



CENTRE OF
MATHEMATICS FOR
APPLICATIONS

A N N U A L R E P O R T 2 0 1 0

Differential Equations

Stochastic analysis

Quantum Mechanics

Geometry

Astrophysics

CMA IN BRIEF in 2010

- CMA counted 97 members / 61 person-years, among these 23 senior scientists, 36 PhD-students, 18 postdocs, 14 adjunct researchers, and 6 technicians / administrative personnel / project fellows.
- 7 fellows completed their PhD-degrees.
- CMA hosted 9 long term and 131 short term international visitors from 21 countries. Together they spent 7 person-years at CMA. Numerous Norwegian guests also visited CMA.
- CMA members published 128 refereed articles in international journals, 6 books, and 15 reviewed book chapters.
- CMA members gave 218 scientific and popular talks outside CMA in 34 different countries.
- CMA hosted 5 conferences/workshops and 6 seminar series in which 35 talks were given by CMA members, 22 by national guests, and 79 by international guests.
- CMA members co-organized in addition 37 international workshops and conferences.
- Total revenues in 2010 were MNOK 48,9. The funding is distributed over: RCN (CoE): 8; UiO: 21,4; SINTEF: 6,3; Other public: 9,8; International: 3,4.

SUMMARY

This eight annual report of The Centre of Mathematics for Applications (CMA) at The University of Oslo is a review of the 2010 progress in meeting the centre's ambitious goals. In 2010, we progressed according to the research plan, achieving many results and having taken new important initiatives.

We are now harvesting from eight years of conscientious investment in research and hard work: 128 papers were published in international journals in 2010 (corresponds to 2.2 articles per researcher-year). Many of the papers are published in scientific journals of the very highest quality. One specific break-through result of our research in 2010 provided the cover story of the prestigious journal "Science" in the January 2011 issue.

Seven PhD students defended their theses in 2010 and a total of 46 have completed their degrees since CMA's start in 2003. With 30 active PhD-fellows still in the centre, CMA will reach its goal, as planned, of 60 during its ten Centre of Excellence-years.

In 2010, together with the leadership of the Faculty of Mathematics and Natural Sciences, we prepared the organization of the CMA-activities beyond 2013 after the CoE-funding has expired. We also continued to strengthen our project portfolio, and include now several projects that will extend beyond 2013.

The 2007-revised research plan remained the beacon for all our activities. It has challenging, though realistic goals. In the revision, we included a set of defined focus areas, and also some quantitative goals. For two years now, we have reported the progress of these in the annual report, and we continue with updates and new information in the present report.

We are enthusiastic about the unique opportunity which the Centre of Excellence-scheme has provided us with respect to performing key research and research training. We are grateful to the Research Council of Norway (RCN) and to our host, the University of Oslo, for their support.

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Handwritten mathematical notes and diagrams:

- Relative index of \mathbb{R}^n (with \mathbb{R}^n circled)
- $K_n = \log_2 n$
- $B_t \sqrt{t} (X - X_n) \rightarrow d = \frac{U''(\epsilon)}{U'(\epsilon)}$
- $\int_0^t \exp(\int_0^s \lambda_n dB) ds$
- $\varphi(x) = E^x \int_0^{\tau_D} f(x_t) dt + g(x_{\tau_D})$
- Diagram of a domain D with boundary $K = 0$
- Equations: $A\varphi + \beta = 0$ in D , $\varphi = 0$ on ∂D
- Other notes: $\lambda(x) = x^{\frac{1}{2}}$, $\int X(x) dx$, $\int X(x) \lambda(x) dB(x)$, $X - \sup_{t \in [0, \tau_D]} X_t$

Highlights

The solar corona can be seen as a faint glow around the Sun at total solar eclipses. One of the most enduring mysteries in solar physics is why the Sun's corona is millions of degrees hotter than its surface. During the past few decades, a wide variety of theoretical models to explain this enigma have been proposed, but the lack of detailed observations of the fundamental heating process has significantly hampered progress. High resolution images show fingers of cold gas being injected into the much hotter corona. Spicules are phenomena that have held particular promise as discrete coronal heating events for decades. Heating of spicules to millions of degrees has never been observed, so their role in coronal heating had been dismissed as unlikely. **Mats Carlsson** and **Viggo Hansteen**, together with American colleagues, have shown for the first time that such heating is observed to occur, and that a significant fraction of the spicular material appears to be brought to coronal temperatures. This result implies that the spicule acceleration mechanism plays an important role in supplying the corona with energy and gas to compensate losses through radiation and the acceleration of the solar wind. The paper was published in "Science" on January 7 2011 as the cover story.

In 2010, **Hans Kristian Eriksen** won a European Research Council Starting Grant for his project called "The anisotropic universe – a reality or fluke?" which started on January 1st, 2011, and will run for five years. This project aims to answer a central question in modern cosmology: Are the properties of the universe the same everywhere, or do they vary with position? Since 2003, there have been subtle hints of the latter, and if these hints are confirmed by new and more sensitive observations, the very foundations of modern cosmology may have to be reconsidered. The total budget of the project is 1.5 M€, and this will cover two Ph.D. fellowships and three postdoctoral fellowships during the project period

CMA postdoc fellow **Jukka Lempa** was awarded the "Best paper"-prize at the "Energy & Finance"-conference in Essen in October 2010 for the paper "*On optimal exercise of swing options in electricity markets*" (written together with Professor Fred Espen Benth and Trygve Nilssen (UiA)), submitted to a special issue of Journal of Energy Markets. The paper studies a class of swing options called flexible load contracts. These contracts are heavily used in the electricity market, and provide the owner with the flexibility to buy electricity at a given number of hours over a year, but restricted by a limit on the total volume power that can be purchased. In practice, the number of hours can be very high, and constitute around 80% of the total number of hours over a year. In the paper, this "discrete" flexibility in choosing the hours is approximated by a "continuous" control, and the optimal use of the contract is studied by means of stochastic control theory. The paper finds that the optimal times to buy electricity are given via the marginal price of the contract. A numerical scheme is developed for fast computation of the optimal use of such flexible load contracts. The paper provides the mathematical and numerical foundation for an industrial implementation of these contracts.

