field Theory I | 7 |
| FY3466 | Quantum Field Theory II | 7 |
| FY3900 | Master Thesis in Physics | 19 |
| FY3950 | Master Thesis in Physics (Teacher Education) | 3 |

**PhD**

| | | |
|---|---|---|
| FY8100 | Characterisation of Solid Surfaces | 0 |
| FY8102 | Electron Microscopy and Diffraction | 2 |
| FY8104 | Symmetry Groups in Physics | 6 |
| FY8201 | Nanoparticle and Polymer Physics | 1 |
| FY8302 | Quantum Theory of Solids | 2 |
| FY8303 | Phase Transitions and Critical Phenomena | 3 |
| FY8304 | Mathematical Approximation Methods in Physics | 2 |
| FY8305 | Functional Integral Methods in Condensed Matter Physics | 0 |
| FY8407 | Magnetic Resonance Imaging | 3 |
| FY8405 | Radiation Therapy Physics | 0 |
| FY8502 | Advanced Biophysics | 0 |
| FY8504 | Advanced Experimental Physics | 1 |
| FY8902 | Atmospheric Physics and Climate Change | 0 |
| FY8904 | Computational Physics | 3 |
| FY8905 | Materials Physics | 5 |
| FY8906 | Biophysical Micromethods | 1 |
| FY8907 | Classical Transport Theory | 10 |
| FY8908 | Quantum Optics | 3 |


Study Credits 2000-2013
30 000
20 000
10 000
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Credits
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year

# THESES – GRADUATE STUDIES

## Master of Science in Technology – Applied Physics and Mathematics

### *Profile – Biophysics and Medical Technology

**Correas Vidaurre, Francisca Belen**
*"Dose Coverage of the Uterus in Patients with Cervix Cancer during the Course of External Radiotherapy. VMAT vs. Four-Field Box Technique"*
Supervisors: Lindmo, Tore, Signe Danielsen, Anne Beate Langeland Marthinsen (St. Olavs Hospital)

**Dalehaug, Ingvild**
*"Optimization in CT. Evaluation of dose saving potential in a thorax-abdomen/pelvis protocol using iterative reconstruction techniques"*
Supervisors: Lindmo, Tore, Kirsten Bolstad (Haukeland universitetssykehus)

**Dybwad, Anniken**
*"Comparison of Dose Distributions resulting from IMRT and VMAT, and Assessment of MLC Leaf Positioning Errors"*
Supervisors: Lindmo, Tore, Jomar Frengen, Trond Strickert (St. Olavs Hospital)

**Finnøy, Andreas**
*"Acoustic and Mechanical Characterization of Microbubbles Stabilized by Polymeric Nanoparticles"*
Supervisor: Davies, Catharina de Lange

**Hauge, Anette**
*"Amphinex-(TPCS2a)-based photodynamic therapy and photochemical internalization of bleomycin and temozolomide - in vitro studies on the glioma cell line F98"*
Supervisors: Lindgren, Mikael, Odrun Gederaas (IKM)

### *Profile – Technical Physics

**Andreassen, Anders Johan**
*"Gauge Dependence of the Quantum Field Theory Effective Potential"*
Supervisors: Olaussen, Kåre, Matthew D. Schwartz (Harvard University)

**Bakken, Øystein Larssen**
*"Jerk in Curved Switches by Analysis of Track Measurements"*
Supervisors: Støvneng, Jon Andreas, Svein-Ole Sjøtun, Sten Inge Tunli (Jernbaneverket)

**Bjørgan, Asgeir**
*"Estimation of Skin Optical Parameters for Real-Time Hyperspectral Imaging Applications using GPGPU Parallel Computing"*
Supervisors: Støvneng, Jon Andreas, Lise Lyngsnes Randeberg (IET)

**Boge, Lars Helge**
*"Investigation of a Water Fraction Meter Based on the High Frequency Electromagnetic Field Technique Using an Uninsulated Inside Coil"*
Supervisors: Støvneng, Jon Andreas, Sigmund Hjermann (Hammertech AS)

**Dobrovolskaia, Polina**
*"Experimental Studies of Catalytic Properties of Gold Nanostructures on Ruthenium Substrate"*
Supervisor: Raaen, Steinar

**Døli, Ellen**
*"X-ray Scattering Study of Nanostructured GaSb Surfaces"*
Supervisor: Breiby, Dag Werner

**Eftevand, Mathias Sandvær**
*"Floating Ceiling in a Concert Hall"*
Supervisors: Simonsen, Ingve, Ulf Kristiansen (IET)

**Ekern, Kjetil Landgraff**
*"Velocity error induced by unevenly sampling wind radars"*
Supervisor: Espy, Patrick Joseph

**Eraker, Andreas Juvkam**
*"Loss measurements in Silicon Core Optical Waveguides"*
Supervisor: Gibson, Ursula

**Espeland, Erlend**
*"Gold Nanostructures on Graphite"*
Supervisors: Raaen, Steinar, Armen Julukian

**Falch, Ken Vidar**
*"Ensemble averaged and single Particle Auger Lifetimes in Zincblende Structure Semiconductors"*
Supervisors: Støvneng, Jon Andreas, Trond Bruvoll (FFI)

