# Curriculum Vitae

for

# Ingve Simonsen

Trondheim, Norway, Feb 2022

# INGVE SIMONSEN

## PERSONAL DETAILS


| | |
|---|---|
| Date of birth | June 6, 1969 |
| Place of birth | Stavanger, Norway |
| Gender | Male |
| Citizenship | Norwegian |
| Marital status | Married |
| Languages | Norwegian (native)<br>English (fluently)<br>German (basic level) |

| | |
|---|---|
| Address | NTNU – Norwegian University of Science and Technology<br>Department of Physics<br>NO-7491 Trondheim<br>NORWAY |
| Phone/Fax | +47 73 59 34 17 / +47 73 59 77 10 |
| E-mail | Ingve.Simonsen@ntnu.no |
| Homepage | `http://web.phys.ntnu.no/~ingves/` |


## EDUCATION

| | |
|---|---|
| 2011–2012 | Pedagogic Development Program (PEDUP)<br>Norwegian University of Science and Technology (NTNU), Norway. |
| 1996–2000 | Dr. Scient. (PhD) in statistical physics : *New Light on Rough Surfaces: Theories of how they appear and consequences of that*<br>The Norwegian University of Science and Technology, Trondheim, Norway. |
| 1992–1994 | Cand. Scient. (MSc) in high-energy physics : *Supersymmetric Quantum Flavor Dynamics and constraints from the Muon anomalous magnetic moment*<br>University of Trondheim, Norway. |
| 1988–1992 | Cand. Mag. (BSc) in physics and mathematics; University of Trondheim, Norway. |

## CURRENT AND PAST APPOINTMENTS

*Regular academic appointments*

| | |
|---|---|
| Dec 07–present | Professor of Physics, Department of Physics,<br>Norwegian University of Science and Technology, Trondheim, Norway. |
| Jan 16–Jun 21 | Chair of Industrial Research and invited professor,<br>Centre National de la Recherche Scientifique (CNRS), Paris, France. |
| Jan 15–Dec 17 | Adjunct professor of Geophysics<br>Department of Petroleum Engineering, University of Stavanger, Norway. |

| | |
|---|---|
| Oct 06–Dec 07 | CNRS Senior Research Scientist (CR1),<br>Labo Mixte CNRS/Saint-Gobain, *Surface du Verre et Interfaces*,<br>Centre National de la Recherche Scientifique (CNRS), Paris, France. |

*Industrial appointments*

| | |
|---|---|
| 2016–2021 | Senior research scientist, SVI, Saint-Gobain Recherche, Aubervilliers, France. |
| 2012–present | Founder and owner ISICON — Ingve Simonsen Consulting |
| 2011–present | Scientific advisor, emseis AS, Norway |
| Sep 05–Oct 05 | Ingenieur de recherche, Saint-Gobain Recherche, Aubervilliers, France. |
| Oct 02–Aug 05 | Senior physicist, Electromagnetic Geoservices AS, Trondheim, Norway |

*Other appointments*

| | |
|---|---|
| Apr 06–Sep 06 | Research fellow, Institute for Economics and Traffic,<br>Dresden University of Technology, Dresden, Germany. |
| Jan 06–Mar 06 | CNRS Senior Research Scientist,<br>Labo Mixte CNRS/Saint-Gobain, *Surface du Verre et Interfaces*,<br>Centre National de la Recherche Scientifique (CNRS), Paris, France. |
| Nov 05–Dec 05 | Researcher, Nordic Institute for Theoretical Physics (NORDITA), Denmark. |
| 2003–2006 | Guest research scientist,<br>Norwegian University of Science and Technology, Trondheim, Norway |
| Oct 00 –Sep 02 | Post doc, Nordic Institute for Theoretical Physics (NORDITA), Copenhagen, Denmark |
| May 00–Sep 00 | Research fellow in physics,<br>The Norwegian University of Science and Technology, Trondheim, Norway |
| Jan 00–Apr 00 | Research fellow in physics, University of Californian, Irvine, USA |
| Jul 99–Dec 99 | Research fellow in physics,<br>The Norwegian University of Science and Technology, Trondheim, Norway |
| Jan 99–Jun 99 | Research fellow, SINTEF Applied Physics, Trondheim, Norway |
| May 98–Dec 98 | Chercheur associe au CNRS<br>Labo Mixte CNRS/Saint-Gobain, *Surface du Verre et Interfaces*<br>Centre National de la Recherche Scientifique (CNRS), Paris, France |
| 1996–Apr 98 | Research fellow, SINTEF Applied Physics, Trondheim, Norway |
| 1995–1996 | Research fellow in physics,<br>The Norwegian Insitute of Technology (NTH), Trondheim, Norway |
| 1994–1995 | Research fellow in geophysics, Statoil Research Center, Trondheim, Norway |

## Invited/Visiting Positions

| | |
|---|---|
| Jan–Jun 2019 | UBB Advanced Fellow, Institute for Advanced Studies in Science and Technology,<br>Universitatea Babeş-Bolyai, Cluj, Romania. |

| | |
|---|---|
| Jun 18–Sep 18 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Jul 17–Oct 17 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Jun 15–Sep 16 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| 2014 | Invited professor (1 month), University Pierre and Marie Curie, Paris, France.<br>Hosted by Labo Mixte CNRS/Saint-Gobain (UMR 125). |
| Jun 14–Aug 14 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| May 13–Aug 13 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| May 12–Aug 12 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Jun 11–Aug 11 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| May 10–Sep 10 | Invited professor, The Centre National de la Recherche Scientifique (CNRS), France.<br>Institut des NanoSciences de Paris (INSP). |
| Jun 09–Jan 10 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Jun 08–Aug 08 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Jun 07–Sep 07 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| May 01–Aug 01 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Feb 01–Mar 01 | Saint-Gobain Research, Labo Mixte CNRS/Saint-Gobain (UMR 125),<br>Surface du Verre et Interfaces" Aubervilliers, France. |
| Feb 99–May 00 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| Aug 99–Sep 99 | University of Brasília, Brasília, Brazil; International Centre for Condensed Matter Physics. |
| May 98–Dec 98 | École Supérieure de Physique et de Chimie Industrielles, Paris, France.<br>Laboratoire de Physique et Mécanique des Millieux Hétérogènes. |
| Sep 97–Oct 97 | University of California, Irvine, USA; Department of Physics and Astronomy. |
| 1995–1998 | Nordic Institute for Theoretical Physics — NORDITA, Copenhagen, Denmark.<br>(Several stays during the period) |

## Honors and Awards

| | |
|---|---|
| 2019 | UBB Advanced Fellow, Institute for Advanced Studies in Science and Technology,<br>Universitatea Babeş-Bolyai, Cluj, Romania. |
| 2015 | Invited to an Industrial Chair position and scientific leader of the project FRAXOS (Fundamental electromagnetic approach to complex optical systems), Paris, France. |
| 2014 | The pedagogical prize of the Faculty of Natural Sciences and Technology, NTNU |
| 2014 | Invited professor, University Pierre and Marie Curie (UPMC), Paris, France. |
| 2010 | The Royal Norwegian Society of Sciences and Letters; Elected member |
| 2010 | Invited professor, Institut des NanoSciences de Paris (INSP)<br>The Centre National de la Recherche Scientifique (CNRS), France. |

| | |
|---|---|
| 2008 | The Norwegian Academy of Technological Sciences; Elected member |
| 2002 | The Max Planck Institute for the Physics of Complex Systems (MPIPKS)<br>Distinguished PKS Postdoctoral Fellow (declined) |

## ADMINISTRATIVE EXPERIENCE

*Board memberships*

| | |
|---|---|
| 2011–present | Board member emseis AS, Norway |
| 2001–2002 | Board member Nordic Institute of Theoretical Physics (NORDITA), Denmark |

*University services*

| | |
|---|---|
| 2020–present | Leader of the research section "Astrophysics and theoretical physics", Department of Physics, NTNU |
| 2019–present | Leader of the study programs: "Bachelor of Science in Physics" (BFY); and the international program "Master of Science in Physics" (MSPHYS) at NTNU. |
| 2019–present | Member of the "Education Committee" (Utdanningsutvalget) at Faculty of Natural Science, NTNU. |
| 2018 | Excursion leader for trip to Japan for about 20 3rd year physics and math students |
| 2017 | Excursion leader for trip to Japan for about 60 3rd year physics and math students |
| 2016 | Excursion leader for trip to Japan for about 60 3rd year physics and math students |
| 2014 | Excursion leader for trip to Singapore for about 50 3rd year physics and math students |
| 2012 | Excursion leader for trip to Singapore for about 50 3rd year physics and math students |
| 2011–2014 | Leader of the study programs: "Bachelor of Science in Physics" (BFY); and "Master of Science in Physics" (MFY) at NTNU. |
| 2011–2014 | Member of the "Education Committee" (Utdanningsutvalget) at Faculty of Natural Science and Technology, NTNU. |
| 2011 | Excursion leader for trip to China for about 50 3rd year physics and math students |
| 2010-2012 | Member of "Prosess utvalget", NTNU (appointed by rector). |
| 2009 | Member of *IKT i sivilingeniørutdanningen*, NTNU (appointed by the rector of NTNU) |
| 2008 | Member of the evaluation committee for the *Study Programs in the Mathematical and Physical Sciences*, NTNU. |

*Committee membership*

| | |
|---|---|
| 2019 | Leader of the Linux-HPC workgroup at the Department of Physics, NTNU.<br>The workgroup was tasked with giving recommendation to the department on the investments/use of the Linux and HPC infrastructures. |
| 2011–present | "Resource Allocation Committee" for CPU-access at National HPC facilities (appointed by the Research Council of Norway); Committee member |

| | |
|---|---|
| 2010 – 2011 | Member of the national work group : *Computing in Science Education (CSE)* (appointed by the Norwegian Ministry of Education and Research) |

*Other administrative experience*

| | |
|---|---|
| 2020–present | WP leader of EU-FET-Open project *nanoLace* (`www.nanolace.eu`), Horizon 2020, EU. |
| 2016–2021 | Scientific leader of *FRAXOS: Fundamental electromagnetic approach to complex optical systems* (`anr.fr/Project-ANR-15-CHIN-0003`) funded by ANR/Saint-Gobain, Paris, France |
| 2014–2017 | WP leader of *Quartz and Glass*, FRIPRO, RCN |
| 2014–2017 | WP leader of *A New Lithography Method*, FORNY2020, RCN |
| 2012–2017 | Project leader, “Multiscale physics on the Computer: A Norwegian Network” ISP-physics project financed by RCN (budget kNOK 22,000/k$3600). |
| 2013–2016 | COST Action MP1205 “Advances in optofluidics: integration of optical control and photonics with microfluidics”: Management Committee member for Norway. |
| 2010 | Conference for Computational Physics 2010 (CCP2010), Trondheim, 23-26 Jun, 2010 : Local organization committee member. |
| 2009–2012 | COST Action MP0801 ”Physics of Competition and Conflicts” : Management Committee member for Norway. |
| 2007 | Advisory board member for *International Workshop on Complex Systems* (Transylvanian Summer School Series), 15–20 July, Sovata, Romania. |
| 2006 | Work Package (WP) leader for WP2.1 of the EU project (FP6-2005-IST-4) IRRIIS |
| 2005 – 2008 | COST Action P10 ”Physics of Risk” : Management Committee member for Norway |
| 2000 – present | Administrated various international industrial consultancy contracts on optics with companies like; Mitsubishi Chemical (Japan), SINTEF (Norway), Borealis (Norway/Denmark) and Saint-Gobain Recherche (France) |

## Editorial and refereeing services

*Editorial Board Membership and Editorial Positions*

| | |
|---|---|
| 2013–present | Associate editor, “Frontiers in Physics”. |
| 2013–2020 | Topical editor, “Applied Optics”. |

*Journal paper reviewing*

- Advances in Complex Systems
- Ann. Phys. (Berlin)
- Appl. Phys. A
- Appl. Surf. Sci.
- Energy Economics
- J. Opt. Soc. Am A
- J. Phys. A: Mathematical and Theoretical
- J. Phys. D: Appl. Phys.
- J. Phys. Chem.