Together with international colleagues (T. Papenbrock and G. Hagen), **Morten Hjorth-Jensen's** research on halo nuclei was highlighted in Science News on May 26, 2010. A halo nucleus differs from the more traditional nuclei because it has one or more nucleons (protons or neutrons) that are only weakly bound to the nuclear core. Consequently, they drift far away from it, forming, in effect, a halo. These nuclei are difficult to study because their lives are both fragile and milliseconds short. Halo nuclei appear at the limits of nuclear existence, very near a place called the dripline. This is the perilous territory where the numbers of protons and neutrons are plotted against each other and one too many of either means the nucleus will not hold together. Halo nuclei also come with a large number of degrees of freedom—independent configurations required to explain how a system is built. Sophisticated methods were used to work with the 17 interacting particles in fluorine 17 to better understand it. The starting point was a nuclear Hamiltonian, the operator that describes the energy of a system in terms of its momentum and positional coordinates. By using the coupled-cluster method — a numerical technique that solves such quantum many-body problems — and supercomputing facilities, the CMA-team successfully completed first-principle calculations of the proton halo state in Fluorine-17. The calculations contain no adjustable parameters and show a computed binding energy that closely reflects experimental data.

The paper "Theory of L^1 dissipative solvers for scalar conservation laws with discontinuous flux" (60 pages), written by **Kenneth Karlsen** and **Nils Henrik Risebro**, together with B. Andreianov (France), has been accepted by the prestigious journal Archive for Rational Mechanics and Analysis. In this paper a new framework is developed which includes and generalizes many previous results regarding well-posedness of conservation laws with a discontinuous flux. This approach leads to a unified theory, and more general results than previously known for such problems.

The paper "Finite element exterior calculus: From Hodge theory to numerical stability" (75 pages), written by **Ragnar Winther**, together with D. Arnold and R. Falk (USA) was published by the Bulletin of the American Mathematical Society. The aim of the paper is to discuss the close connection between geometry and algebraic topology on one side, and computational mathematics, in particular numerical analysis of partial differential equations, on the other.

From September 28 – October 1, 2010 CMA hosted The 2010 Abel Symposium on the subject of "Nonlinear Partial differential Equations". The scientific program spanned a broad variety of topics and included both theoretical and numerical approaches. Invited speakers included Fields-medal winners Pierre-Louis Lions (Paris) and Cédric Villani (Lyon). The fact that most of the leading international scientists in the field of partial differential equations participated reflects the high standing of both the Abel symposia and the research group at CMA in this field. Villani was also invited by the Norwegian TV-host Fredrik Skavlan to his Friday night show, one of the most popular TV-programs in Scandinavia.

Revised Research Plan

In 2008, CMA implemented its revised research plan after the midway evaluation of the Centre of Excellence. We reformulated our vision, now reading: *To create significant development in modern mathematics based on interplay between theory, computations, and applications.* Moreover we defined 12 specific focused areas for the remaining years. The full plan can be found on <http://www.cma.uio.no/researchplan>. From 2010 we emphasize progress in the following nine areas:

FOCUS area	PROGRESS 2010
Develop further the activity in geometric modelling based on a combination of mesh based modelling, algebraic methods and differential equation methods, and strengthen the link to applications in medicine.	In 2010 important contributions to polynomial and spline interpolation in several variables have been obtained by using algebraic and combinatorial techniques. In particular, tools from algebraic geometry have been used to classify lattices of points that support polynomial interpolation in several variables, and Schumaker's pioneering work on the dimension of spline spaces of triangulations has been extended by algebraic homology theory.
Maintain the stochastic analysis group as a leading international research group in mathematical finance, and to increase the activity in other areas of applications like electricity markets and insurance mathematics.	The group continued its contributions to the value of information in financial investment problems, and recently moved towards the question of model robustness in financial applications. The activity in energy finance has developed in the direction of swing options and control theory, along with the use of infinite dimensional analysis to modeling prices. A four-year eVITA-project from the Norwegian Research Council was granted in 2010, which will further extend the activity in this group.
Strengthen the basic activity in mathematical and numerical analysis of partial differential equations, and use this foundation as a basis for increased focus on industrial projects and on scientific problems arising outside mathematics.	During 2010 the CMA-group in partial differential equations strengthened its position as an international leading research group in the field, with key publications both within theory for nonlinear equations and a better understanding of numerical methods. In particular, the work on conservation laws with discontinuous flux functions, discrete exterior calculus, and generalizations of lattice Gauge theory, are key contributions.
Stimulate further the ongoing interdisciplinary activity engaged in developing new numerical schemes for radiation magneto-hydrodynamics, as motivated from the modeling of the outer solar atmosphere.	The work on the development of a modern code for MHD-type systems, using recent numerical concepts, has continued. In particular, radiation effects were built into the model. The code has also been used to investigate turbulence spectra for supersonic MHD-flows, a key ingredient in understanding star formation.
Continue: to organize workshops and conferences focusing on the various parts of the research plan, to invite guests, both prominent international experts and promising young research talents, and to send our own researchers out to present their and CMA's recent results and achievements	We are very proud to have been responsible for the 2010 Abel symposium: "Nonlinear partial differential equations," in which most of the leading international scientists in this field participated. We have also been hosting key workshops in numerical analysis/ quantum mechanics and mathematics/life sciences.
Seek new opportunities to extend our international network, both by partnerships with relevant institutions, as well as through joint proposals for EU- and other international funding	Associate professor Hans Kristian Eriksen succeeded on his ERC Starting grant proposal, and the project started in 2010. Professor Snorre Christiansen submitted his ERC Starting grant proposal a few months later, and we have recently been notified that he has reached the final selection heat with interviews in Bruxelles in May 2011.
Maintain a well-functioning national Research School in mathematics for applications, where a number of PhD and postdoc fellows work with related problems in a stimulating environment.	7 PhD defences took place in 2010, bringing the total up to 46 in the life-time of CMA. Also new fellows were welcomed, and by year-end 2010 we still count 30 PhD- and 15 postdoc fellows working in the centre.
Continue to provide a top quality scientific environment for the teaching project "Computers in Science Education."	At UiO the project is expanding to new areas, and is increasing in significance and visibility. As a result of this, in 2010 the Ministry of Education and research formed a group to stimulate similar activities at the national level. The group is headed by Prof. Knut Mørken from CMA.
Prepare to continue these vigorous research efforts after the funding from the Research Council has ended.	At the moment we are working closely with the leadership of the University to prepare for a proper organization of the CMA-activities for the time after the CoE-funding has expired. Furthermore, several research groups at CMA are engaged in the preparation for new CoE-applications.

We defined a list of quantitative indicators as measurable outcome from the centre. Results are as follows, with level per Dec 31, 2010 in the right column.