**Gjennestad, Magnus Aashammer**
*"Modeling of Heat Transfer in Two-Phase Flow Using the Level-Set Method"*
Supervisors: Støvneng, Jon Andreas, Svend Tollak Munkejord (SINTEF Energi)

**Grav, Torstein**
*"Mechanisms Governing the occurrence of Partial Discharges in Insulation Liquids"*
Supervisors: Raaen, Steinar, Lars Lundgaard (SINTEF Energi)

**Gu, Shangdong**
*"From Rock Scissor Paper to study and modeling of Chinese Five Elements. Evolutionary Game Thory."*
Supervisors: Simonsen, Ingve, Sheng Li (Jiaotong University)

**Hagen, Brede Andre Larsen**
*"Sensitivity Analysis of O&M Costs for Offshore Wind Farms"*
Supervisors: Simonsen, Ingve, Matthias Hofmann (SINTEF Energi)

**Hatlen, Morten**
*"On-board, Fourier-Based Image-Analysis System for Satellite Observation of Gravity Waves"*
Supervisor: Espy, Patrick Joseph

**Helland, Sjur Peder**
*"Pressure Fluctuations and Correlations in Steady State two Phase Flow in Porous Media"*
Supervisor: Hansen, Alex

**Hennum, Endre Asheim**
*"A new algorithm for remote sensing mesopause temperatures using the hydroxyl airlgow"*
Supervisor: Espy, Patrick Joseph

**Hov, Amund**
*"A workflow for Diffraction/Scattering Computed Tomography using the XRDtoolkit. Presenting the easy to use Python module for online XRD processing."*
Supervisors: Mathiesen, Ragnvald H., Olof Svensson, Veijo Honkimaki (ESRF)

**Hovdan, Ane Kamilla**
*"Experimental studies of clay-stabilized oil-in-water emulsions"*
Supervisor: Fossum, Jon Otto

**Hverven, Stine Myhre**
*"Laser Induced Incandescence with long-pulsed duration"*
Supervisors: Støvneng, Jon Andreas, Mario Ditaranto (SINTEF Energi)

**Johnsrud, Emilie Lund**
*"Experimental Studies of Monodisperse Pickering Emulsions Stabilized by Laponite Clay"*
Supervisors: Fossum, Jon Otto, Marcio Carvalho (PUC-Rio)

**Karlsen, Bjørnar**
*"Carrier Scattering Rates in Zincblende Structure Semiconductors derived from 14 × 14 k · p and ab initio Pseudopotential Methods"*
Supervisors: Støvneng, Jon Andreas, Trond Brudevoll, Asta Katrine Storebø (FFI)

**Klungerbo, Alexander Tallund**
*"Drop-on-Demand in Precision Farming"*
Supervisors: Støvneng, Jon Andreas, Simen Ellingsen, Trygve Utstumo (IEP/Adigo AS)

**Kolnes, Nils Henrik**
*"Gravity wave Climatology for Trondheim using a Meteor Radar"*
Supervisor: Hibbins, Robert Edward

**Kongsmo, Rakel**
*"Microscopical Characterization of Metal-Coated Polymer Microspheres under Mechanical Compression"*
Supervisor: Breiby, Dag Werner

**Lerstad, Stine Alm**
*"Matlab Based Music Analyses of Piano Recordings. An Attempt to Connect Quantitative Acoustical Parameters to Subjective Performance Intention"*
Supervisors: Simonsen, Ingve, Jan Tro (IET)

**Lisø, Daniel**
*"Pressure Fluctuations in Steady State Two-Phase Flow in Porous Media"*
Supervisor: Hansen, Alex

**Lysdahl, Asgeir Olaf Kydland**
*"The effect of ball-milling lithium hydride with lithium/rare-earth borohydrides. Synthesis, decomposition pathways and hydrogenation properties"*
Supervisors: Holmestad, Randi, Bjørn Christian Hauback, Christoph Frommen (IFE)

**Løtveit, Sjur Vullum**
*"Cost Optimality of Energy Systems in Zero Emission Buildings in Early Design Phase"*
Supervisors: Mikkelsen, Arne, Vojislav Novakovic, Igor Sartori (EPT/SINTEF)

**Murer, Fredrik Kristoffer**
*"X-ray Diffraction Computed Tomography of a Fossil Bone Sample"*
Supervisors: Breiby, Dag Werner, Martin Bech (München universität)

**Nærø, Karoline**
*"Gravity Wave Refraction in the Atmosphere: Ray tracing versus Geometric Location from a Single Image"*
Supervisor: Espy, Patrick Joseph

**Ofstad, Johannes**
*"Ferromagnetic Resonance Spectroscopy Studies of Permalloy/Copper/Chromium/Copper thin films"*
Supervisor: Wahlstrøm, Erik