- New J. Phys.
- Opt. Lett
- Opt. Express
- Physica A
- Physica D
- Phys. Rev. A
- Phys. Rev. B
- Phys. Rev. E
- Phys. Rev. Lett.
- Quant. Fin.
- Remote Sensing
- Thin Solid Films
- Indian J. Phys.
- Int. J. Mod. Phys. B
- Int. J. Frac.
- JVST A: Journal of Vacuum Science and Technology A
- Journal of Nanoparticle Research
- Journal of the European Optical Society-Rapid Publications

*Publishers (book proposals)*

- IOP Publishing
- Elsevier
- John Wiley & Sons

*Funding Agencies*

- AXA Research Fund
- European Union, Cost Action

*PhD evaluation committees*

| | |
|---|---|
| 2014 | *Statistical methods for scale-invariant and multifractal stochastic processes: With applications in finance and climate*, Ola Løvsletten, The Artic University of Norway, Tronsø, Norway. |
| 2014 | *Stochasticity in biophysical systems: aging, searching and spreading*, Lloyd Sanders, Lund University, Sweden. |
| 2013 | *Statistical physics of opinions and social conflicts*, Gerardo Iñiguez González, Aalto University, Finland |
| 2012 | *Photonic crystals for light trapping in solar cells*, Jo Gjessing, University of Oslo, Norway |
| 2008 | *Complex Networks and Spectral Methods: An Econophysics Approach to Equity Markets*, Tapio Heimo, Helsinki University of Technology, Finland |

## RESEARCH GRANTS

| | |
|---|---|
| 2020–2024 | "NanoLace – Mask Based Lithography for Fast, Large Scale Pattern Generation with Nanometer Resolution", FET-Open Horizon 2020 EU-project EUR 3,357,000 `www.nanolace.eu` (Role: PI) |

| | |
|---|---|
| 2016–2021 | "FRAXOS – Fundamental electromagnetic approach to complex optical systems)", French National Research Agency (ANR), Research Council of Norway, EUR 1,200,000 (with UMR 125 CNRS/Saint-Gobain, Paris, France) |
| 2014–2017 | "Quartz and Glass", Research Council of Norway [FRIPRO]; Approximately EUR 650,000 (with Prof. Bodil Holst, UiB) |
| 2014–2017 | "A New Lithography Method", Research Council of Norway [Forny2020]; Approximately EUR 400,000 (with Prof. Bodil Holst, UiB) |
| 2014–2017 | "Window Integrated Solar Collector", Research Council of Norway, kNOK 351 (approximately $57,500). (with Prof. Johannes Skaar) |
| 2012–2017 | "Multiscale physics on the computer; a Norwegian network" (partners NTNU, UiO, UMB), ISP-Physics Grant from the Research Council of Norway, kNOK 22,000 (approximately $4,000,000). |
| 2012–2013 | Leiv Eirikson, kNOK 80 (approximately $9,000). |
| 2010–2012 | Aurora research grant for French-Norwegian research collaboration, kNOK 80 (approximately $9,000).<br>Together with : R. Lazzari and J. Jupille |
| 2011 | NOTUR Advanced User Support Grant (High Performance Computing) $20.000. RCN grant, Småforsk $15,000 |
| 2010 | RCN grant, Småforsk $15,000 |
| 2009 | RCN grant, Småforsk $15,000 |
| 2008 | NTNU mobility grant, $20,000 |
| 2008 | RCN grant, Småforsk $12,000 |
| 2006 | Personal research fellow grant from the Research Council of Norwegian (1.5 MNOK)<br>Declined (due to other position) |
| 2001 | Aurora research grant for French-Norwegian research collaboration.<br>Together with : D. Vandembroucq and S. Roux |
| 1998 | Total Norge AS, Research grant for doing research in France. |

## Teaching experience

| | |
|---|---|
| 2014–present | *TFY4235/FYS8904 — Computational Physics*, MSc and PhD course, NTNU.<br>Instructor, exercises and projects. |
| 2014 | *FY8503 — Advanced Theoretical Physics*, PhD course, NTNU.<br>Instructor and exercises |
| 2008–2014 | *TFY4275/FY8907 — Classical Transport Theory*, MSc and PhD course, NTNU.<br>Instructor, exercises and projects. |
| 2008–2013 | *TFY4240 — Electromagnetic Theory*, advanced BSc course, NTNU.<br>Instructor, exercises and projects |
| 1993 | *Quantum Mechanics I*, University of Trondheim (AVH)<br>Instructor and exercises |

| | |
|---|---|
| 1990–1993 | University of Trondheim, Norway<br>Teaching assistant for various undergraduate courses |

## Student Advising Experience

Under my supervision, 7 graduate students have received their PhD and more than 50 their MSc.
Currently I have 1 PostDoc, 2 PhD- and 2 MSc-students.

*Current Doctor Student*

| | |
|---|---|
| 2020– | Hale, Nathan: *Topic*: Surface Magnon Polaritons |
| 2013–present | Kryvi, Jacob B.: *Topic*: Electromagnetic scattering; Computational physics |

*Graduated Doctor Students*

| | |
|---|---|
| 2017–2020 | Indrehus, Sunniva : *Plasmonic properties of supported nanoparticles*. |
| 2013–2019 | Storesund Hetland, Øyvind : *Theoretical and computational studies of the scattering of light from randomly rough dielectric surfaces*, NTNU. |
| 2016–2018 | Turbil, Colette : *Light scattering from complex rough surfaces*, Sorbonne University, Paris, France. |
| 2013–2018 | Banon, Jean-Philippe : *On the simulation of electromagnetic wave scattering by periodic and randomly rough layered structures based on the reduced Rayleigh equations : theory, numerical analysis and applications*, NTNU. |
| 2013–2018 | Nesse, Torstein : *Wave scattering theory applied to inversion and design*, NTNU. |
| 2009–2013 | Nordam, Tor : *Scattering of light from weakly rough surfaces*, NTNU. |
| 2010–2013 | Wei, Yingkang *Propagation of Electromagnetic Signal along a Metal Well in an Inhomogeneous Medium*, NTNU (co-supervisor). |
| 2008–2012 | Letnes, Paul Anton : *Optical Polarization Effects of Rough and Structured Surfaces*, NTNU. |

*Master Students*

| | |
|---|---|
| 2015 | Kringstad, Aleksander H. : *Approximating Haze in Reflection* |
| 2015 | Stein, Timo A. : *Development of a compact radiation monitor for space application* |
| 2014 | Lerstad, Stine Alm : *Matlab Based Music Analyses of Piano Recordings* |
| 2013 | Skrondal, Hans Marius : *Time Series Analysis of Shipping Rates* |
| 2013 | Eftevand, Mathias Sandvær : *Flytende tak i en konsertsal* |
| 2013 | Gu, Shangdong : *From Rock Scissor Paper to study and modeling of Chinese Five Elements Evolutionary Game Theory* |
| 2013 | Stavseng, Sindre Vegard : *Numerical Modelling of the Optical Properties of Truncated and Coated Prolate Spheroidal Nanoparticles* |
| 2013 | Hagen, Brede Andre Larsen : *Sensitivity Analysis of O& M Costs for Offshore Wind Farms* |
| 2013 | Suleng, Arne : *The Bak-Sneppen Model on coupled complex networks* |

| | |
|---|---|
| 2013 | Uthushagen, Kristian Siegel : *Entropy in Dynamical Networks* |
| 2012 | Aas, Rune Øistein : *Electromagnetic Scattering A Surface Integral Equation Formulation* |
| 2012 | Aursand, Eskil : *Optical Properties of truncated and coated spheroidal Nanoparticles on a Substrate* |
| 2012 | Ervik, Åsmund : *The Local Level-Set Extraction Method for Robust Calculation of Geometric Quantities in the Level-Set Method* |
| 2012 | Hansen, Eirik Schrøder : *Numerical modelling of marine icing on offshore structures and vessels* |
| 2012 | Marthinsen, Eirik : *Modellering av Termisk Stråling for Bruk i Brannsimuleringer. En teoretisk analyse og studie av noen aspekter* |
| 2012 | Persvik, Øyvind Othar Aunet : *Non-destructive Evaluation of Stress and Fatigue Damage in Welded Carbon Steel Specimens Using Ferrx Electromagnetic Method (FEMM)* |
| 2011 | Aanensen, Nina Sasaki : *Nonlinear Laser-induced Deformations and Forces at Liquid-Liquid Interfaces near the critical Point* |
| 2011 | Aursand, Peder Kristian : *Hyperbolic Conservation Laws with Relaxation Terms A Theoretical and Numerical Study* |
| 2011 | Brandsæter, Tord Bjørnevaagen : *Designing a Free-Form-Lens to Optimize the Illumination of Cylindrical Objects* |
| 2011 | Brende, Ole Martin : *Complex Networks Development of a three particle reaction-diffusion model on a complex network* |
| 2011 | Fosli, Carl Huseby : *Plasmonics for Light Trapping in Thin Silicon Solar Cells* |
| 2011 | Hansen, Christoffer Berge : *A random Matrix Approach to collective Trends of falling and rising Stock Markets* |
| 2011 | Haugan, Einar : *Colloidal Crystals as Templates for Light Harvesting Structures in Solar Cells* |
| 2011 | Hegge, Torstein Storflor : *Scalar wave scattering from two-dimensional, randomly rough surfaces* |
| 2011 | Håkonseth, Gunnar : *Diffusjon av vann i sotfylte kappematerialer for polymere sjøkabler* |
| 2011 | Jensen, Jens Tarjei : *Minimum Ignition Energy in a Hygrogen Combustible Mixture* |
| 2011 | Kiær, Anders Fredrik : *Trykkutvikling under CO2-lagring Numerisk simulering på Sleipnerinspirert modell* |
| 2011 | Mersland, Mailinn Blandkjenn : *Asymmetriske Energivariasjoner i Turbulens Invers statistikk metode for beskrivelse av asymmetrisk energivariasjon* |
| 2011 | Daniel Strand : *Wave scattering from two-dimensional self-affine surfaces* |
| 2011 | Walle, Øystein : *Engineered Surfaces for Redirection of Light* |
| 2011 | Walter, Erik Løkken : *Time Series Analysis of Electricity Prices: A comparative study of power markets* |
| 2011 | Winjum, Ingebrigt : *Reconstruction of Images From a Compact Spectral Camera* |