INDICATOR / GOAL FOR 2003 - 2013 (adjusted after midway evaluation)	STATUS		
	2008	2009	2010
60 PhD defenses	28	39	46
40 post-doctoral fellowships of at least two year's duration	19	28	31
1000 papers (co-)authored in internationally reviewed journals.	613	783	911
45 books and anthologies	27	33	39
150 book chapters	86	104	119
100 long term research visitors (more than 1 month)	75	103	112
1100 short term international visitors	832	1099	1229
1200 invited talks outside the CMA	737	874	1013
90 workshops and conferences organized at/by CMA	55	63	68
160 co-arranged workshops and conferences	94	122	159

Scientific Activity Report 2010

Geometry

The activity in Geometry focuses on geometric modelling. Many scientific and industrial problems require a digital description of geometry. The CMA research in this area is based on combining techniques and theory from splines and mesh based modelling, algebraic methods and differential equation methods.



The following personnel were part of the Geometry group in 2010:

- Full time senior scientists: Geir Dahl, Geir Ellingsrud, Michael Floater, Tom Lyche, Knut Mørken, Ragni Piene, and Martin Reimers
- Adjunct researchers: Tor Dokken, Carlo Mannino, Ewald Quak, and Eigil Samset
- Postdoc fellows: Jon Hjelmervik (from May), Elisa Postinghel (from Oct)
- PhD-students: Egil Bae, Oliver Barrowclough (Sintef/SAGA), Sverre Briseid (Sintef), André Brodtkorb (Sintef), Solveig Bruvoll, Heidi Dahl (Sintef/SAGA), Eivind Lyche Melvær, Torgunn Karoline Moe, Nikolay Qviller, Atle Riise (Sintef), Petter Risholm, Martin Sætra, Nelly Villamizar, Bartlomiej Siwek

Piene continued her collaboration with Steven Kleiman (MIT, USA) on enumerative geometry related to string theory in physics, concerning the enumeration of curves on surfaces. Her PhD student Nikolay Qviller obtained significant results on this subject, in particular proving the Bell polynomial shape of node polynomials and obtaining a proof of the Di Francesco-Itzykson-Göttsche conjecture on node polynomials for the plane. Piene continued her collaboration with Sandra Di Rocco (KTH, Stockholm) and Alicia Dickenstein (Buenos Aires) on toric varieties, and completed a paper with Raquel Mallavibarrena (Madrid) and Antonio Lanteri (Milano) on the inflection loci of scrolls over an arbitrary base. Her PhD student Georg Muntingh completed his thesis "Topics in polynomial interpolation theory," and her PhD student Torgunn Karoline Moe continued her work on cuspidal plane curves and Cremona transformations.

CMA is the hub of the Marie Curie Initial Training Network SAGA ShApes, Geometry and Algebra (2008-2012), <http://www.saga-network.eu>, with SINTEF the coordinator, headed by Tor Dokken, and with Piene as the CMA partner. The CMA ESR fellow Nelly Villamizar worked on determining dimensions of bivariate spline spaces, partially in collaboration with SAGA partner Bernard Mourrain (Sophia-Antipolis). Elisa Postinghel started as SAGA ER fellow in October, and has been working on toric secant varieties. The SINTEF ESR fellow Oliver Barrowclough has been working on extending the theory of approximate implicitization to triangular Bezier surfaces, and addressed alternative bases for approximate implicitization such as the Lagrange and Chebyshev bases, and established their relation to the original and weak formulations of approximate implicitization. Tor Dokken, Tom Lyche and Kjell Fredrik Pettersen (SINTEF) addressed the theoretical basis for Locally Refined B-splines (LRB-splines) a more general approach to local refinement than T-splines. The LRB-splines have been presented at four international workshops/conferences during 2010.

Lyche has worked with Elaine Cohen and Richard Riesenfeld from Utah on extending B-spline theory to surfaces over triangulations and with Dokken and Pettersen on splines on nontensor meshes suitable for solving partial differential equations. Together with a group at Société de Mathématiques Appliquées et Industrielles he was main organizer of the Seventh International Conference on Curves and Surfaces, Avignon, France, June 24-30, 2010 with close to 300 participants and more than one hundred lectures. The conference proceeding will be published in the Springer series Lecture Notes in Computer Science.

Mørken worked with PhD-student Solveig Bruvoll and Tom Lyche on constructing piecewise linear wavelets over planar triangulations. The main result is that for a general base triangulation, and quite general refinement strategies, it is possible to perform a wavelet-like decomposition that is uniformly stable, independently of the geometry and topology of both the base triangulation and the refinement strategy. Mørken's PhD-student Eivind Lyche Melvær completed a paper which describes a technique for constructing 3D medical images using a simple 2D ultrasound probe.

Floater found a new way of determining the Hölder regularity and approximation properties of certain interpolatory subdivision schemes, by viewing the limit function as the limit of piecewise polynomials, rather than polygons. This technique is particularly useful for data that is irregularly spaced, for which very few results were previously known. This work subsequently led to results on the approximation properties of parametric curve fitting, and also, in the functional setting, to showing that a conjecture of Daubechies, Guskov, and Sweldens is false. Floater hosted visits from Stefano de Marchi and Kai Hormann and organized a lively and fruitful geometry seminar in the autumn.

Reimers and PhD student Bruvoll completed an article on a new method for the Shape From Shading problem in computer vision. Together with PhD student Morvan, he continued research in efficient collision detection, exploiting the computational power of modern computer graphics hardware. Reimers also developed new algorithms for computing Geodesic Polar Coordinates on triangle meshes, together with PhD student Lyche Melvær. In a joint project with the PDE group, Reimers started a collaboration with researchers from the Centre for Molecular Biology and Neuroscience, aiming at modeling signal propagation in the brain.

Dahl worked on combinatorial matrix theory and studied classes of zero-one matrices with fixed row sums and certain additional constraints on the rows, expressed in terms of majorization. This work was a part of the ongoing collaboration with Richard A. Brualdi (University of Wisconsin, Madison). Dahl continued his work on polyhedra in connection with majorization, and showed a result which generalizes the classical Gale-Ryser theorem for zero-one matrices. Dahl also continued his collaboration with Mike Ball (University of Maryland, College Park) on optimization models and algorithms related to transportation problems. In addition Dahl together with Carlo Mannino and Fred E. Benth (CMA) worked on optimization problems related to correlated default in financial systems. Dahl also worked on some optimal control problems in collaboration with Harald Minken (Institute of Transport Economics).