**Rusten, Emile Simen Augustin**
*"Numerical study of the droplet-interface dynamic related to liquid-liquid separators"*
Supervisors: Støvneng, Jon Andreas, Carlos Dorao (IEP)

**Seth, Julie Janine Ravnanger**
*"Electrohydrodynamic Structuring of Colloidal Particles on Leaky Dielectric Drops"*
Supervisors: Fossum, Jon Otto, Marcio Carvalho (PUC-Rio)

**Skjønsfjell, Eirik Torbjørn Bakken**
*"Mapping Orientation Distribution of Talc Particles in Polypropylene by Small-Angle X-ray Scattering Tomography"*
Supervisor: Breiby, Dag Werner

**Skrondal, Hans Marius**
*"Time Series Analysis of Shipping Rates"*
Supervisor: Simonsen, Ingve

**Stavseng, Sindre Vegard**
*"Numerical Modelling of Optical Properties of Truncated and Coated Prolate Spheroidal Nanoparticles"*
Supervisor: Simonsen, Ingve

**Stornes, Morten**
*"Optimal Paths in Random Conductor Networks"*
Supervisor: Hansen, Alex

**Svennevik, Stein Magnus**
*"Can a meteor measure vertical winds?"*
Supervisor: Hibbins, Robert Edward

**Thon, Bjørn Olav**
*"Friction Models for Oscillating Flow in a U-tube"*
Supervisors: Støvneng, Jon Andreas, Ole Jørgen Nydal (IEP)

**Uthushagen, Kristian Siegel**
*"Entropy in Dynamical Networks"*
Supervisor: Simonsen, Ingve

## Master of Science in Technology – Nanotechnology

**Blikø, Monika**
*"Low Energy Electronic Properties of Graphene and Molybdenum Disulfide"*
Supervisor: Brataas, Arne

**Bøe, Andreas Gagnat**
*"Degradation and Stability of PBCA and POCA Nanoparticles"*
Supervisors: Davies, Catharina de Lange, Yrr Mørch

**Espedal, Camilla**
*"Static and Dynamic Transport Properties in Superconductors, Normal Metals and Ferromagnets"*
Supervisor: Brataas, Arne

**Muri, Harald Ian**
*"Atomic force microscope measurements for surface and interaction characterizations to optimize the surface patterning for bacterial micro arrays"*
Supervisors: Stokke, Bjørn Torger, Nina Bjørk Arnfinnsdottir

**Nesse, Torstein**
*"Rotation of the onion state in micromagnetic rings"*
Supervisor: Gibson, Ursula

**Ratnavel, Inthu**
*"Swelling properties of bioresponsive hydrogels. Swelling kinetics, and transport mechanisms in a hydrogel for signal transducing"*
Supervisors: Stokke, Bjørn Torger, Kamila Gawel

**Snipstad, Linn Sofie**
*"Mechanisms for delivery of hydrophobic drugs from polymeric nanoparticles to cancer cells"*
Supervisor: Davies, Catharina de Lange

**Snustad, Ingrid**
*"Selective examination of optically and structurally separable parts within GaAs/AlGaAs core-shell nanowires by micro-photoluminescence and tranwmission electron microscopy"*
Supervisor: Van Helvoort, Antonius Theodorus Johannes

**Søvik, Kishia Stojcevska**
*"Effect of ultrasound on the distribution of nanoparticles in tumor tissue"*
Supervisors: Davies, Catharina de Lange, Siv Eggen

**Torstensen, Jonathan Økland**
*"Investigating Endocytosis in HeLa Cells seeded on CuO Nanowires"*
Supervisor: Sikorski, Pawel Tadeusz

**Westrøm, Sara**
*"Cellular Interaction with Polymeric Nanoparitcles: The Effect of PEGylation and Monomer CoMposition"*
Supervisor: Davies, Catharina de Lange

## Master of Science in Physics

**Andresen, Haakon**
*"Numerical studies of Supernova Remnants"*
Supervisor: Kachelriess, Michael

**Bauer, Dag-Vidar Krogstad**
*"Particle Production in Gravitational Fields"*
Supervisor: Kachelriess, Michael

**Berge, Eirik Samuel**
*"The Structure of Quark Stars"*
Supervisor: Andersen, Jens Oluf

**Bergslid, Tore Sivertsen**
*"Implementing a Full-Band Monte Carlo Model for Zincblende Structure Semiconductors"*
Supervisors: Støvneng, Jon Andreas, Trond Brudevoll, Asta-Katrine Storebø (FFI)

**Berzi, Alan**
*"Relativistic Fermions in Graphene"*
Supervisor: Olaussen, Kåre

**Birkeland, Sigmund Andreas**
*"Transient dynamic in gas transport"*
Supervisors: Hansen, Alex, Tor Ytrehus

**Glesaaen, Jonas Rylund**
*"The Chiral Phase Transition in QCD. Mean-Field Versus the Functional Renormalisation Group"*
Supervisor: Andersen, Jens Oluf