| | |
|---|---|
| 2010 | Leif Amund Lie : *Optical properties of a thin Film of coated, truncated, spheres* |
| 2010 | Anders Langseth : *Lydhastighet i Væsker* |
| 2010 | Merete Jaarvik : *Analysis of CSEM data near salt* |
| 2009 | Henrik Enoksen : *Theoretical and Numerical Studies of Diffractive Scattering of Polarized Light from a Relaxing Periodic Nanostructured Highly Viscous Fluid Surface* |
| 2009 | Ole Martin Hansen : *Wave Scattering and Transmission from Penetrable Self-Affine Surfaces* |
| 2009 | Jørgen Kristoffersen : *Synchronization of pulse-coupled oscillators* |
| 2009 | Halvor Lund : *Epidemic Spreading on Complex Networks: A Reaction-Diffusion Approach* |
| 2008 | Paul Fredrik Sandvik Aas : *Electric dipole scattering by a conductive sphere in conductive background medium*<br>(Co-supervisor, jointly with Dr. Lars O. Løseth, StatoilHydro, Norway) |
| 2008 | Trygve Mongstad : *Scattering of light from dielectric films deposited on randomly rough substrates* (Principle supervisor) |
| 2008 | Amund Stokke : *Optical Response of Periodically Nanostructured Metal Surfaces: A Numerical Study* (Principle supervisor) |
| 2007 | Luba Magdenko : *Atomic optics* (Principle supervisor) |
| 2006–2007 | Peter T.H. Ahlgren : *Stochastic Finance*<br>(Co-supervisor, jointly with Prof. Mogens H. Jensen, Niels Bohr Institute, Denmark) |
| 2005–2006 | Thomas Berg : *Electromagnetic wave propagation*<br>(Co-supervisor, jointly with Prof. Ola Hunderi, NTNU, Norway) |

## Consulting

| | |
|---|---|
| Jan 14–present | Ascent Geophysical AS, Norway.<br>Electromagnetics and wave propagation |
| Oct 06–Dec 11 | Saint-Gobain Recherche, Aubervilliers, France.<br>Optics of structured materials including photovoltaic |
| Jan 06–Apr 06 | Saint-Gobain Recherche, Aubervilliers, France.<br>Optics of structured materials (mainly applied to flat screen technology) |
| Nov 01–Mar 02 | Sintef (Material Technology) and Borealis, Oslo, Norway.<br>Polymer-films and their optical properties |
| Dec 00–Jan 01 | Mitsubishi Chemical, Yokohama Research Center, Yokohama, Japan.<br>Optical properties of LCD-screens |

## Scientific Publications

At present I have an H-index of 32.

An online version, from where many of the papers can be downloaded in printer friendly formats, can be found at `http://web.phys.ntnu.no/~ingves/Publications/`.

*Published scientific material*


[1] C. Turbil, J. Cabrero, I. Simonsen, D Vandembroucq and I Gozhyk. *Statistically representative estimators of multi-scale surface topography: example of aluminum blasted rough samples*. (2021). Submitted.

[2] N. Hale, I. Simonsen, C. Brüne and M. Kildemo. *Use of* $4 \times 4$ *transfer matrix method in study of surface magnon polaritons via simulated attenuated total reflection measurements on antiferromagnetic semiconductor* $MnF_2$. (2021). Submitted.

[3] M. Tømterud, S. D. Eder, C. Büchner, M. Heyde, H.-J. Freund, I. Simonsen, J. R. Manson and B. Holst. *Observation of the Boson Peak in a 2D Material*. (2021). Submitted.

[4] I. Simonsen, J.B. Kryvi and A.A. Maradudin. *Inversion of computer generated and experimental in-plane, co-polarized light scattering data in p and s polarization to obtain the normalized surface-height auto-correlation function and the rms-roughness of a two-dimensional randomly rough metal surface*. (2021). Submitted.

[5] V.P. Simonsen, D. Bedeaux and I. Simonsen. *Nonparametric reconstruction of the statistical properties of penetrable, isotropic randomly rough surfaces from in-plane, co-polarized light scattering data: Application to computer generated and experimental scattering data*. Phys. Rev. A **104**, 043502 (2021).

[6] J.-P. Banon, I. Simonsen and R. Carminati. *Perfect depolarization in single scattering of light from uncorrelated surface and volume disorder*. Opt. Lett. **45**, 6354–6357 (2020).

[7] J.-P. Banon, I. Simonsen and R. Carminati. *Single scattering of polarized light by correlated surface and volume disorder*. Phys. Rev. A. **101**, 053847 (2020).

[8] C. Turbil, T. S. HyukYoo, I. Simonsen, J. Teisseire, I. Gozhyk and E. Garcia-Caurel. *Experimental studies of the transmission of light through low coverage regular or random arrays of silica micropillars supported by a glass substrate*. Appl. Opt. **58** (33), 9267–9278 (2019).

[9] J.-P. Banon, Ø. S. Hetland and I. Simonsen. *On the physics of polarized light scattering from weakly rough dielectric surfaces: Yoneda and Brewster scattering phenomena*. Phys. Rev. A **99**, 023834 (2019).

[10] T. Nesse, I. Simonsen and B. Holst. *Nanometer resolution mask lithography with matter waves: Near-field binary holography*. Phys. Rev. Applied **11**, 024009 (2019).

[11] T. S. Hegge, T. Nesse, A. A. Maradudin and I. Simonsen. *The scattering of a scalar beam from isotropic and anisotropic two-dimensional randomly rough Dirichlet or Neumann surfaces: The full angular intensity distributions*. Wave Motion **82**, 30–50 (2018).

[12] D. Strand, T. Nesse, J. B. Kryvi, T. S. Hegge and I. Simonsen. *Wave scattering from two-dimensional self-affine Dirichlet and Neumann surfaces and its application to the retrieval of self-affine parameters*. Phys. Rev. A **97**, 063825 (2018).

[13] A. A. Maradudin, V. Pérez-Chávez, A. Jędrzejewski and I. Simonsen. *Features in the diffraction of a scalar plane wave from doubly-periodic Dirichlet and Neumann surfaces*. Low Temp. Phys. **44**, 733–743 (2018).

[14] J.-P. Banon, Ø. S. Hetland and I. Simonsen. *Selective enhancement of Selényi rings induced by the cross-correlation between the interfaces of a two-dimensional randomly rough dielectric film*. Ann. Phys. **389**, 352–382 (2018).

[15] A. A. Maradudin and I. Simonsen. *Replacement of ensemble averaging by the use of a broadband source in scattering of light from a one-dimensional randomly rough interface between two dielectric media*. Int. J. Antennas. Propag. **2018**, 6768306 (2018).

[16] M. Kildemo, J.-P. Banon, A. Baron, B. B. Svendsen, T. Brakstad and I. Simonsen. *Optical response of gold hemispheroidal lattices on transparent substrates*. Appl. Surf. Sci. **421**, 593–600 (2017).

[17] T. Nesse, J.-P. Banon, B. Holst and I. Simonsen. *Optimal design of grid-based binary holograms for matter-wave lithography*. Phys. Rev. Applied **8**, 024011 (Aug 2017).

[18] J.-P. Banon, T. Nesse, Z. Ghadyani, M. Kildemo and I. Simonsen. *Critical dimension metrology of a plasmonic photonic crystal based on Mueller matrix ellipsometry and the reduced Rayleigh equation*. Opt. Lett. **42** (13), 2631–2634 (Jul 2017).

[19] T. Nesse, S. D. Eder, T. Kaltenbacher, J. O. Grepstad, I. Simonsen and B. Holst. *Neutral-helium-atom diffraction from a micron-scale periodic structure: Photonic-crystal-membrane characterization*. Phys. Rev. A **95**, 063618 (Jun 2017).

[20] A. A. Maradudin and I. Simonsen. *Control of the coherence of light transmitted through a one-dimensional randomly rough interface that acts as a Schell-model source*. In *2017 International Applied Computational Electromagnetics Society Symposium – Italy (ACES)* pages 1–2 March 2017. 2017 International Applied Computational Electromagnetics Society Symposium, Florence, Italy.

[21] I. Simonsen and A. A. Maradudin. *A one-dimensional randomly rough interface that produces a specified angular distribution of the intensity of the light transmitted through it*. In *2017 International Applied Computational Electromagnetics Society Symposium – Italy (ACES)* pages 1–2 March 2017. 2017 International Applied Computational Electromagnetics Society Symposium, Florence, Italy.

[22] V. Pérez-Chávez, I. Simonsen, A. A. Maradudin, S. Blaize and E. R. Méndez. *Effective optical properties of supported silicon nanopillars at telecommunication wavelengths*. Opt. Commun. **399**, 127–134 (2017).

[23] Ø. S. Hetland, A. A. Maradudin, T. Nordam, P. A. Letnes and I. Simonsen. *Numerical studies of the transmission of light through a two-dimensional randomly rough interface*. Phys. Rev. A **95**, 043808 (2017).

[24] I. Simonsen and A. A. Maradudin. *The excitation and detection of a leaky surface electromagnetic wave on a high-index dielectric grating in a prism-coupler geometry*. Low Temp. Phys. **43**, 193 (2017).

[25] A. K. González-Alcalde, J.-P. Banon, Ø. S. Hetland, A. A. Maradudin, E. R. Méndez, T. Nordam and I. Simonsen. *Experimental and numerical studies of the scattering of light from a two-dimensional randomly rough interface in the presence of total internal reflection: Optical Yoneda peaks*. Opt. Express **24**, 25995 – 26005 (2016).

[26] J. B. Kryvi, I. Simonsen and A. A. Maradudin. *Determination of the normalized surface height autocorrelation function of a two-dimensional randomly rough dielectric surface by the inversion of light scattering data in p-polarization*. Proc. Int. Soc. Opt. Eng. **9961**, 99610F (2016).

[27] B. Sándor, I. Simonsen, B. Z. Nagy and Z. Néda. *Time-scale effects on the gain-loss asymmetry in stock indices*. Phys. Rev. E **94**, 022311 (2016).

[28] A.A. Maradudin and I. Simonsen. *Rayleigh and Wood anomalies in the diffraction of acoustic waves from the periodically corrugated surface of an elastic medium*. Low Temp. Phys. **42**, 354 (2016).

[29] Ø. S. Hetland, A. A. Maradudin, T. Nordam and I. Simonsen. *Numerical studies of the scattering of light from a two-dimensional randomly rough interface between two dielectric media*. Phys. Rev. A **93**, 053819 (2016).

[30] I. Simonsen, Ø. S. Hetland, J. B. Kryvi and A. A. Maradudin. *Determination of the normalized surface height autocorrelation function of a two-dimensional randomly rough dielectric surface by the inversion of light scattering data*. Phys. Rev. A **93**, 043829 (2016).

[31] A. A. Maradudin, I. Simonsen and W. P. Zierau. *Leaky surface electromagnetic waves on a high-index dielectric grating*. Opt. Lett. **41**, 2229 (2016).

[32] A. A. Maradudin, I. Simonsen, J. Polanco and R. M. Fitzgerald. *Rayleigh and Wood anomalies in the diffraction of light from a perfectly conducting reflection grating*. J. Opt. **18**, 024004 (2016).