Mannino worked on the development of new polyhedral techniques for solving large optimization problems arising in transportation and telecommunication. Concerning wireless network design problems, Mannino (in cooperation with his former PhD student Fabio D'Andreagiovanni) developed a new pure 0,1 linear programming approach with excellent performance compared to the classical approach (where transmission powers are expressed by continuous variables). Polyhedral properties and algorithmic features of the new approach were investigated. For this work, Fabio D'Andreagiovanni received the 2010 Best Dissertation Award assigned by the INFORMS section on telecommunication. Mannino also developed a general framework for job-shop scheduling problems based on Mixed Integer Linear Programming.

Stochastic analysis

Stochastic analysis is the mathematical language for analysis of stochastic processes. The core of the theory is integration and differentiation of processes, and it is the main framework for studying random phenomena in nature and life. The group at CMA has continued their research on theoretical developments and practical applications of stochastic analysis, with mathematical finance being the key motivation.

The following personnel were part of the Stochastic analysis group in 2010:

- Full time senior scientists: Fred Espen Benth, Giulia Di Nunno, Tom Lindstrøm, and Bernt Øksendal,
- Adjunct researchers: Yaozhong Hu, Rüdiger Kiesel, Tusheng Zhang, Knut Aase, and Francesca Biagini (from Aug)
- Postdoc fellows: Jukka Lempa, Trygve K. Nilssen, Olivier Pamen, An Ta Thi Kieu.
- PhD-students: Sven Haadem, Asma Khedher, Mark Rubzov, Maren Schmeck, Linda Vos, Marcus Eriksson (from Oct), Heidar Eyjolfsson (From Sep), Torstein Nilssen, Steffen Sjursen, and Imran Taib (Fom Oct)

In 2010 Øksendal has been working with Agnès Sulem (INRIA, Paris) and Tusheng Zhang (University of Manchester and CMA) on the following topics:

- *A Malliavin calculus approach to singular control with partial information of jump diffusions.* The purpose of this project was twofold: Firstly, to get tractable criteria for solutions of singular control problems when we have only partial information, e.g. when the information flow from the system has a delay or is otherwise incomplete. Secondly, to solve some *partial information optimal stopping* problems. We do indeed succeed to find the explicit solution in some cases that were not known before.
- *Optimal control of systems with delay.* This is an important, but challenging problem with many applications, e.g. in finance and in biology. We have developed a (Pontryagin type) maximum principle for such problems, and shown that the adjoint equation is a *time-advanced* backward stochastic differential equations (BSDE), which is a new type of BSDEs.
- *Optimal portfolio under model uncertainty.* This is a topic that has received a lot of attention lately, partly because of the financial crisis. In 2010 we have completed the first of several papers on this topic, where we combine Malliavin calculus, BSDEs and *forward-backward stochastic differential games* to establish criteria for a Nash equilibrium.

Lindstrøm has been working with students on diffusions on fractals, deterministic control problems in biology, and finance in Lévy markets. With former CMA-researcher Klara Hveberg he has completed a textbook on several variable calculus connected to the project "Computers in Science Education."

Lempa has worked on an optimal stopping game with asymmetric information. In this project, an optimal stopping game with random random time horizon was studied. The time horizon is exponentially distributed and independent of the underlying process. The players have asymmetric information on the expiry time, namely only one of the players is able to observe its occurrence. We proposed a set of conditions under which we solved the saddle point equilibrium and studied the implications of the information asymmetry.

A second question studied by Lempa is: do standard real option models overestimate the required rate of return of real estate investment opportunities? To answer this, we studied irreversible investment on real estate market using real options approach. The decision maker is facing both return and cost uncertainty. We investigated how the discreteness of the underlying revenue and cost dynamics affect the optimal timing of investment opportunities in comparison with continuous time models. We showed that the standard continuous time real option model of irreversible investment leads to slower investment timing than the discrete time model and that this difference is increasing as a function of the length of the time step used in the discretization.

Benth and Di Nunno have together with PhD student Asma Khedher studied the robustness of option prices and their deltas in the jump diffusion framework. In particular we consider models in which the small variations in price dynamics are modeled with a Poisson random measure with infinite activity and models in which these small variations are modeled with a Brownian motion. We show that option prices are robust. Moreover we study the computation of the deltas in this framework with two approaches, the Malliavin method and the Fourier method. In particular we have extended and applied Malliavin calculus techniques for the computation of the Greeks. Within the same area we have also studied the robustness of option prices to model variation when various changes of measures are considered for pricing purposes. In fact in incomplete markets the choice of an equivalent risk neutral measure is not unique and for various specifications of the pricing measure we show that the option prices and their corresponding deltas converge as the scaling of the Brownian motion part tends to zero. As a follow-up of the research of 2009, we have applied the conditional density method for the computation of the Greeks to the case of options written on assets modeled by a multi-factor dynamics. This has found applications in the energy and commodities market models. Benth and PhD student Maren Schmeck have considered robustness issues for these models in the context of portfolio optimization

in Levy markets. Our investigations in these areas are now under generalization to the multi-dimensional case in collaboration with Maren Schmeck.

With PhD student Steffen Sjursen, Di Nunno has studied optimal investment in assets subject to risk of default for investors that rely on different levels of information. The price dynamics include noises both from a Wiener process and a Poisson random measure with infinite activity. The default events are modeled via doubly stochastic Poisson processes. We apply techniques of forward integration to solve the optimization problem for maximum expected utility at terminal time for a large class of utility functions.

With Øksendal, Jose. Manuel Corcuera, and Farkas, Di Nunno has extended the continuous-time version of Kyle-Back model of asset pricing with asymmetric information to include a larger class of price processes and a larger classes of noise traders processes. The process of the noise traders is considered to be an inhomogeneous Lévy process. The goal is the study of equilibria and the results can be summarized as follows. If the informed agent is risk-neutral then the price pressure is constant over time and there is no equilibrium in the presence of jumps. If the informed agent is risk-averse, then there is no equilibrium in the presence of either jumps or drift in the process of the noise traders.