**Rønning, Snorre Stavik**
*"Optimizing an Infrared Camera for Observing Atmospheric Gravity Waves from a CubeSat Platform"*
Supervisors: Espy, Patrick Joseph, Roger Birkeland, Robert Hibbins

**Sjøstrøm, Dag-Morten**
*"Bosons and Fermions in Curved Spacetime"*
Supervisor: Olaussen, Kåre

**Sogge, Nicolas Vallet**
*"Neutron Stars. The electromagnetic forces at the surface and its implications."*
Supervisor: Myrheim, Jan

**Stieng, Lars Einar**
*"The Diffuse Synchrotron Radio Background from Normal Spiral Galaxies in the Context of the ARCADE Excess"*
Supervisor: Kachelriess, Michael

**Vatanparast, Maryam**
*"Low-Energy Electronic Properties of Graphene"*
Supervisor: Brataas, Arne

## Master of Science in Condensed Matter Physics

**Dibbs, Andrew**
*"Silicon Core Optical Fibre Production and Characterisation. An investigation of alkali earth metal oxide interface additives in a fibre production method"*
Supervisor: Gibson, Ursula

**Gebremedhin-Abraha, Friew**
*"Statistics of Electric Power Blackouts: Data Analysis and Data Modeling"*
Supervisor: Hansen, Alex

**Hedayatfar, Keivan**
*"Affect of Time Dependent Magnetization on SFS junctins"*
Supervisor: Brataas, Arne

**Jayakumari, Sethulakshmy**
*"The effects of Be doping on the structure of Ga and Au-assisted GaAs-based heterostructured semiconductor nanowires."*
Supervisor: Van Helvoort, Antonius Theodorus Johannes

**Karbaschi, Mona**
*"Optical Edge- Scanning Measurements of Damage in Silicon Wafers"*
Supervisor: Gibson, Ursula

**Liudi-Mulyo, Andreas**
*"Characterisation of quantum dot-intermediate band solar cells with optical spectroscopy"*
Supervisor: Kildemo, Morten, Turid Worren Reenaas, Lars Martin Aas

## Master of Science in Science Education

**Mongstad, Eirik**
*"Variability of the Quasi Two-Day Wave in the Mesosphere"*
Supervisor: Espy, Patrick Joseph

**Nordvang, Andreas**
*""That Figure is not relevant for me" A qualitative study about student's use of images and figures in physics textbooks"*
Supervisor: Bungum, Berit

**Suleng, Arne**
*"The Bak-Sneppen Model on coupled complex Networks"*
Supervisor: Simonsen, Ingve

**Trøen, Thomas**
*"Development of Signal Processing Tools and Analysis of Hyperspectral Imaging Data in Diagnostics of Prion Diseases"*
Supervisor: Lindgren, Mikael

# PARTICIPATION IN COMMITTEES

## EVALUATION COMMITTEES

**Berg, P.:**
* Administrator for the PhD defense of Knut Gjerden, Department of Physics, NTNU, March 2013
* Opponent at the PhD defense of Karen Chan, Department of Chemistry, Simon Fraser University, Canada, August 2013
* Administrator for the PhD defense of Arne Stormo, Department of Physics, NTNU, October 2013

**Borg, A.:**
* Member of the evaluation committee on Physics study programs at Swedish universities, Högskoleverket, 2012-2013.
* Opponent at the PhD defense of Phuong Dan Nguyen, Department of Physics, University of Oslo, February 2013.
* Member of examination committee (betygsnemnd) at the PhD defense of Nicklas Anttu, Lund University, June 2013.
* Evaluation committee for tenure track position with qualifications as associate and full professor, Tampere University of Technology, 4 candidates, March 2013.
* Evaluation committee for appointing professor in Applied Physics at Linköping University, spring 2013.

**Breiby, D.W.:**
* Opponent at the PhD defense of Yun Gu, Department of Physics, University of Copenhagen

**Dias, R.S.:**
* Member of the evaluation committee for PhD thesis: Nils Carlsson, Chalmers University of Technology, Göteborg, Sweden, September 2013.

**Davies C. de L.;**
* Evaluation committee for application on infrastructure to the regional health authorities Helse Sør-Øst
* Evaluation committee for applications to The Norwegian Cancer Society
* Opponent for PhD defence of Maja Muju Monica Hellesøy, Univ of Bergen, June 2013
* Opponent for PhD defence of Jens Andreas Lindin Jørgensen, Univ of Oslo, October, 2013

**Fjærestad, J.O.:**
* Administrator for PhD defence of Henrik Enoksen, Dept of Physics, NTNU, August 2013.

**Fossum J.O.:**
* Opponent for PhD defense of Haijiang Zhang, Chalmers University of Technology, Sweden June 2013
* In jury for PhD defence of Baudouin Saintyves, CEA-Saclay & ESPCI-PariTech February 2013

**Gibson, U.:**
* Faculty hiring board, American University of Kuwait
* Administrator for Teferi Dejene Demissie, NTNU
* Administrator for Tor Olav Sunde, NTNU
  * Selection committee for section engineer

**Hansen, A.:**
* Member of the award committee for the CECAM Berni Alder Prize in Computational Physics.
* Member of evaluation committee for associate professorship in physics at the University of Oslo.
* Evaluator for the European Research Council.
* Evaluator for PRACE.
* Evaluator for Agence Nationale de la Recherche, France.
* Administrator for PhD defense of Tor Nordam, Department of Physics, NTNU.