[33] T. Brakstad, M. Kildemo, Z. Ghadyani and I. Simonsen. *Dispersion of polarization coupling, localized and collective plasmon modes in a metallic photonic crystal mapped by Mueller Matrix Ellipsometry*. Opt. Express **23**, 22800 (2015).

[34] S. Chakrabarti, A. A. Maradudin, I. Simonsen and E. I. Chaikina. *The inversion of incoherent light scattering data to obtain statistical and optical properties of a two-dimensional randomly rough dielectric surface*. Proc. Int. Soc. Opt. Eng. **9205**, 920505 (2014).

[35] R. Lazzari, J. Jupille, R. Cavallotti and I. Simonsen. *Model-free unraveling of supported nanoparticles plasmon resonance modes*. J. Phys. Chem. C **118**, 7032–7048 (2014).

[36] T. Nordam, P. A. Letnes, I. Simonsen and A. A. Maradudin. *Numerical solutions of the Rayleigh equations for the scattering of light from a two-dimensional randomly rough perfectly conducting surface*. J. Opt. Soc. Am. A **31**, 1126–1134 (2014).

[37] R. Lazzari, I. Simonsen and J. Jupille. *Interfacial susceptibilities in nanoplasmonics via inversion of Fresnel coefficients*. Plasmonics **9**, 261–272 (2014).

[38] T. Nordam, P. A. Letnes and I. Simonsen. *Numerical simulations of scattering of light from two-dimensional surfaces using the reduced Rayleigh equation*. Front. Phys. **1**, 8 (2013).

[39] B. Hagen, I. Simonsen, M. Hofmann and M. Muskulus. *A multivariate Markov Weather Model for O&M Simulation of Offshore Wind Parks*. Energy Procedia **35**, 137 (2013).

[40] T. Nordam, P. A. Letnes and I. Simonsen. *Validity of the Rayleigh hypothesis for two-dimensional randomly rough metal surfaces*. J. Phys: Conf. Ser. **454**, 012033 (2013).

[41] P. A. Letnes, T. Nordam and I. Simonsen. *Coherent effects in the scattering of light from two-dimensional rough metal surfaces*. J. Opt. Soc. Am. A **30**, 1136 (2013).

[42] H. Lund, L. Lizana and I. Simonsen. *Effect of city-size heterogeneity on epidemic spreading in a metapopulation: A reaction-diffusion approach*. J. Stat. Phys. **151**, 367 (2013).

[43] P. A. Letnes, A. A. Maradudin, T. Nordam and I. Simonsen. *Calculation of all elements of the Mueller matrix for scattering of light from a two-dimensional randomly rough metal surface*. Phys. Rev. A **86**, 031803(R) (2012).

[44] T. Nordam, P. A. Letnes, I. Simonsen and A. A. Maradudin. *Satellite peaks in the scattering of light from the two-dimensional randomly rough surface of a dielectric film on a planar metal surface*. Opt. Express **20**, 11336 – 11350 (2012).

[45] P. A. Letnes, I. Simonsen and D. L. Mills. *Erratum: Substrate influence on the plasmonic response of clusters of spherical nanoparticles [Phys. Rev. B 83, 075426 (2011)]*. Phys. Rev. B **85**, 149901 (Apr 2012).

[46] T. A. Leskova, P. A. Letnes, A. A. Maradudin, T. Nordam and I. Simonsen. *The scattering of light from two-dimensional randomly rough surfaces*. Proc. Int. Soc. Opt. Eng. **8172**, 817209 (2011).

[47] Y. Wei, B. Holter, I. Simonsen, J. Kuhnle, K. Husby and L. E. Norum. *Calculation of Sommerfeld Integrals for Conductive Media at Low Frequencies*. (2011). IEEE International Workshop on Electromagnetics, Applications and Student Innovation (iWEM), 8-10 August, 2011, Taipei. IEEE conference proceedings 2011.

[48] I. Simonsen, J. B. Kryvi, A. A. Maradudin and T. A. Leskova. *Light Scattering from Anisotropic, Randomly Rough, Perfectly Conducting Surfaces*. Comp. Phys. Commun. **182**, 1904–1908 (2011).

[49] P. A. Letnes, I. Simonsen and D. L. Mills. *Substrate influence on the plasmonic response of nanoparticle clusters*. Phys. Rev. B **83**, 075426 (2011).

[50] D. Ahalpara and I. Simonsen. *Forecasting of Spot Electricity Prices by Genetic Programming: Examples from the Nordic Power Market*. Dynamics of Socio-Economic Systems **2**, 183 (2010).

[51] Y. Wei, B. Holter, I. Simonsen and L. E. Norum. *Wave Propagation Along a Thin Vertical Wire Antenna Placed in a Horizontally Layered Medium*. (2010). IEEE Conference on Electromagnetic Field Computation (CEFC), Chicago, USA.

[52] E. Balogh, I. Simonsen, B. Z. Nagy and Z. Néda. *Persistent collective trend in stock markets*. Phys. Rev. E **82**, 066113 (2010).

[53] I. Simonsen. *Enhanced Back and Forward Scattering in the Reflection of Light from Weakly Rough Random Metal Surfaces*. Phys. Status Solidi B **247**, 2075 (2010).

[54] P. A. Letnes and I. Simonsen. *Spectrally dependent hot-spot locations in metallic nano-clusters*. Phys. Status Solidi B **247**, 2084 (2010).

[55] I. Simonsen. *Optics of Surface Disordered Systems: A Random Walk Through Rough Surface Scattering Phenomena*. Eur. Phys. J. Special Topics **181**, 1 – 103 (2010).

[56] I. Simonsen, A. A. Maradudin and T. A. Leskova. *The Scattering of Electromagnetic Waves from Two-Dimensional Randomly Rough Penetrable Surfaces*. Phys. Rev. Lett. **104**, 223904 (2010).

[57] P. T. H. Ahlgren, H. Dahl, M. H. Jensen and I. Simonsen. *What Can Be Learned from Inverse Statistics?* In M.Takayasu, T. Watanabe and H. Takayasu, Editoren, *Econophysics Approaches to Large-Scale Business Data and Financial Crisis* page 247. Springer-Verlag Tokyo 2010.

[58] I. Simonsen, A. A. Maradudin and T. A. Leskova. *The Scattering of Electromagnetic Waves from Two-Dimensional Randomly Rough Perfectly Conducting Surfaces: The Full Angular Intensity Distribution*. Phys. Rev. A **81**, 013806 (2010).

[59] A. A. Maradudin, T. A. Leskova and I. Simonsen. *Scattering of electromagnetic waves from two-dimensional randomly rough perfectly conducting surfaces*. Annual Review of Progress in Applied Computational Electromagnetics **25**, 505 (2009).

[60] I. Simonsen, Å. Larsen, E. Andreassen, E. Ommundsen and K. Nord-Varhaug. *Haze of surface random systems: An approximate analytic approach*. Phys. Rev. A **79**, 063813 (2009).

[61] T. A. Leskova, A. A. Maradudin and I. Simonsen. *The design of random surfaces that produce nonstandard refraction of light*. Proc. Int. Soc. Opt. Eng. **7065**, 706506 (2008).

[62] T. A. Leskova, A. A. Maradudin and I. Simonsen. *Surface electromagnetic waves on two-dimensional rough perfectly conducting surfaces*. Rev. Mex. Fis. **S54**, 54 (2008).

[63] I. S. Nerbø, M. Kildemo, S. Le Roy, I. Simonsen, E. Søndergård, L. Holt and J. C. Walmsley. *Characterisation of nanostructured GaSb : Comparison between large-area optical and local direct microscopic techniques*. Appl. Opt. **47**, 5130 (2008).

[64] I. Simonsen, L. Buzna, K. Peters, S. Bornholdt and D. Helbing. *Transient Dynamics Increasing Network Vulnerability to Cascading Failures*. Phys. Rev. Lett. **100**, 218701 (2008).

[65] M. Kildemo, I. S. Nerbø, E. Søndergård, L. Holt, I. Simonsen and M. Stchakovsky. *Optical response of nanostructured GaSb*. Phys. Status Solidi C **5**, 1382 (2008).

[66] V. Rosato, I. Simonsen, S. Meloni, K. Peters, N. von Festenberg and D. Helbing. *A Complex System's View of Critical Infrastructures*. In D. Helbing, Editor, *Managing Complexity: Insights, Concepts, Applications* Understanding Complex Systems pages 241–260. Springer-Verlag Berlin 2008.

[67] P. T. H. Ahlgren, M. H. Jensen, I. Simonsen, R. Donangelo and K. Sneppen. *Frustration driven stock market dynamics: Leverage effect and asymmetry*. Physica A **383**, 1 (2007).

[68] I. Simonsen, P. T. H. Ahlgren, M. H. Jensen, R. Donangelo and K. Sneppen. *Fear and its implications for stock markets*. Eur. Phys. J. B **57**, 153 (2007).

[69] A. Johansen, I. Simonsen and M. H. Jensen. *Optimal Investment Horizons for Stocks and Markets*. Physica A **370**, 64 (2006).

[70] R. Donangelo, M. H. Jensen, I. Simonsen and K. Sneppen. *Synchronization Model for Stock Market Asymmetry*. J. Stat. Mech. **L11001**, 1–8 (2006).

[71] J. Perello, M. Montero, L. Palatella, I. Simonsen and J. Masoliver. *Entropy of the Nordic electricity market: anomalous scaling, spikes, and mean-reversion*. J. Stat. Mech. **P11011**, 1–16 (2006).

[72] A. Johansen, I. Simonsen and M. H. Jensen. *Inverse Statistics for Stocks and Markets*. Physica A **370**, 64–67 (2006).

[73] R. Weron and I. Simonsen. *Blackouts, risk, and fat-tailed distributions*. In H. Takayasu, Editor, *Practical Fruits of Econophysics* pages 215–219. Springer Verlag Tokyo 2006.

[74] I. Simonsen, A. Johansen and M.H. Jensen. *Investment horizons : A time-dependent measure of asset performance*. In H. Takayasu, Editor, *Practical Fruits of Econophysics* pages 246–251. Springer Verlag Tokyo 2006.

[75] I. Simonsen, Å. Larsen, E. Andreassen, E. Ommundsen and K. Nord-Varhaug. *Estimation of gloss from rough surface parameters*. Phys. Status Solidi B **242**, 2995–3000 (2005).

[76] I. Simonsen. *Diffusion and networks: A powerful combination!* Physica A **357**, 317–330 (2005).

[77] I. Simonsen. *Volatility of power markets*. Physica A **355**, 10 (2005).

[78] M. H. Jensen, A. Johansen, F. Petroni and I. Simonsen. *Inverse Statistics in the Foreign Exchange Market*. Physica A **340**, 678 (2004).

[79] I. Simonsen, K. A. Eriksen, S. Maslov and K. Sneppen. *Diffusion on Complex Networks : A way to probe their large scale topological structures*. Physica A **336**, 163 (2004).

[80] R. Weron, I. Simonsen and P. Wilman. *Modeling highly volatile and seasonal markets:evidence from the Nord Pool electricity market*. In H. Takayasu, Editor, *Toward Control of Economic Change - Applications of Econophysics* pages 182–191. Springer Verlag 2004.