The activity in energy finance has been very succesfull in 2010. Benth was awarded a research grant of approx. NOK 6,5 million in the eVita program of the Norwegian Research Foundation with his EMMOS

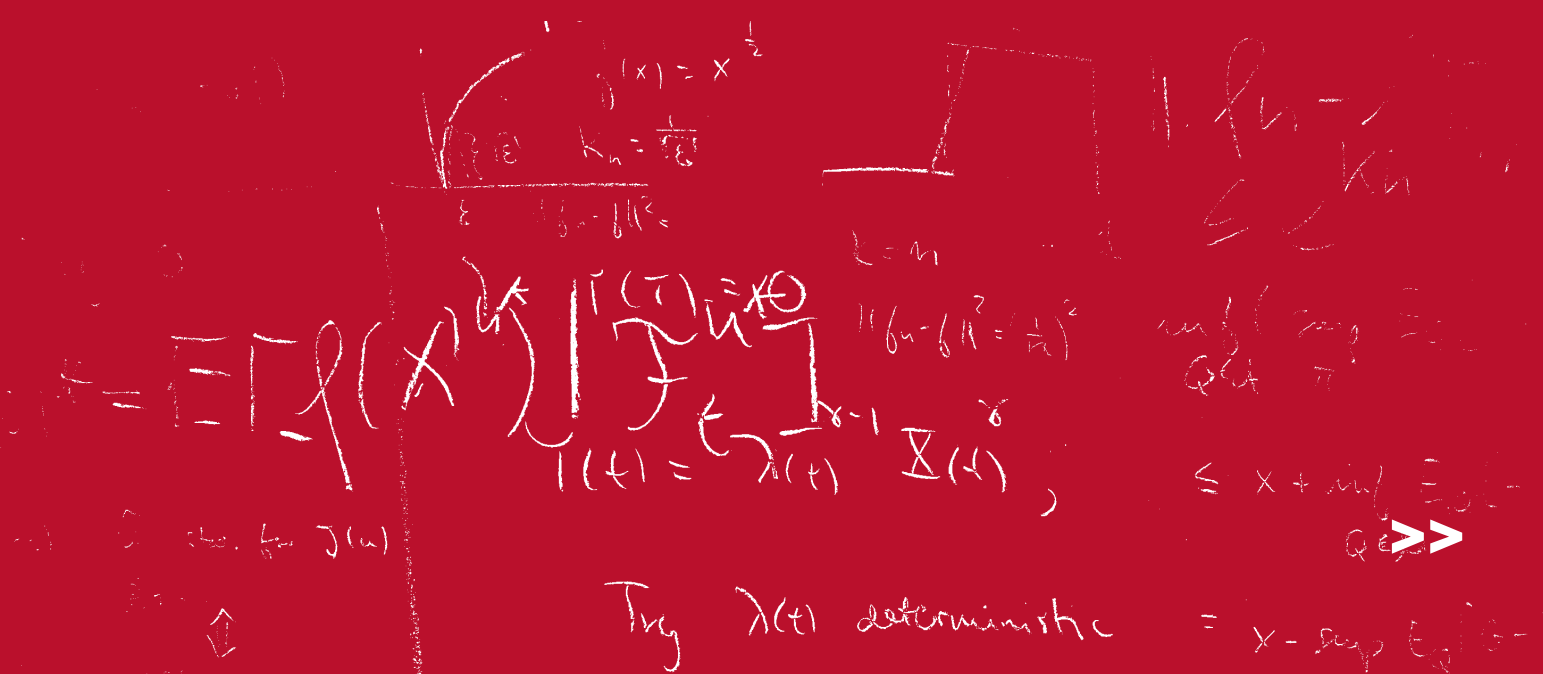
(electricity markets:modelling, optimization and simulation) project. The grant runs over 4 years and includes 2 post doc positions and one PhD. The EMMOS project will focus on the development of advanced mathematical and numerical methods for modelling and analysis of energy markets. Benth is a fellow at the Wolfgang Pauli Institute in Vienna in connection with a thematic program on energy risk management, run in cooperation with professors Peter Laurence and Valery Kholodnyi. The EMMOS post doc Jukka Lempa was awarded a prize for the best technical paper at the Conference on Energy Finance in Essen in October. The paper was on swing options, and Jukka's talk attracted significant attention from world-leading experts. Together with PhD student Marcus Eriksson he is generalizing the analysis of swing options to more realistic market situations.

Benth has continued his collaboration on ambit models for energy markets and turbulence with Barndorff-Nielsen and Veraart in Århus, Denmark, looking into stochastic optimization and integration theory. Together with PhD student Heidar Eyjolfsson, they are working on a novel method for numerical simulation of ambit processes. With Kluppelberg in Munich, Benth and PhD student Linda Vos are working on the use of Levy models with memory for power markets.

Benth enjoys a close collaboration with Rudiger Kiesel in Essen, Germany, who is also adjunct professor at CMA. With Kiesel and his PhD students, there are several projects involving energy market related developments, including a new class of models for emission markets, the use of indifference pricing in weather markets and empirical studies of the value of information in power markets.

Differential equations

Partial differential equations are one of the most fundamental tools in the construction of mathematical models in science and technology. The activity in differential equations at CMA is devoted to theoretical aspects of partial differential equations and to the numerical treatment of such problems.



The following personnel were part of the Differential equations group in 2010:

- Full time senior scientists: Snorre H. Christiansen, Kenneth H. Karlsen, Nils Henrik Risebro, and Ragnar Winther,
- Adjunct researchers: Jörg Frauendiener, Helge Holden, Knut-Andreas Lie, and Xue-Cheng Tai,
- Postdoc fellows: Franz Fuchs, Runhild Aae Klausen, Ilia Musco, Xavier Raynaud
- PhD-students: Ujjwal Koley, Agnieszka Wasylewicz

Karlsen, with Betancourt (Concepcion), Burger (Concepcion) and Tory (Sackville), have proposed and analysed a modification of the well-known kinematic sedimentation model by Kynch. This model states that the settling velocity of small equal-sized particles in a viscous fluid is a function of the local solids volume fraction, while the new model is based on the assumption that either the solids phase velocity or the solid–fluid relative velocity at a given position and time depends on the concentration in a neighbourhood via convolution with a symmetric kernel function with finite support. This assumption is justified by theoretical arguments arising from stochastic sedimentation models, and leads to a conservation law with a nonlocal flux. Karlsen, Betancourt and Burger have also proposed and analyzed a strongly degenerate partial differential equation with convective flux involving a nonlinear function of the total mass to one side of the given spatial position. This equation can be understood as a model of aggregation of the individuals of a population with the solution representing their local density. The aggregation mechanism is balanced by a degenerate diffusion term describing the effect of dispersal. Karlsen, with S. Cifani (Trondheim) and Jakobsen (Trondheim), have proposed and analyzed a discontinuous Galerkin methods for strongly degenerate convection-diffusion equations perturbed by a fractional diffusion operator.