**van Helvoort, A.T.J.:**
* Administrator for the PhD thesis of Morteza Esmaeili, Institutt for fysikk, NTNU, March 2013.
* Opponent for the PhD thesis of Fredrik S. Hage, Institutt for fysikk,, UiO, November 2013.

**Holmestad, R.:**
* Administrator for PhD defense of Bjørn Tore Esjeholm,(Physics, NTNU) June 2013
* Administrator for PhD defense of Håvard Granlund ,(Physics, NTNU), November 2013.
* European Research Council (ERC) – proposal reviews, September 2013.

**Kachelriess, M.:**
* Opponent at the PhD defence of Mahdi Poormohammadi (Universitetet i Bergen, 10/2013).
* Member of the steering committee of "ISAPP: International School on AstroParticle Physics European Doctorate School".

**Linder, J.:**
* Member of the Nordita Research Committee for Condensed Matter Physics, Nordita (SWE).

**Lindgren, M.:**
* Evaluation committees (x2) for appointing adjunct professors at NTNU-IFY.

**Mathiesen, R.H.**
* Administrator of PhD committee for Hanne Kauko, NTNU, (Dec. 2013)

**Mikkelsen, A.:**
* Administrator of PhD committee for Elisabeth Lindbo Hansen, Department of Physics (Defense August 27th)
* Administrator of PhD committee for Armen Julukian, Department of Physics (Defense December 12th)

**Olaussen, K.:**
* Administrator for the PhD defense of Asle Heide Vaskinn, Department of Physics, NTNU, November 2013
* IEEC/CSIC, Campus UAB, Barcelona (Sergei Odintsov)
* Max Planck Institute for Intelligent Systems, Stuttgart (Ania Maciolek)

**Reenaas, T. W.:**
* Administrator for the PhD thesis of Tine Nærland (Department of Materials Science and Engineering), November 2013
* Opponent for PhD thesis of Mareike Trunk (Department Physics, UiO), January 2013

**Sikorski, P.:**
* Opponent for the PhD thesis of Trine Berthing, Graduate School of Health and Medical Sciences, Faculty of Health and Medical Sciences, University of Copenhagen

**Stokke, B.T.:**
* Administrator for dr philos thesis, Olga Sekurova, NTNU
* Evaluation committee for assoc. professorship in medical physics, NTNU
* Advisory Board, Nordic Physics Days, Lund 2013

**Støvneng, J. A.:**
* Administrator for the PhD thesis of Severin Sadjina, Institutt for fysikk, NTNU
* Administrator for the PhD thesis of Mohammad Alidoust, Institutt for fysikk, NTNU

**Wahlström E.**
* Member in evaluation committee of PhD for Yeyu Fang, Göteborg University, Sweden.
* Member in evaluation committee of PhD for Sohrab Redjai Sani, Royal institute of tehcnology, Sweden.

## INTERNATIONAL COMMITTEES

**Borg, A.:**
* Member of "Beredningsgrupp för kondenserade materiens fysik", Swedish Research Council (VR), Sweden.
* Member of the board of The Nanometer Consortium, Lund University, Sweden.
* Member of Administrative Council of SEFI (European Society for Engineering Education)
* Member of the "Program Advisory Committee" (PAC) of MAX-lab.
* Member of the External Advisory Panel, Department of Materials, Imperial College, London, UK.
* Member of the European Science Foundation Materials Science and Engineering Expert Committee (MatSEEC).
* Member of the Scientific Selection Panel of the Helmholtz-Zentrum Berlin für Materialien und Energie
* Member of the "Program Advisory Committee" (PAC) of MAX-lab

**Brataas, A.:**
* Chairman, Kavli prize in Nanoscience
* Coordinator, EU Future and Emergining Technologies, "InSpin - Insulator Spintronics"
* Member, EU ITN "SpinIcur"

**Espy, P.:**
* Member SCOSTEP Climate and Weather of the Sun-Earth System (CAWSES-II) Task Group 2, 2013.
* Member International ALOMAR Science Advisory Committee, 2013.
* Management board Network for the Detection of Mesospheric Change, 2013

**Fossum, J. O.:**
* Project leader of a Nordforsk funded Nordic Researcher Network in Soft Matter Physics (2010-2014) involving ~100 scentists in ~10 groups in the Nordic countries (Denmark, Finland, Norway, Sweden)