[81] T. A. Leskova, A. A. Maradudin and I. Simonsen. *Coherent scattering of an electromagnetic wave from, and its transmission through, a slab of a left-handed medium with a randomly rough illuminated surface*. Proc. Int. Soc. Opt. Eng. **5189**, 22 (2003).

[82] M. H. Jensen, A. Johansen and I. Simonsen. *Inverse Fractal Statistics in Turbulence and Finance*. Int. J. Mod. Phys. B **17**, 4003 (2003).

[83] K. A. Eriksen, I. Simonsen, S. Maslov and K. Sneppen. *Modularity and Extreme Edges of the Internet*. Phys. Rev. Lett. **90**, 148701 (2003).

[84] M. H. Jensen, A. Johansen and I. Simonsen. *Inverse Statistics in Economics : The gain-loss asymmetry*. Physica A **324**, 338 (2003).

[85] R. Lazzari, I. Simonsen and J. Jupille. *Onset of charge localisation on coupling multipolar absorption modes in supported metal particles*. Europhys. Lett. **61**, 541 (2003).

[86] I. Simonsen. *Measuring Anti-Correlations in the Nordic Electricity Spot Market by Wavelets*. Physica A **322**, 597 (2003).

[87] R. Lazzari and I. Simonsen. *GRANFILM: a software for calculating thin-layer dielectric properties and Fresnel coefficients*. Thin Solid Films **419**, 124 (2002).

[88] E. R. Méndez, E. E. García-Guerrero, T. A. Leskova, A. A. Maradudin, J. Muñoz-López and I. Simonsen. *Design of One-Dimensional Random Surfaces with Specified Scattering Properties*. Appl. Phys. Lett. **81**, 798 (2002).

[89] I. Simonsen, A. Tarrats and D. Vandembroucq. *Characterization of rough self-affine surfaces from electromagnetic wave scattering*. J. Opt. A: Pure Appl. Opt. **4**, S168 (2002).

[90] E. R. Méndez, E. E. García-Guerrero, T. A. Leskova, A. A. Maradudin, J. Mu noz López and I. Simonsen. *Design of one-dimensional random surfaces with specified scattering properties*. Proc. Int. Soc. Opt. Eng. **4780**, 40 (2002).

[91] I. Simonsen, M. H. Jensen and A. Johansen. *Optimal Investment Horizons*. Eur. Phys. J. B **27**, 583 (2002).

[92] R. Lazzari, S. Roux, I. Simonsen, J. Jupille, B. Bedeaux and V. Vlieger. *Multipolar plasmon resonances in supported silver particles: The case of Ag/ $\alpha$-$Al_2O_3$(0001)*. Phys. Rev. B **65**, 235424 (2002).

[93] I. Simonsen and K. Sneppen. *Profit Profiles in Correlated Markets*. Physica A **316**, 561 (2002).

[94] I. Simonsen and A. Hansen. *Fast Algorithm for generating long self-affine profiles*. Phys. Rev. E **65**, 037701 (2002).

[95] T. A. Leskova, I. Simonsen and A. A. Maradudin. *The Angular Intensity Correlation Functions $C^{(1)}$ and $C^{(10)}$ for the Scattering of Light from Randomly Rough Dielectric and Metal Surfaces*. Wave. Random Media **12**, 307 (2002).

[96] I. Simonsen, T. A. Leskova and A. A. Maradudin. *Light scattering from an amplifying medium bounded by a randomly rough surface: A numerical study*. Phys. Rev. B **64**, 035425 (Jun 2001).

[97] A. A. Maradudin, I. Simonsen, T.A. Leskova and E.R. Mé ndez. *Localization of surface plasmon polaritons on a random surface*. Physica B **296**, 85 (2001).

[98] A. A. Maradudin, I. Simonsen, T. A. Leskova and E. R. Méndez. *Design of one-dimensional Lambertian diffusers of light*. Waves Random Media **11**, 529 (2001).

[99] T. A. Leskova, A. A. Maradudin and I. Simonsen. *Scattering of electromagnetic waves from the random surface of a left-handed medium*. Proc. Int. Soc. Opt. Eng. **4447**, 6 (2001).

[100] I. Simonsen, D. Vandembroucq and S. Roux. *Electromagnetic wave scattering from conducting self-affine surfaces: an analytic and numerical study*. J. Opt. Soc. Am. A **18**, 1101 (2001).

[101] A. A. Maradudin, E. R. Méndez, T. A. Leskova and I. Simonsen. *A band-limited uniform diffuser in transmission II: A multilayer system*. Proc. Int. Soc. Opt. Eng. **4447**, 130 (2001).

[102] R. Lazzari, I. Simonsen, D. Bedeaux, J. Vlieger and J. Jupille. *Polarizability of truncated spheroidal particles supported by a substrate: model and applications*. Eur. Phys. J. B **24**, 267 (2001).

[103] I. Simonsen, T. A. Leskova, A. A. Maradudin and O. Hunderi. *Wavelength dependence of the light scattered from a dielectric film deposited on a metal substrate*. Proc. Int. Soc. Opt. Eng. **4100**, 65 (2000).

[104] A. A. Maradudin, I. Simonsen, T. A. Leskova and E. R. Méndez. *The Design of Random Surfaces with Specified Scattering Properties: Surfaces that Suppress Leakage*. Communicaciones Opticas **1**, 28 (2000).

[105] T. A. Leskova, A. A. Maradudin, E. R. Méndez and I. Simonsen. *Band-Limited Uniform Diffuser in Transmission*. Proc. Int. Soc. Opt. Eng. **4100**, 113 (2000).

[106] I. Simonsen, D. Vandembroucq and S. Roux. *Wave scattering from self-affine surfaces*. Phys. Rev. E **61**, 5914 (2000).

[107] I. Simonsen, R. Lazzari, J. Jupille and S. Roux. *Numerical modeling of the optical response of supported metallic particles*. Phys. Rev. B **61**, 7722 (2000).

[108] I. Simonsen, R. Lazzari, J. Jupille and S. Roux. *On an optical in situ technique for thin film growth studies*. Communicaciones Opticas **1**, 48 (2000).

[109] I. Simonsen, A. A. Maradudin and T. A. Leskova. *The Angular Intensity Correlation Functions $C^{(1)}$ and $C^{(10)}$ for the Scattering of S-Polarized Light from a One-Dimensional Randomly Rough Dielectric Surface*. Proc. Int. Soc. Opt. Eng. **3784**, 218 (1999).

[110] A. A. Maradudin, I. Simonsen, T. A. Leskova and E. R. Méndez. *Random Surfaces that Suppress Single Scattering*. Opt. Lett. **24**, 1257 (1999).

[111] I. Simonsen and A. A. Maradudin. *Numerical simulation of electromagnetic wave scattering from planar dielectric films deposited on rough perfectly conducting substrates*. Opt. Commun. **162**, 99 (1999).

[112] I. Simonsen, A. Hansen and O. M. Nes. *Determination of Hust exponents by use of the wavelet transform*. Phys. Rev. E **58**, 2779 (1998).

*Thesis*

[1] I. Simonsen. *New Light on Rough Surfaces: Theories of how they appear and consequences of that*. PhD thesis The Norwegian University of Science and Technology, Trondheim, Norway 2000.

[2] I. Simonsen. *Supersymmetric Quantum Flavour Dynamics and constraints from the Muon anomalious magnetic moment*. Master's thesis University of Trondheim, Norway 1994.

## Recent Presentations (not complete)

| | |
|---|---|
| Nov 2021 | *Statistical characterization of disordered surfaces by light scattering* 7th Workshop on Soft & Complex Matter The Norwegian Academy of Science and Letters, Oslo, Norway. |

| | |
|---|---|
| Sep 2019 | *Critical dimension metrology of a plasmonic photonic crystal based on Mueller matrix ellipsometry and the reduced Rayleigh equation* Nanophotonics and Micro/Nano Optics International Conference 2019, Munich, Germany |
| Jun 2019 | *Complex optical systems: A potpourri of rough surface scattering phenomena* Department seminar, Babes-Bolyai University, Cluj, Romania |
| Jun 2019 | *Cascading Failure in Complex Systems: Real world examples and generic modeling* Econophysics MOCS, Babes-Bolyai University, Cluj, Romania |
| Sep 2017 | *Aspects of Rough Surface Scattering: A potpourri of scattering phenomena*, CReO Conference, CICESE, Ensenada, Mexico |
| May 2017 | *Complex optical systems*, "Crossing Frontiers in Science: a Physicist's Approach", 38 Max Born Symposium, Wroclaw, Poland. |
| Feb 2017 | *Grid-based binary holography for matter waves*, University of Bergen, Norway |
| Nov 2016 | *A Potpourri of Rough Surface Scattering Phenomena*, Department seminar, Institut Langevin, Paris, France. |
| Aug 2016 | *Determination of the normalized surface height autocorrelation function of a two-dimensional randomly rough dielectric surface by the inversion of light scattering data in p polarization*, SPIE 2016, San Diego, USA |
| Aug 2016 | *Optical response of gold hemispheroidal lattices supported by transparent substrates*, Méndez Symposium, CICESE, Ensenada, Mexico. |
| Feb 2016 | *Polarization effects in light scattered from ordered and disordered surfaces*, Department seminar, Optics department, CICESE, Ensenada, Mexico. |
| Sep 2015 | *In-situ studies of supported and growing, nanoscale metal droplets by optics*, Workshop on *Optofluidic Sensor Systems and Technologies*, Karlsruhe, Germany. |
| Jun 2015 | *Complex Optical Systems: Phenomenology of Disordered Systems*, The Niels Bohr Institute, Copenhagen, Denmark. |
| Feb 2015 | *Polarization effects in the light scattered from randomly rough surfaces*, 9th Workshop Ellipsometry, University of Twente, Enschede, Netherlands |
| Feb 2014 | *Cascading failures in complex networks: Generic modeling and examples of power blackouts and the domino effect*, Department of Astronomy and Theoretical Physics, Lund University, Sweden. |
| Oct 2013 | *Lightscattering from soft surfaces*, COST action "Advances in Optofluidics" (MP1205) meeting, Münster, Germany. |
| Jan 2013 | *Power Blackouts and the Domino Effect: Real-Life Examples and Modeling*, Institut des NanoSciences de Paris (INSP), Paris, France. |
| Nov 2012 | *Optics on the computer*, Department of Physics, University of Bergen, Norway. |
| Oct 2012 | *Photonics on the computer*, Conference on Computational Physics (CCP2012), Kobe, Japan. |
| May 2012 | *Power Blackouts and the Domino Effect: Real-Life Examples and Modeling*, Department of Theoretical and Computational Physics, Babes-Bolyai University, Cluj, Romania. |