Karlsen and Risebro, with Andreianov (Besançon), have proposed a general framework for the study of L^1 contractive semigroups of solutions to conservation laws with discontinuous flux. Developing the ideas of a number of preceding works it is claimed that the whole admissibility issue is reduced to the selection of a family of “elementary solutions”, which are certain piecewise constant stationary weak solutions. Such a family is referred to as a “germ.” This work revisits a number of the existing admissibility (or entropy) conditions and identify the germs that underly these conditions. Specific attention is devoted to the vanishing viscosity” germ. For any given germ, the work formulates “germ-based” admissibility conditions in the form of a trace condition on the flux discontinuity line $x=0$, in the spirit of Vol’pert, and in the form of a family of global entropy inequalities following Kruzhkov and Carrillo. The proposed approach offers a streamlined and unifying perspective on many of the known entropy conditions.

Holden and Karlsen, with Frid (Rio de Janeiro), have established the global existence of solutions for a model of polytropic gas

flow with varying temperature governed by a Fourier equation in the Lagrangian coordinates. The result is obtained by showing the convergence of a class of finite difference schemes, which includes the Lax–Friedrichs and Godunov schemes. Such convergence is achieved by proving the estimates required for the application of the compensated compactness theory. Raynaud and Cohen (Basel) derived numerical schemes for the generalized hyperelastic rod equations, which preserve the geometrical structure of the equations. Holden, Raynaud and Grunert (Vienna) solved a stability problem for the Camassa–Holm equation, in the periodic case as well as in the more difficult case of the whole real line. They construct a new metric which is intimately related to the way the solutions themselves are obtained, and establish a strong stability result of the solutions, which cannot be obtained otherwise by using standard metrics. Such stability results can be used to prove the uniqueness of the semigroup of solutions.

Klausen and Winther has done work on general principles for preconditioning in $H(\text{curl})$ with relationship to H^1 , enabling H^1 techniques on $H(\text{curl})$ situations. Klausen, with Stephansen (Bergen) and Rasmussen (SINTEF, Oslo), have studied discretization and interpolations on polygon and polyhedron meshes. This includes use of generalized barycentric coordinates as edge based interpolation functions for $H(\text{curl})$ and $H(\text{div})$, and streamline tracing.

Christiansen, Winther and collaborators have continued to work on extensions of finite element methods in various directions, including wave equations from mathematical physics. In particular they have clarified the relationship between eigenvalue convergence, discrete compactness, Friedrichs estimates and the existence of bounded cochain projections, proving equivalences and implications where appropriate, and constructing counter examples in the remaining cases.

Christiansen and Halvorsen have introduced a new discretization of Yang–Mills theories. Whereas conventional Lattice Gauge Theory, which is at the basis of simulations in high energy physics, is based on cubical grids, they constructed an analogue over simplicial grids, allowing for instance local mesh refinements. Thus they obtained a discretely gauge invariant, yet consistent, action, defined over Lie algebra valued Whitney forms. A discrete Noether’s theorem sheds light on its advantages. Christiansen has refined some smoothing operators introduced earlier with Winther, to preserve polynomials locally up to prescribed order. The theory also gives L^p estimates on associated smoothed interpolation operators for mixed finite elements. These operators can be used to prove Sobolev injections, local estimates and to give general and optimal versions of some translation estimates previously introduced by Karlsen and Karper, for mixed finite elements. Christiansen, Frauendiener and Rippis have collaborated on simplified models in general relativity discretized in terms of Regge calculus. Musco and Rippis have continued their work on primordial black holes, comparing singular shell computations with numerical methods.

Astrophysics

The physical description of the outer stellar atmospheres results in large sets of coupled partial differential equations. There are major difficulties in constructing numerical methods for these equations related to highly nonlinear reaction terms and in devising proper boundary conditions, an activity pursued at CMA. In addition, the activity in cosmology is focused on developing improved algorithms for studying stochastic fields on a sphere and applying them to data on the Cosmic Microwave Background.

The following personnel were part of the Astrophysics group in 2010:

- Senior scientists: Mats Carlsson, Hans Kristian K Eriksen, Boris Gudiksen, Frode Hansen, Viggo Hansteen, and Per Barth Lilje,
- Postdoc fellows: Iain A. Brown, Håkon Dahle, Simona Donzelli, Jostein R. Kristiansen, Jussi Väliiviita, and Sven Wedemeyer-Böhm,
- PhD-students: Patrick Antolin, Leandro Gomez de Jesus, Nicolaas Groenebom, Sigurd Næss, Kosovare, Olluri, Øystein Rudjord.

We have completed the rewrite of our radiation hydrodynamics code using the Message Passing Interface to create the massively parallel code Bifrost. With this code we are able to simulate the solar atmosphere from the convection zone, where the motions feed energy into the magnetic field, all the way to the corona where the release of magnetic energy is more or less violent. During 2010 we have published the first code paper, describing the radiation module, and in 2011 we will complete the code description with the main code paper (submitted January 2011) and papers describing several other aspects of the code.

In 2010 we also completed a number of simulations in order to study the magnetic couplings of the solar atmosphere: The minimum achievable temperature in the chromosphere using our model has been studied, it turns out that the temperature can fall as low as 1500 K or below in the absence of magnetic heating. When the magnetic field is stronger and more complicated a number of phenomena appear in our models that are of relevance to chromospheric and coronal energetics. These include: increased heating in the vicinity of strong magnetic fields in the chromosphere, jets that are quite similar to observed spicules, and episodic heating in transition region and corona. The diagnostic consequences of the latter have been studied and seem able to reproduce the observations quite well. The

more complicated diagnostics of the chromosphere, where radiative transfer is much more complicated, have also been studied in a number of important chromospheric lines such as those from Na I, Ca II, and H I in order to characterize the differences between observed and modelled spectral lines. Also phenomena such as coronal rain and Alfvén waves propagating into the outer corona have been studied, initial results show that these are fields that should yield important insights in the near future.

After the launch of Planck in May 2009 and a first test and calibration phase, real science data have been recorded since August of that year. There was therefore a very large effort in 2010 on applying our previously developed methods to real data, and on modifying them after they had been tested on the real data. Emphasis is put on estimation of CMB power spectra and likelihoods and cosmological parameters with data that are contaminated by radiation from our own galaxy. The methods developed at ITA in recent years, based on the Gibbs sampling and internal template fitting algorithms (using needlets) by Hans Kristian Eriksen and collaborators and by Frode Hansen and collaborators (including Simona Donzelli and Øystein Rudjord), respectively, were successfully applied to the real Planck data. The resulting codes are now routinely used by many groups within the large Planck collaboration. Also, Jussi Väliiviita has developed jackknife tests for the mapmaking algorithms.