* In International Scientific Advisory Board for Center of Physics, Minho University, Braga, Portugal
* In International Scientific Advisory Board for International Center for Condensed Matter Physics (ICCMP), Universidade de Brasilia (UnB), Brasilia, Brazil
* Guest Editor in Cuban Journal of Physics
* Main organizer of *International Mini-Workshop on Multi-Component Soft and Complex Fluids*, at International Center for Condensed Matter Physics (ICCMP), University of Brasilia (UnB), Brasilia-DF, Brazil, July 15-16, 2013 (Co-organized with Prof. Geraldo Jose da Silva, UnB, Brasilia, Brazil)
* Main organizer of *International Mini-Workshop on Complex Drops and Emulsions* at Department of Mechanical Engineering at Pontifícia Universidade Católica do Rio de Janeiro, Brazil, July 12, 2013 (Co-organized with Prof. Marcio Carvalho, PUC-Rio, Brazil)
* Convener of Symposium: *Self-organization from Clay Particles: From Nano to Macro* as part of the 15th International Clay Conference, Rio de Janeiro, Brazil, July 7-11, 2013.
* In scientific committee of *15th International Clay Conference*, Rio de Janeiro, Brazil, July 7-11, 2013.
* Main organizer of Nordforsk *International Workshop on Soft Matter Physics and Biomembranes*, Reykjavik, Iceland, May 21-24 2013. (Co-organized with Prof. Aldo Jesorka, Chalmers Univ. Gotheborg, Sweden)

**Gibson, U.:**
* Editorial Board, Materials Characterization (Elsevier)
* Editorial Board, NanoEthics (Springer)
* International Commission for Optics, Board member

**Hansen, A.:**
* Chair of the Board of European Physical Society's Computational Physics group.
* Chair of the Commission on Computational Physics (C20) of the International Union of Pure and Applied Physics (IUPAP).
* Vice President of the International Union of Pure and Applied Physics (IUPAP).
* Member of the Scientific Advisory Board to the Center of Excellence in Computational systems Research, Helsinki University of Technology.
* Member of Scientific Advisory Board to the Center of Excellence G-Eau-Thermie Profonde, Univ. Strasbourg.
* Member of the ESF Network "Exploring the Physics of Small Devices" steering committee.
* Member of the Editorial board of the European Journal of Physics.
* Member of the Editorial Board of the International Journal of Modern Physics C.
* Member of the Editorial Board of Journal of Computational Interdisciplinary Sciences.
* Editor-in-Chief, Frontiers in Physics.

**Holmestad, R.:**
* Member of the board of the Nordic microscopy society, SCANDEM.
* Leader of the Nordic network (NordForsk) within TEM – NorTEMnet
* Member of the board of European Microscopy Society (EMS)

**Kildemo, M.:**
* Program comittee member International Conference on Spectroscopic Ellipsometry ICSE-VI (Kyoto,2013)

**Lilledahl, M.B.:**
* International committees: Management committee member for Cost Action: Chemical imaging by coherent Raman microscopy.

**Linder, J.:**
* Member of the Management Committee for COST Action MP1201 (EU).

**Mathiesen, R. H.**
* Program Advisory Committee of Max-laboratory, Lund University, Sweeden.
* Scientific Adivisory Comimittee of the European Synchrotron Radiation Facility, Grenoble, France
* Chairman ESRF ID11 5-year beam line review comimittee, European Synchrotron Radiation Facility, Grenoble, France
* ESRF C02 Beam Time Allocation Rev. Comm., Grenoble, France

**Stokke, B.T.:**
* Editorial Advisory Board – Biopolymers (Wiley).

**Sudbø, A.:**
* Steering Committee Member, European Science Foundation Network on Nanoscience and Engineering in Superconductivity (NES).
* Member of ESA' Physical Sciences Working Group, European Space Agency
* Member Managing Committee Cost Action MP-1201 Nanoscale Superconductivity: Novel Functionalities through Optimized Confinement of Condensate and Fields
* Advisory Board, Physica C Superconductivity and its applications
* Member of the Board Nordita, Stockholm.

## NATIONAL COMMITTEES

**Borg, A.:**
* Member of the Board for the Niels Henrik Abel Prize.
* Member of the board at UNIK

**Breiby, D.W.:**
* Member of the ColdWear steering committee.

**Davies, C. de L.:**
* Member of the board of the National Interdisciplinary Research School in Medical Technology

**Espy, P.:**
* Member, Committee for Co-operation in Space Related Activities between NTNU-National Centre for Space Related Education- Andøya Rocket Range, 2013
* Science management team for Birkeland Centre for Space Science, 2013

**Fossum, J.O:**
* Member of the Board of the Norwegian Physical Society
* Chair of the Division for Condensed matter Physics with Atomic Physics in The Norwegian Physical Society

**Hansen, A.:**
* Member of Board of Trustees, National Museum of Applied Arts, Trondheim.

**Holmestad, R.:**
* Member of the board of 'Bardalfondet' (Fond for belønning av fremragende studentarbeid innen økologiske aspekt av materialteknologi ved NTNU) and 'Fondet til professor Leif Tronstads minne'

**Linder, J.:**
* Leader of 'Formidlingsutvalget', Department of Physics

**Stokke, B.T.:**
* Norwegian national committee for the evaluation of professor competence in physics, member.
* Chairman of the board, NORFAB, National large scale research infrastructure project.