| | |
|---|---|
| Feb 2012 | *Use of ICT in the class : Electromagnetic Theory (TFY4240): Our Experience*, Faculty Seminar, NTNU, Feb. 29, 2012 |
| Sep 2011 | *Cascading failures in complex-networks: Power Blackouts and the Domino Effect*, Statistical Mechanics of Inference, Kavli and Nordita Workshop, NTNU Sep. 07, 2011 |
| Feb 2011 | *Diffusion and Networks: From simple models to Applications* 47th Karpacz Winter School of Theoretical Physics "Simple Models of Complex Systems", Ladek, Polen. |
| Dec 2010 | *Power blackouts and the domino effect: real-life examples and modeling*, Random Geometry and Applications, Nordita, Stockholm, Sweden. Theoretical Physics Seminar, NTNU, Trondheim, Norway. |
| Nov 2010 | *The Scattering of Electromagnetic Waves from Two-Dimensional Randomly Rough Metal Surfaces*, Theoretical Physics Seminar, NTNU, Trondheim, Norway. |
| Nov 2010 | *From Statistical Physics to other branches of Physics via the Random walk*, Department of Mathematics, Imperial College, London. |
| Aug 2010 | *Power Blackouts and the Domino Effect: Real-Life Examples and Modeling* TWCS'2010 - Turunc Workshop on Complex Systems 2010, Turunc, Turkey. |
| Jun 2010 | *The Scattering of Electromagnetic Waves from Two-Dimensional Randomly Rough Metal Surfaces*, Conference on Computational Physics (CCP 2010), Trondheim, Norway. |
| Apr 2010 | *The Scattering of Electromagnetic Waves from Two-Dimensional Randomly Rough Perfectly Conducting Surfaces: The Full Angular Intensity Distribution*, Norwegian Electro-Optics Meeting, Ålesund, Norway. |
| Mar 2010 | *Power Blackouts and the Domino Effect: Real-Life examples and Modeling*, Physical Chemistry seminar, NTNU, Norway. |
| Sep 2009 | *Optics of Surface Disordered Systems; No Disorder — No Fun!*, Optics of Surfaces and Interfaces VIII (OSI-8), Ischia, Italy. |
| Sep 2009 | *Optics of Surface Disordered Systems; No Disorder — No Fun!*, Department Colloquium, Institut des NanoSciences de Paris, Paris, France. |
| Jun 2009 | *Scattering of electromagnetic waves from two-dimensional randomly rough surfaces*, Workshop on Waves in Complex Media, Nappa Valley Lodge, Yountville, California, USA. |
| May 2009 | *Deregulated Power Markets: Their Characteristic Stylized Facts*, Net 2009: Evolution and Complexity Rome, Sapienza Universitá di Roma, Italy. |
| Aug 2008 | *Er Facebook forskning?*, Researcher Night 2008, NTNU. |
| Aug 2008 | *Cascading failure in Complex Networks*, Department Seminar, University of Stavanger, Stavanger, Norway. |
| Aug 2008 | *In Search of the Weakest Links : Cascading failures in Networks*, Nordita Workshop on Movement and Search: From biological cells to spider monkeys, Nordita, Stockholm, Sweden. |
| Aug 2008 | *Large Area Optical Characterization of Self-Organized Nanostructured GaSb*, SharcNet seminar (video-conferenced to universities throughout Ontario), University of Windsor, Windsor, Canada. |

| | |
|---|---|
| May 2008 | *Optical response of nano-structured GaSb*, Department seminar (EM2C), Ecole Centrale, Paris, France |
| May 2008 | *Fear in Financial Markets: Model and Empirical Observations*, Econophysics: Trends & Challenges, Niels Bohr Institute, Copenhagen, Denmark |
| Apr 2008 | *Anomalous Diffusion*, Biophysics group seminar, NTNU, Norway. |
| Apr 2008 | *My Scientific Life: Past, Present, and Future*, SINTEF, Thin film group seminar, Trondheim, Norway. |
| Mar 2008 | *Polariton enhanced absorption in solar cells*, 2nd Nordic Workshop on Crystalline Silicon Solar Cells, Narvik, Norway |
| Feb 2008 | *Power Blackouts and the Domino Effect: Real-Life examples and Modeling*, Physics Department seminar, NTNU, Norway. |
| Sep 2007 | *Stationary network loads may underestimate vulnerability to cascading failures*, Cost P10 meeting, Palermo, Italy. |
| Jun 2007 | *Light playing Houdini: Squeezing light through sub-wavelength openings*, Saint-Gobain Recherche, Aubervilliers, France. |
| Feb 2007 | *Roadmap to the inversion of Helium scattering data*, Workshop on Imaging with Neutral Atoms (INA), Department of physics, Universidad Autnoma de Madrid , Madrid, Spain. |
| Nov 2006 | *Gain-loss asymmetry in stock markets: empirical facts and model based explanation* Department of physics, Babes-Bolyai University, Cluj, Romania. |
| May 2006 | *Gain-loss asymmetry in stock markets: empirical facts and model based explanation* Physics of Risk & Workshop on Complex System Science, Vilnius, Lithuania. |
| May 2006 | *Asymmetry in stock markets*, NORDITA Conference on Statistical Physics, Soft Matter, and Biological Physics, Copenhagen, Denmark. |
| Apr 2006 | *Light playing Houdini: Squeezing light through sub-wavelength openings*, Department of Physics, NTNU, Trondheim, Norway. (Invited department seminar). |
| Feb 2006 | *Engineered Surfaces for Optics: Tailoring structures and patterns for specific properties*, Saint-Gobain Recherche, Aubervilliers, France. |
| Jan 2006 | *Diffusion of Helium from glass surfaces; What do we need to interpret the HAS data on glass?* Cambridge University, Department of Physics, Cambridge, UK. |
| Oct 2005 | *Random walk through rough surface scattering phenomena*, Service de Physique et Chimie des Surfaces et des Interfaces, Commissariat à l'Energie Atomique (CEA) Saclay, France. |
| Oct 2005 | *Surface design and other applications of theoretical optics*, Saint-Gobain Recherche, Research center seminar, Aubervilliers, France. |
| Jun 2005 | *Visual appearance of industrial surfaces: Haze and gloss*, Optics of Surfaces and Interfaces (OSI-VI) From Basic Research to Applications, Aalborg, Denmark. |
| May 2005 | *Fractures at geological length scales*, Laboratoire Fluide Automatique et Sytemes Thermique (FAST), Universite Paris-Sud 11, Orsay, France. |
| Feb 2005 | *Diffusion and Networks*, *41st Karpacz Winter School of Theoretical Physics*, Ladek, Poland (Invited Plenary lecturer). |

| | |
|---|---|
| Dec 2004 | *Perturbations and Relaxations on Networks*, Nordic Workshop on networks, Nordita, Copenhagen, Denmark. |
| Nov 2004 | *Designer surfaces*, Mitsubishi Chemical, Yokohama Research Center, Yokohama, Japan |
| Nov 2004 | *Investment Horizons: A time-dependent measure of asset performance*, *The third Nikkei Econophysics Research Workshop and Symposium*, Tokyo, Japan (Invited) |
| Nov 2004 | *Introduction to Econophysics*, Mitsubishi Chemical, Yokohama Research Center, Yokohama, Japan |
| Sep 2004 | *Stylized Facts of a Deregulated Power Market*, *First Bonzenfreies colloquium on market dynamics and qunatitative economics*, Alessandria, Italy (Invited) |
| Aug 2004 | *Fractures at geological length scales*, Nordita Workshop on Statistical physics, soft matter and biological physics, Nordita, Copenhagen, Denmark |
| Jun 2004 | *A random walk through surface scattering phenomena*, Nordic Light Summer school: *Propagation and scattering of photons in simple and complex systems*, Røst Lofoten, Norway (Invited) |
| May 2004 | *Extreme edges of the Internet*, Institute of Theoretical Physics, University of Wrocław, Poland |
| Sep 2003 | *Diffusion on complex networks: A way to probe their large scale topological structures*, XVIII Max Born Symposium, Ladek, Poland |
| May 2003 | *Anomalous Dynamical in the Nordic Electricity Market*, INTAS03: Meeting and Mini-Symposium on Anomalous Dynamical Processes, Nordita, Copenhagen, Denmark |
| Aug 2002 | *Inverse statistics in Economics*, The International Econophysics Conference, Nusa Dua, Bali, Indonesia |
| Aug 2002 | *A random walk through surface scattering phenomena*, Caltech, USA |
| Jul 2002 | *Wavelets : Theory and applications*, Hugo Steinhaus Center for Stochastic Methods, Wrocław University of Technology, Wrocław, Poland |
| Jul 2002 | *Inverse Statistics in Economics*, Hugo Steinhaus Center for Stochastic Methods, Wrocław University of Technology, Wrocław, Poland |
| Apr 2002 | *A random walk through scattering phenomena*, Department of physics, NTNU, Trondheim, Norway |
| Mar 2002 | *A random walk through scattering phenomena*, Department of physics, Århus University, Århus, Denmark |
| Feb 2002 | *Designer surfaces*, Labo Mixte CNRS/Saint-Gobain, *Surface du Verre et Interfaces*, Paris, France |

## RESEARCH EXPERIENCE

My research has mainly been focused on wave propagation, various surface phenomena, theoretical studies of surfaces, and complex systems. Extensive use of computer simulation methods has been required for large parts of this research. My expertise is in the fields of optics (statistical optics, nanoplasmonic), computational physics including computational electromagnetism, physics of complex systems, and statistical mechanics. In what follows, I briefly summarize my research and discuss my contributions to these fields.

*Optics of disordered systems* As students we learn that when light impinges onto the flat interface of a semi-infinite homogeneous medium, the scattered and transmitted fields are fully determined by the Fresnel formulae. However, if the interface has a nontrivial structure, and/or the medium shows some degree of bulk randomness, *i.e.* not being homogeneous, the distribution of the scattered light is much harder to predict. Lord Rayleigh, well over one hundred years ago, was probably the first to study this problem theoretically. Since then, partly because of the wide range of practical (and military) applications, large research resources have been allocated to the topic. After many years of research, the field is still vibrant and keeps fascinating mathematicians, physicists and engineers alike.

My research in this field has been concentrated around rough surface scattering, and in particular on multiple scattering phenomena and coherent effects that those give rise to. Given the scattering geometry and the surface topography — or more precisely its statistical properties — one wants to predict the angular distribution of the scattered light. This is called the forward scattering problem. To achieve this, one has in principle to solve the Maxwell's equations subjected to the appropriate boundary conditions at the surface. For a surface random system, this is presently too hard of a problem in general. It is almost like doing chemistry by always having to solve the Schrödinger equation; it is practically impossible. As a consequence, much of my research related to this problem has been devoted to finding approximate solutions to it, judging their quality, and to try to locate simple geometries where certain optical phenomena can be observed under favorable experimental conditions. One simplification that we have often applied is to study one-dimensional scattering geometries, *i.e.* scattering systems where the surface roughness is a function of one variable, $x_3 = \zeta(x_1)$, and the incident light being polarized either in, or out of, the incident $x_1x_3$-plane. Under these conditions, the scattering problem still shows many of the characteristic features of the general problem. Moreover, it can be formulated by a scalar wave equation — resulting in dramatic simplifications, in particularly for numerical simulations.