This was also a very important year for the QUIET group at the University of Oslo (Hans Kristian Eriksen, Sigurd Næss and Ingunn Kathrine Wehus), which has the main responsibility for developing one of two independent data reduction pipelines in the experiment. In 2010, the first QUIET results were made public, and these put very strong constraints on the amplitude of primordial gravity waves. These results were based on only nine out of thirty months of observations, and work is still on-going at full speed to analyze the remaining 21 months. Once those go public later this year, QUIET will be world-leading in the search for gravitational waves from the Big Bang.

Quantum mechanics

The starting point for all of the group's investigations is the development of appropriate techniques for studying systems of many interacting particles, so-called many-body methods. The systems of interest span most of the fields in physics covered by non relativistic quantum mechanics that is atomic, molecular, nuclear and solid-state physics and the physics of quantum liquids. Beside the importance for our basic understanding of quantal systems, the capability to handle numerically quantum mechanical systems with many degrees of freedom is of strategic importance for both the materials science and nanotechnology programs in Norway. Analytic solutions are rare or impossible to obtain. Thus to develop and study stable numerical schemes is of utter importance.

The following personnel were part of the Quantum mechanics group in 2010:

- Senior scientists: Morten Hjorth-Jensen
- Adjunct researcher: David Dean,
- Postdoc fellows: Simen Kvaal and Sølve Selstø
- PhD-students: Gustav Bårdsen, Gustav Ragnar Jansen

Our research has focused mainly on many-body methods applied to problems in solid state physics, atomic physics and nuclear physics. In solid state physics the emphasis has been on properties of so called quantum dots, and in particular on mathematical properties of various many-body techniques. Many of the techniques are also used to describe nuclear systems. The methods we are working on in this context are so-called self-consistent Green's functions theories, coupled-cluster methods and large-scale diagonalization techniques. We have recently also developed variational and diffusion Monte Carlo codes for studies of several quantum mechanical systems in both two and three dimensions.

Our main emphasis has however been on ab initio coupled-cluster theory. The last years have seen our first application of these many-body theory to many systems in solid state physics and nuclear physics. In particular, we have studied stable and unstable nuclear system in the mass region from $A=4$ to $A=56$ and for the whole chain of isotopes such as the oxygen or the calcium isotopes. Our team of researchers from Oslo and Oak Ridge National Laboratory has computed the binding energies, radii, and densities for selected medium-mass nuclei within coupled-cluster theory employing unrenormalized nucleon-nucleon interactions. These calculations are now being extended to include three-nucleon interactions and studies of heavier nuclei such as isotopes in the mass region of tin. Within the next few years we expect to be able to carry out ab initio calculations for all doubly magic nuclei from ${}^4\text{He}$ to ${}^{208}\text{Pb}$. This will put the theoretical modeling of nuclei in a position where truly quantitative and reliable predictions can be made. The coupled-cluster machinery developed for nuclei can easily be extended to

other quantal systems as well, from atoms to studies of materials. Our recent development of theories for studies of spectroscopic factors holds great promise for linking structure calculations with reaction theory. Our recent studies of weakly bound oxygen nuclei were highlighted in Science news in 2010.

Using coupled-cluster theories we performed also extensive comparisons of electrons in quantum dots and compared these results with virtually exact and state-of-the-art diffusion Monte Carlo calculations, with excellent agreement. Coupled-cluster calculations are less CPU intensive than Monte Carlo calculations and can easily be extended to systems with more particles. Linked with density functional theories, our research can therefore provide an ab initio procedure for studies of most non-relativistic quantum mechanical systems.

Furthermore, explicitly time-dependent many-body problems have also been the subject of attention. In particular, unbounded many-body systems are of interest as they present a wide range of complex and relevant theoretical challenges - such as interference between various decay-channels, the population and decay of resonance states and inter-particle interactions mixed with external perturbations. To this end, the extension of standard many-body techniques for structure calculations, such as the coupled cluster method, to explicitly time dependent problems has been a topic of interest. Moreover, we have been able to generalize the concept of absorbing boundary conditions to systems consisting of more than one particle. This has been achieved via formalism used to describe open quantum systems. Imposing absorbing boundary conditions makes it possible to describe unbound systems, which in general are not restricted in spatial extension, on a finite region of space, and it facilitates the interpretation of the final state of the system after interaction. Several applications of this technique have been developed.

Our group has also large collaborations on the development of many-body theories with Michigan State University and The University of Tokyo.

Publications 2010

Appendices 7a – 7e plus parts of appendix 9 provide a complete overview of all written output from the centre in 2010. Refereed journal articles count 128, all in international scientific journals, many of them being of the highest standard. With approximately 58 researcher-years in the centre in 2010, CMA produced 2.2 articles per researcher-year, which we consider a very good result. In addition 6 research monographs / books and 15 chapters of anthologies were published.

Main events 2010

Our main research events brought together hundreds of Norwegian and international researchers in stimulating collaboration and transfer of knowledge. For statistical details on participants and lectures, see Appendix 5. For more details on speakers, participants, programs and abstracts, please consult the CMA web for a complete overview.

A School on Topics in Nuclear Many-Body Theory, from Lattice QCD to Nuclei, Jan 4-9, 2010, Gålå.

The school was part of CMA's established cooperation with North-American universities, aiming to strengthen the active collaborative research between UiO, Tennessee and Michigan specifically. This school consisted of 25 lectures a 45 min each, followed by Q&A sessions. Topics included The Nuclear Shell Model, Non-empirical Energy Density Functional (method) for nuclei, From Lattice QCD to Hadronic Interactions, Open Quantum Systems, Nuclear Many-Body Theories.

Mathematics and Life Sciences, Oslo, January 26

The importance of mathematical models and computations in biology and many fields of medical research is strongly increasing. The purpose of this internal workshop at UiO was to focus on this development by bringing together researchers from applied mathematics, biology, and medicine. The idea is to focus on certain research problems which potentially might lead to joint and interdisciplinary research projects. Topics included Chromatin organization and gene regulation in stem cells, A two-tiered adaptive response to loss of DNA repair modulates aging and stress response pathways, Models in population ecology and evolution, The meningitis model, Dynamics of extracellular glutamate.