## UNIVERSITY AND DEPARTMENTAL COMMITTEES

**Berg, P.:**
* Chairman, "Studieprogramråd for BFY Fysikk og MSc Physics (realfag)"
* Member, "Undervisningsutvalget ved institutt for fysikk"
* Member, "Utdanningsutvalget ved NT fakultetet"
* Member, "Formidlingssutvalget", Instituttt for fysikk

**Borg, A.:**
* Member of FUS ("Forvaltningsutvalget for sivilingeniørutdanningen") at NTNU.
* Member of FUL ("Forvaltningsutvalget for Lærerutdanningen") at NTNU.
* Member of Educational Committee of NTNU
* Member, "Studieprogramråd for Lærerutdanningen i Realfag".
* Member of the board at Department of Industrial Economics and Technology Management
* Member of the council for KOMPiS ("Kompetanse i skolen")

**Brataas, A.**
* Chairman, Natural Science Library Committee

**Davies, C. de L.:**
* Director of NTNU's Strategic Area of Medical Technology.
* Member of the board for the Research School for Medical Imaging

**Dias, R.S.:**
* Member of 'Formidlingsutvalget', Department of Physics

**Espy, P.:**
* Head of Section of Applied physics and Didactic Physics.

**Fjærestad, J.O.:**
* Member, "Studieprogramråd for PhD-utdanningen ved Institutt for fysikk".

**Gibson, U.:**
* Program committee for MTFYMA
* Elected member of the departmental board

**Holmestad, R.:**
* Leader of the TEM Gemini Centre
* Project leader of the large scale infrastructure project NORTEM (up to Mach 2013).

**Høye, J.S.:**
* Head of Section of Theoretical Physcis.

**Linder, J.:**
* Member of 'Formidlingsutvalget', Department of Physics

**Lindmo, T.:**
* Head of Section of Biophysics and Medical Technology.
* Member, "Studieprogramråd for fysikk og matematikk".
* Chairman, "Studieprogramråd for International MSc Medical Technology".
* Member "Studieprogramråd for PhD i medisinsk teknologi".

**Olaussen, K.:**
* Member of 'Forskningsutvalget', NT-fakultetet
* Chairman 'Formidlingsutvalget', Institutt for fysikk

**Reenaas, T.W.:**
* Member, "Studieprogramråd for MSc Condensed Matter Physics".
* Substitute for the Elected member of the Departmental Board.

**Sikorski, P.:**
* Chairman, Study program board, Master in Nanotechnology, NTNU
* Member. NTNU NanoLab leader group

**Stokke, B.T.:**
* Member, "Studieprogramråd for fysikk og matematikk".
* Chairman of the Board, MARPOL project (http://www.ntnu.edu/marpol/marpol)

**Støvneng, J.A.:**
* Chairman, "Undervisningsutvalget ved institutt for fysikk".
* Chairman, "Studieprogramråd for MSc Fysikk og matematikk"

**Wahlström, E.:**
* Head of Section of Condensed Matter Physics.
* Member. NTNU NanoLab ledergruppen.
* Deputy Head of department of physics.
* Member of "arbeidsgruppen IKT muliggjørende teknologi."
* Chairman "Studieproramråd for PhD i fysikk"
* Chairman "Studieproramråd for PhD i bio-fysikk"
* Member "Studieprogramråd for Baechelor og master i fysikk"
* Member of 'Forskningsutvalget', NT-fakultetet.

## ARRANGEMENT COMMITTEES

**Berg, P.:**
* Main organizer of International Workshop on Water Phenomena in Polymer Electrolyte Membranes (PEM2013), NTNU, 03-04 October 2013 (co-organized with Prof. M. Eikerling, Simon Fraser University, Canada)

**Fossum J.O.:**
* Organizer of Mini-Workshop on Complex Flows and Turbulence, Departamento de Fisica, UFPE Recife, PE, Brazil, December 7, 2012 (Co-organized with Prof. Giovani Vasconcelos, UFPE Recife Brazil)
* Main organizer of International Workshop on Soft Matter Physics and Complex Flows, Svolvær. Lofoten, Norway, May 22 – 25 2012 (Co-organized with Prof. E. Bouchaud. ESPCI-Paris, France)
* In scientific committee of International Conference: New materials in the Age of Convergence, Havana, Cuba, March 12-16, 2012
* Main organizer of International workshop on Complex matter physics: Materials, dynamics and patterns, Havana, Cuba, March 5-8 2012 (Coorganized with Prof. Ernesto Altshuler, Univ. Havana, Cuba)
* Main organizer of International Mini-Workshop on Complex Flows, International Center for Condensed matter Physics (ICCMP), Universidade de Brasilia (UnB), Brasilia, Brazil, February 6-7 2012 (co-organized with Prof. Geraldo Jose da Silva, ICCMP and UnB, Brasilia, Brazil)
* Main organizer of 2nd International Workshop on Complex Physical Phenomena in Materials, Hotel Armacao, Porto de Galinhas PE, Brazil, January 31- February 3 2012 (Co-organized with Prof. Giovani Vasconcelos, UFPE Recife Brazil)