Figure 1 depicts one of our simulation results for the angular distribution of the incoherently (diffusely) scattered light from a one-dimensional film geometry where the lower surfaces was rough and the incoming $s$-polarized light was incident at an angle of $\theta_0 = 5°$ from the (mean) surface normal. The intensity distribution shows a rich structure; the peak at $\theta_s = -5°$ is attributed to the *enhanced backscattering phenomenon*, while those located at $\theta_s = 12°$ and $-26°$ make out the *satellite peak phenomenon*. By various types of perturbation theories and numerical simulations, both these phenomena (and others) have been studied with the aim of uncovering their origin and to identify under which experimental conditions they can occur. The peak structure that can be observed from Fig. 1 is a result of constructive interference of multiple scattered light paths and their reciprocal partners (coherent effect). Such coherent interference effects will systematically only take place in certain well defined directions determined by the scattering geometry and the optical properties of the media involved.

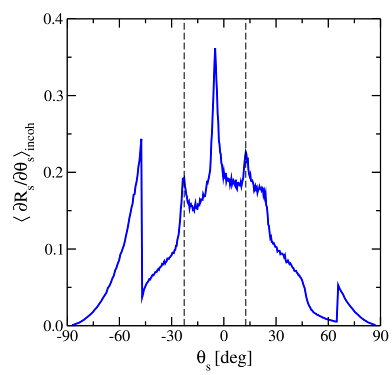



Figure 1: Angular distribution of the scattered light from a film geometry with a rough (West-O'Donnell) lower surface.

Furthermore, we have extensively studied the properties of the so-called intensity-intensity correlation functions. These correlation functions tell us statistically how two intensities from two experiments conducted on one and the same scattering system are interrelated. Similar to bulk random systems, these correlation functions can be classified as *short*, *long* and *infinitely* range correlation function. The former is independent of the length of the illuminated section of the rough surface and has been observed experimentally. The two latter, however, scale as one over the surface length and can therefore more difficultly be accessed experimentally. Surface random systems, in contrast to bulk random systems, do in addition give rise to *intermediate* range correlation functions. The various types of correlation functions show a rich (peak) structure, including the *memory effect* and the *reciprocal memory effect*. Our main finding on intensity-intensity correlations functions relates the statistical properties of the *scattered fields* to if certain correlation functions are non-zero or not. In particular, we can distinguish if the random process satisfied by the scattered (or transmitted) field is *(i)* Gaussian, *(ii)* complex circular Gaussian, *(iii)* or non-Gaussian.

Lately, together with industrial partners, we have been involved in an initiative trying to derive approximative expressions for parameters used in the optical industry to characterize optical materials. These expressions have been utilized to determine optimal production parameters in order to achieve certain optical properties of the resulting products. In particular, we have worked on the quantities haze and gloss. Crudely speaking, they are relative measures of how diffuse or specular, respectively, a material is (as "seen" by the incident light of given wavelength). Our analytic approximations were compared to rigorous computer simulation results, and good agreement was found over large regions of parameter space.

I have also been involved in optical inverse scattering problems that deal with the question of how to construct randomly rough surfaces with well defined scattering properties. This we refer to as a *designer surface problem*. The starting point of this research is the assumption that the rough surface can be written as an infinite sum of a characteristic profile or groove weighted by random amplitudes. The angular distribution of the scattered or transmitted light from such surfaces does depend on the distribution from which these amplitudes are drawn. After specifying a desired angular distribution for the scattered or transmitted light, we try to "design" a surface, by adjusting the distribution of the random amplitudes such that the resulting angular distribution coincides with the desired one. Technically, the geometrical optics limit of the Kirchhoff approximation enabled us to derive analytic expressions for the (often complicated) distributions satisfied by the amplitudes. These expressions were then used to generate ensembles of rough surfaces that were used in rigorous (Monte Carlo) simulations in order to judge the "quality of the design". The results were often found to be quite satisfactory. Hence, we were able to design surfaces with well defined scattering properties, an often desired capability in practical applications. One example is given in Fig. 2 where the surface was designed to act as a two-dimensional uniform diffuser.

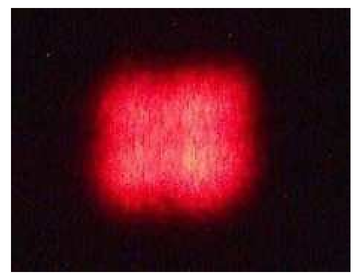


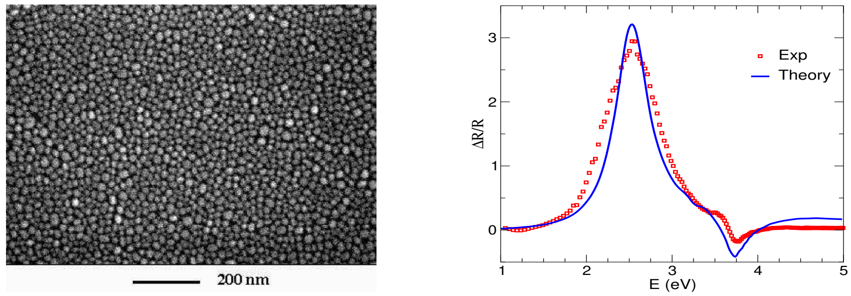
Figure 2: Experimental results for the scattered intensity from a *designed* rectangular uniform diffuser surface.

While with Electromagnetic Geoservices AS, I worked on forward modeling and inversion of extremely low frequency ($\nu \sim 1Hz$) electromagnetic data. The main application of their technology is in the petroleum industry where one tries to distinguish hydrocarbon filled reservoirs from those that are (salt) water filled. This can by achieved due to the pronounced difference in reservoir resistivity between the two situation.

**Optics of granular thin films (nanoplasmonic)**

When a metal, say, under ultra-high vacuum conditions is evaporated onto a dielectric substrate, *granular thin metal films* may result depending on the wetting properties. The result of Ag evaporated onto MgO is depicted in Fig. 3(a). Such thin discontinuous films are characterized by small nano-meter sized islands distributed over the entire surface of the substrate.

Optical techniques has the potential of being used as *in situ*, non-invasive monitoring tools that are inexpensive and easily adaptable to changing environments. In our research, we have focused on the optical properties of such




(a) (b)

Figure 3: (a) SEM image of the surface resulting from Ag deposited onto MgO. (b) The relative specular reflectance $\Delta R/R$ *vs.* energy of the incident light.

nano-sized thin films. The goal was to be able to monitor the parameters characterizing the island film (particle sizes, aspect ratio, mean island-island separation *etc.*) during the growth process.

To this end, we focused on the positions of the plasmon resonances of the system. The degeneracy of the transverse and longitudinal modes of the free-standing particles were lifted due to the presence of the surface and the interaction between the islands. It turned out that the positions of these resonances were rather sensitive to the geometrical parameters. In order to be able to calculate the optical properties of such island films, one needs to know their polarizeabilities. A pure dipole interaction was insufficient to reproduce the experimental spectra (Fig. 3(b)). However, mainly due to the interaction with the substrate, higher order multipoles had also to be taken into account. Retardation effects over the size of the particles could, however, be neglected to a good approximation. Hence the scattering problem is reduced to solving the Laplace equation for which a complete set of function exists when the particles have a spherical or spheroidal shape. Thus the problem amounted to finding the unknown coefficients of the *multipole expansion*. They are determined by a system of linear equations that results from imposing the boundary conditions on the interface of the particle and substrate.

To generate the coefficients matrix of this system in an accurate way turned out to be rather challenging. The cause of the problem was severe numerical cancellation taking place when integrating essentially the product of two highly oscillating associated Legendre functions (of high order). To handle these cancellations, extended precision had to be used in parts of the calculations (often using 30–40 significant digits!).[1] The reward, however, was that we in the end were able to extract accurate quantitative information about the layer structure by fitting the model to the experimental $\Delta R/R$-spectra (Fig. 3(b)). The parameters characterizing the layer obtained in this way were later compared to the results of more costly *ex situ* synchrotron radiation measurements, and more than satisfactory agreement was found.

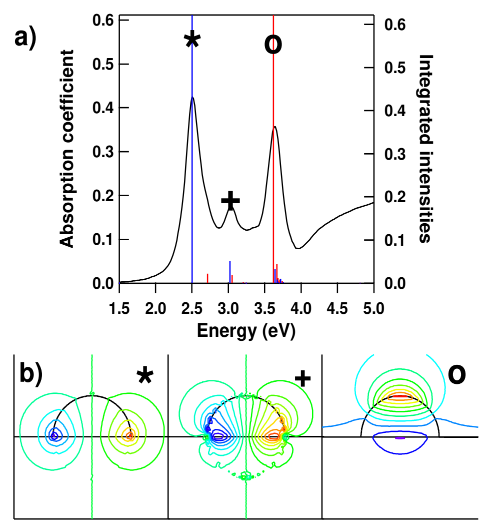



Figure 4: (a) The absorption spectrum associated with the island layer morphology. (b) Equipotential maps of the potentials at the position of the resonances.

We also studied metal deposition on absorbing oxide substrates, like $TiO_2$ and ZnO. For the former system, we started with a numerical study, and found as expected two plasmon resonances. Here, first to our surprise, we in addition observed an additional third peak (Fig. 4(a)). After having rejected this as a numerical artifact, we realized by generating potential maps that this peak in fact could

[1] The resulting software package, GranFilm, has been made available by us in the public domain to the benefit of the research community. It can be found at www.phys.ntnu.no/˜ingves/Software/GranFilm.

be attributed to a quadrupole resonance (Fig. 4(b)). The existence of this resonance was later confirmed experimentally.

**Self-affine scale invariant structures**

Nature is full of complex structures at all scales; from the scale of the universe down to the building blocks of how it is put together. Self-affinity is a term that is used to characterize a certain class of surfaces. In particular, if the surface height at position $\mathbf{x}$ is denoted $h(\mathbf{x})$, then the surface is said to be self-affine if the statistical properties of $h(\mathbf{x})$ and its rescaled version, $\lambda^{-H}h(\lambda\mathbf{x})$, are identical (scale invariance). Here $H$ is a parameter characterizing this scale invariance and it is known as the *Hurst* or *roughness* exponent. Over the years, it has been apparent that self-affine surfaces are abundant in nature. What makes such an invariance particularly interesting, is the fact that the properties of the system can be studied at a given length scale, say, the laboratory scale, and the results obtained there rescaled (within the self-affine regime) to the scale of interest, typically beyond laboratory scales.

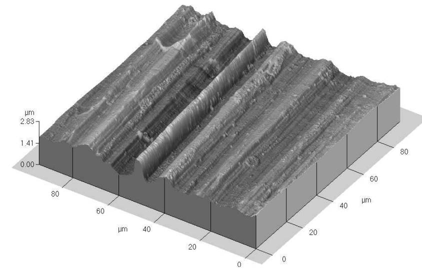


Figure 5: A self-affine cold rolled Aluminum surface.

In order to take advantage of the powerful concept of rescaling, one does need to know the appropriate Hurst exponent of the system at hand and the range of scales over which it applies. To obtain such kind of information, we have developed a wavelet based technique for the determination of the Hurst exponent from numerical (experimental) data. This method we termed the *average wavelet coefficient method* (AWC), and it was tested for consistency against well-established self-affine structures with success. The methodology is particularly powerful when the self-affine scaling regime does not extend over all available scales, and/or the scaling shows some cross-over phenomena. Technically this cross-over detection ability is related to the fact that wavelets at different scales are orthogonal. With most other Hurst exponent measuring techniques, including detrended fluctuation analysis (dfa) and the Fourier spectrum method, this cross-over scale cannot be easily extracted since the behavior around this scale is smeared out. Later the AWC-method was generalized to handle scaling in higher dimensions, as well as multi-affine structures. Furthermore, based on wavelets, we developed a new *fast* algorithm for generating self-affine profiles. This methods is, relative to other methods, most powerful for long profiles due to its speed and reliability in generation (extremely) long profiles with the desired scaling property extending over the *entire* range of scales without any need for additional modification of the algorithm.