**Hansen, A.:**
* International Advisory Board Member of Conference on Computational Physics (CCP) 2013, Moscow, Russia.

# FRIDAY COLLOQUIUM – ”Fredagskollokviet i fysikk”

**Convenors:** Erik Wahlström (spring)
Justin Wells and Dag Werner Breiby (autumn)

## Programme – spring term

**February 1st: Justin Wells, Department of Physics, NTNU**
«Understanding charge and spin transport phenomena: an experimental approach»

**February 15th: Frank Filthaut, Radboud Universiteit Nijmegen, The Netherlands**
«Physics harvest at the LHC»

**February 22nd: Suzanne McEnroe, Department of Geology and Mineral Resources Engineering, NTNU**
«Natural memory systems: Old rocks, long memories and consequences of remanent magnetization on anomaly interpretation»

**March 8th: Jarosław Piasecki, Faculty of Physics, University of Warsa**w
«Casimir forces in condensed matter physics: The case of Bose-Einstein condensation»

**March 15th: Dietrich Wolf , University of Duisburg-Essen**
«Structural features emerging from nano-powder sintering»

**March 22nd: Nikolai Østgaard, Department of Physics and Technology (Birkeland Centre for Space Science), University of Bergen**
«Birkeland Centre for Space Centre and Terrestrial gamma ray flashes, the most energetic photon phenomenon in our atmosphere»

**April 5th: Pär Olsson, Reactor Physics Division, Kungliga Tekniska Högskolan (KTH)**
«The search for high performance photovoltaic materials»

**April 12th: Yasser Roudi, Roudi group, Kavli Institute for Systems Neuroscience, NTNU**
«Spin glass physics and computation»

**April 19th: Alexander Balatsky, Nordic Institute for Theoretical Physics (Nordita), Sweden**
«DNA Electronic Fingerprints by Local Spectroscopy on Graphene»

**April 26th: Ralf Eichhorn, Nordic Institute for Theoretical Physics (Nordita), Sweden**
«From Brownian motion to Stochastic Thermodynamics»

**May 10th: Bernd Rosenow, Universität Leipzig**
«Exotic particles in two dimensions: interferometry with anyons»

## Programme – autumn term

**September 13th: Olle Inganäs, Biomolecular and organic electronics, IFM, Linköping University**
«Electronic polymers and biopolymers in self-assembling materials and devices»

**September 27th: Lee Sang Wook, Konkuk University, South Korea**
«Carbon Based Nanoelectromechanics»

**October 4th: Paul Dommersnes, Paris Diderot University**
«Fluid Drops covered by Particles: Physics and Applications»

**October 25th: Tony Cafolla, School of Physical Sciences, Dublin City University (DCU)**
«From porphyrins to nanoribbons: STM and synchrotron studies of molecules on surfaces»

**November 1st: Philip King, Cornell University, USA**
«Confining correlated electrons to nanoscale dimensions»

**November 22nd: Gaute Einevoll, Norwegian University for Life Sciences**
«Power laws in the brain»

**November 15th : Brit Salbu, Norwegian University for Life Sciences**
«Radioactive particles, sources and potential impact»

**November 29th : Jan Skov Pedersen, Aarhus University**
«Kinetics in surfactant solutions studied by combing stopped-flow mixing with synchrotron small-angle X-ray scattering»

**December 6th: Pål Erik Goa, Department of Physics, NTNU**
«Magnetic Resonance Imaging: Technology and Applications»

**November 8th: Peter Bøggild, DTU Nanotech, Technical University of Denmark**
«Graphene technology - a reality check»

**December 13th: Suddho Mahapatra, Indian Institute of Technology Bombay, India**
«Quantum computing with electron spins in silicon»

# Annual Report for Department of Physics 2013

NTNU
Norwegian University of Science and Technology

**NTNU**

The Norwegian University of Science and Technology (NTNU) in Trondheim represents academic eminence in technology and the natural sciences as well as in other academic disciplines ranging from the social sciences, the arts, medicine, teacher education, architecture to fine art. Cross-disciplinary cooperation results in innovative breakthroughs and creative solutions with far-reaching social and economic impact.


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Svanemerket trykksak fra Skipnes Kommunikasjon Lisensnr. 241 731



Department of Physics

Annual Report 2013


**www.ntnu.no/fysikk**