The identification of physical systems showing self-affine scale invariance is not interesting in its own right. However, the ultimate interest of scientists is in the end to study the consequences of such an invariance on the physical parameters used to characterize the properties of the system. For instance, together with Drs. Stephane Roux and Damien Vandembroucq we studied wave scattering from self-affine surfaces. We were able to, within the single-scattering approximation, to solve for the angular distribution of the scattered intensity in *closed form*. This expression was given in terms of the Lévy (or stable) distribution known from statistics and the parameters defining the self-affinity and the scattering geometry. The prediction of this model was compared to rigorous Monte-Carlo simulations, and later to experimental scattering data obtained for self-affine rolled Aluminum surfaces (Figs. 5 and 6). The conclusion was that the model outperformed previous models, and it could be used to extract with confidence the Hurst exponent and the so-called topothesy of the underlying surface. For the future, we will try to also include multiple scattering

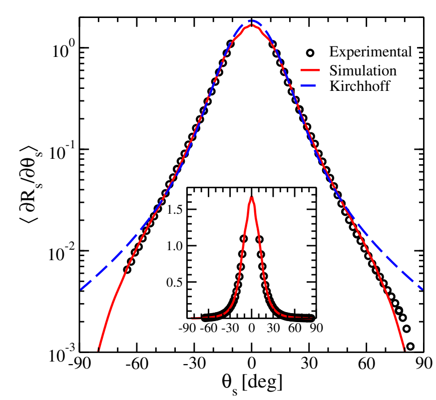



Figure 6: Wave scattering from the self-affine Aluminum surface of Fig.5. The open symbols are experimental data, the dashed line our approximation, and the solid line represents a rigorous simulation result.

into this model by introducing a truncation of the Lévy distribution. Empirically, we hope to be able to relate the degree of multiple scattering to the truncation parameter. Furthermore, we have studied the implications of scale invariance in economical systems and how such structures can be used to optimize portfolios and investment strategies (more on this below).

*Complex random networks* The word network we are familiar with from daily life in contexts like, say, computer networks and social networks. In technical terms it is used for a set of countable objects, called nodes or vertices, where relations or dependencies (links or edges) are defined among them (an example of a power grid network is given in Fig.8(a)). For instance, sociologists have studied such network structures for years. They are interested in, for instance, friendship-networks, where individuals are the nodes, and the existence of a friendship between them corresponds to the links. With the advent of the computer, however, the amount of data contained in typical networks of interest, became just too large for using the human eye as the analyzing tool. Up till then, the visual inspection of networks drawn on a piece of paper had been common, but such strategy is insufficient for large networks. It was at this point in the history of network analysis that the (statistical) physicist enter the arena equipped with his/her statistical physics toolkit.

In many real-world networks like the WWW, social networks, protein interaction networks *etc*. it is of interest to be able to find group of nodes (home-pages, friends, proteins), that are highly linked among themselves and less to the rest of the network. Such set of nodes is said to form a community or a cluster. For instance, within a cell such communities might represent proteins allocated specialized tasks or related functions. We have developed an algorithm, based on diffusion or the paradigm of the random walk, that gives an overview of the network structure at the global scale. Notice that in order to obtain such information, one needs a global measure; a local one is insufficient. Our algorithm prescribes in a systematic way a *walker current* (real number) to every node of the network. The main idea was that nodes belonging to the same cluster would have similar current values. It has been interesting to notice that the search engine Google seems (at least) initially to have use a similar random walk picture for their "Page Ranking", a number used to define the order in which search results were presented. This feature has undoubtably contributed substantially to the great success of this search engine. Technically the (outgoing) walker currents (per unit link weight) prescribed to the nodes come from the master equation obtained by considering the artificial random walk (diffusion) process on the network. This equation is the result of the conservation of walkers. Starting from any initial state, walkers will with time redistribute themselves throughout the network so that eventually the stationary state is reached. The time evolution of the system can be described in terms of decaying modes, that formally comes about as eigenvalues and eigenvectors of the transfer or diffusion matrices. By considering less and less slowly decaying modes (corresponding to smaller and smaller eigenvalues) more and more detailed community structures can be mapped out.

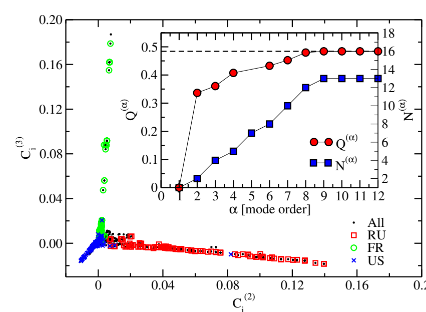



Figure 7: Analysis of an autonomous system network. Notice the geographical modules corresponding to the star like structure.

We applied, for instance, this algorithm to a coarse grained version of the Internet (autonomous system network) consisting of several thousand nodes. The two slowest decaying modes gave the star-like structure of Fig. 7. This structure could be identified as the geographical and political sub-division of nodes. The main structure of the network, signaled by different signs of $c_i^{(2)}$, was found to correspond to American and Russian nodes.

Furthermore, we have extended the algorithm to handle a higher number of decaying modes in a natural way. To this end, one needed a measure for deciding to accept a potential subdivision or not, and we ended up using the clustering coefficient $Q^{(\alpha)}$. The number of modes ($\alpha$) was increased till no more clusters were identified (inset to

Fig. 7). For the autonomous system network, this number was found to be 13. Recently, the procedure was extended to weighted networks as well. We have found that the additional link weight information makes the identification of community structures more robust. In some cases, to include weighted links into the analysis is essential for the identification of the underlying community structure.

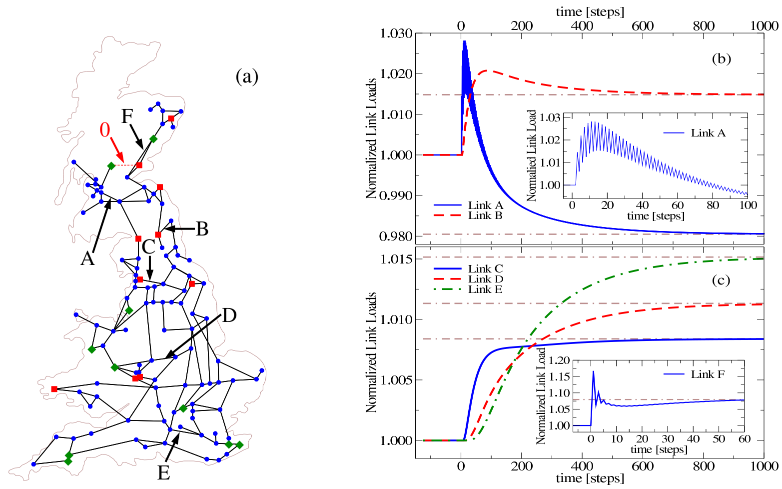



Figure 8: (a) The UK high-voltage power transmission grid (300–400 kV) consisting of 120 geographically correctly placed nodes (generators, utilities, and transmission stations) and 165 links (transmission lines). Fig. 8(b) and (c) depict the time-dependence of the (normalized) link loads for some selected link and show their reaction to the removal of the link marked 0 in Fig. 8(a) at time $t = 0$. For $t < 0$ it was assumed that the flow was in the stationary state, but the link removal brings the system out of the steady-state.

Following the increasing interest in the study of dynamical processes taking place on networks, we have adopted the above mentioned particle flow model as a simple and generic prototype model for flow on graphs. In particular, it was used to study the influence on dynamics on cascading failures (Figs. 8). It was found that the role of dynamics can be significant and should be included when evaluating network robustness.

*Economical and social systems* Social and economical systems are examples of complex systems known to everyone. It is, however, only recently that it has become mainstream for physicists to analyse and try to model such complicated and fascinating systems. The application of methodology from physics, particular taken from statistical physics, has created buzz words line “econphysics” and “sociophysics”.

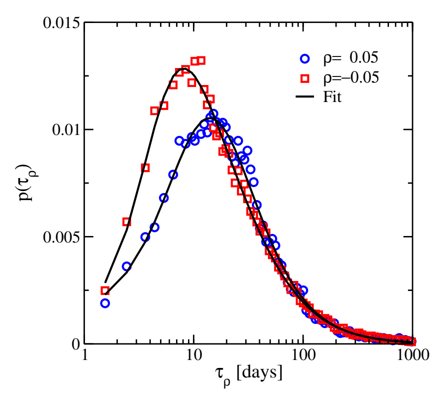



Figure 9: The (historic) waiting time distributions for the Dow Jones Industrial Average (DJIA) for return levels $\rho = \pm 0.05$.

In this field, I have experience from both the analysis of empirical data and the construction and study of (toy) models used to identify and analyze specific mechanisms. Quite a bit of our research in this field has been devoted to what we have called *inverse statistics*. It is a concept that was first developed fruitfully for turbulence. We later adapted it to economical time series. In contrast to using the return distribution as a (fixed time horizon) estimate of performance, the inverse statistics approach provides a time varying measure that is useful, for instance, in portfolio optimizations. In particular, if the desired performance goal is a return of, say, 5%, then the inverse statistics method describes this, using historic data, as the distribution of *waiting times* needed to achieve this goal. Such distribution for the DJIA is presented in Fig. 9 and one observes the pronounced asymmetry between positive and negative levels of returns ($\rho$). This means that one tends to loose money faster than one earns them in this marketplace.

The asymmetric behavior is found to be typical for stock indicies. Moreover, this and other features of the inverse statistics point towards the non-geometrical Brownian motion character of stock fluctuations. As a paradox, we have established that within the statistical uncertainty, *no* similar well-expressed asymmetry is identifiable for (individual) stocks that are part of the DJIA index. How is it possible that such asymmetry appears in the index, but not in the stocks that the index is based upon? For the moment, we believed that this difference can be attributed to a kind of collective synchronization phenomenon taking place among the individual stocks of the index. However, we do not have the full detailed understanding of the matter yet, but work is in progress to resolve it.

Our works on deregulated power markets have established that the price process of these commodities are highly anti-persistent (mean reverting). Unlike in a stock market, this does not represent an arbitrage opportunity since produced electric power cannot presently be stored effectively and, therefore, money can not be gained directly from the knowledge of this additional information. Moreover, we have performed stylized facts studies of such markets, trying to uncover their typical characteristics. Furthermore, we have work in progress focusing on the development of pricing models for (Asian and exotic) power options. This is more challenging than for stock markets due to the mean reverting character (anti-correlation) and sesonality of the underlying price process. Recently we have started to study blackout dynamics in power systems. This phenomenon is important to fully understand (and prevent) due to the dependence of contemporary societies on a continuous and stable supply of electric power. It has been suggested that blackouts in power systems can be modeled by self organized criticality. We have, however, partly questioned this statement.