Time dependent quantum mechanics — analysis and numerics, CMA, April 28-30

This 3-day workshop at CMA was in the heart of our vision on interdisciplinarity, bridging gaps from PDE to physics, with both theoretical and numerical perspectives. Topics included: Splitting methods and the Magnus expansion for the time dependent Schrödinger equation, Benefits and inconveniences of channel-specific absorption boundaries for the solution of the TDSE, Parallel exponential integrators for quantum dynamics, Observable phenomena which can not be predicted by the standard formalism of quantum mechanics, Numerical analysis of the stability of absorbing boundary conditions for quantum systems in intense laser pulses,

ime dependent coupled cluster approach to many-body quantum dynamics, Variational approximations in quantum dynamics and the MCTDH method, Monte Carlo wave packet approach to dissociative multiple ionization in diatomic molecules, A perfectly matched layer approach to a reactive scattering problem, Elliptically polarized high-order harmonics from aligned molecules within the strong-field approximation, Absorbing boundaries for more than one particle, Quantum Optimal Control Theory with Time Dependent Density Functional Theory, Applications of lattice gauge theory to the coupling of Maxwell with Klein-Gordon and Schrödinger equations, An implicit method for large-scale quantum simulations

A CMA-CTCC Workshop on Computational Quantum Mechanics, Oslo, June 17-18, 2010

Many-body problems in physics and chemistry are today studied using a variety of methods. On the one hand, the traditional many-body methods such as coupled cluster, configuration-interaction and Monte Carlo methods are continuously being refined and routinely applied to problems in quantum chemistry, nuclear, atomic, molecular and solid-state physics. This workshop aimed at bringing together people who work with different quantum-mechanical many-body methods, with an emphasis on recent advances and developments in Coupled-cluster theory and density-functional theories.

The Abel Symposium 2010 – Nonlinear Partial Differential Equations, Oslo, Sep 28 – Oct 1

The scientific program focused on mathematical and numerical aspects of various classes of nonlinear partial differential equations (PDE). The symposium brought together leading experts to learn about current trends in the field. Relevant topics include (i) nonlinear hyperbolic equations arising in fluid mechanics and general relativity, including questions of existence, uniqueness, regularity, formation of singularities, and asymptotic behaviour of solutions; (ii) nonlinear elliptic equations and variational methods with applications to mathematical physics, relativistic quantum mechanics, and quantum chemistry; (iii) construction and analysis of numerical methods for nonlinear PDE.

The seminar series of 2010

In addition to the specific workshops presented above, a number of seminar and lecture series took place as usual. Appendix 5 provides the full list.

Prizes and awards

Associate Professor at The Institute of Theoretical Astrophysics and CMA-member **Hans Kristian Eriksen** won a European Research Council Starting Grant for his project called “The anisotropic universe – a reality or fluke?” which started on January 1st, 2011, and will run for five years. This project aims to answer a central question in modern cosmology: Are the properties of the universe the same everywhere, or do they vary with position? Since 2003, there have been subtle hints of the latter, and if these hints are confirmed by new and more sensitive observations, the very foundations of modern cosmology may have to be reconsidered. The total budget of the project is 1.5 M€, and this will cover two Ph.D. fellowships and three postdoctoral fellowships during the project period

CMA postdoc fellow **Jukka Lempa** was awarded the “Best paper”-prize at the “Energy & Finance”-conference in Essen in October 2010 for the paper “On optimal exercise of swing options in electricity markets”, submitted to a special issue of Journal of Energy Markets. The committee consisted of Rene Carmona from Princeton and Rüdiger Kiesel from Essen, as well as two representatives from RWE, a large German power company. The jury remarked that the paper laid the foundation for analysis of swing options in energy markets, with solid theory and numerics.

Management

Daily leadership

Professor Ragnar Winther (Director), Professor Fred Espen Benth (Vice-director), and Helge Galdal (Administrative Director) form the operational leadership of CMA. They have the authority to make day-to-day decisions on practical matters, financial transactions, research activities within the budget and the research plan. CMA has an extended leadership group composed of principal investigators, broadly representing each research group in CMA. In 2010, this group consisted of Tom Lyche, Knut Mørken, Geir Dahl, Ragni Piene, Tor Dokken, Bernt Øksendal, Helge Holden, Morten Hjorth-Jensen, and Mats Carlsson. The mandate of the leadership group is to ensure consensus decisions at important crossways.

The Board

The governing board of CMA consisted of the following members in 2010:

- **Kjell Bendiksen**, chair, Managing Director of The Institute for Energy Technology
- **Suzanne Lacasse**, co-chair, Managing Director of The Norwegian Geotechnical Institute
- **Trygve Helgaker**, Professor at the Department of Chemistry, UiO
- **Jarle Nygard**, Director of the Faculty of Mathematics and Natural Sciences, UiO
- **Kristian Ranestad** Professor at the Department of Mathematics, UiO

In addition, head of The Department of Mathematics, **Arne Bang Huseby**, also meets at the board.

The board’s authority focuses primarily on strategic and control functions, with clear instruction to approve budgets, accounts, and annual reports on the administrative side, and the research plan on the research side.

Scientific Advisory Board

CMA’s Scientific Advisory Board, appointed by the board, remained unchanged in 2010:

- Professor **Hans-Peter Seidel**, Max-Planck Institut, Saarbrücken,
- Professor **Mark Davis**, Imperial College, London,
- Professor **Douglas Arnold**, University of Minnesota,
- Professor **Jan Trulsen**, University of Oslo.

Economy

Total revenues and expenditures

The total revenues and expenditures are presented below. More details are presented in appendices 2 and 3.

Total activity, accounted	Note, app 3	Budget 2010	Acc. 2010	Budget 2011
Revenues				
Own projects, OH+terminations	1,2	-2 000 000	-2 912 957	-220 059
RCN funding	3,17,22	-17 609 301	-12 997 888	-19 316 333
Univ. Oslo funding	4,21	-20 719 840	-21 423 000	-21 940 000
Sintef funding	5,23	-6 658 000	-6 286 333	-6 735 000
Other public funding	6,19,24	-3 662 500	-4 793 648	-2 794 000
International funding	7,18,25,26	-3 077 500	-3 428 874	-10 123 145
Private funding	8,27	0	0	0
NAV Reimbursements	9	0	0	0
Total revenues		-53 727 141	-51 842 700	-61 128 537
Expenditures				
Salary costs	10,20,28	40 882 807	40 600 858	40 155 448
Indirect costs	11	7 512 334	7 296 193	7 895 798
Teaching services	12	100 000	36 423	50 000
Equipment	13	1 386 000	1 062 793	998 000
Guests, traveling, conferences	14	1 560 000	1 779 293	1 500 000
Public outreach	15	250 000	212 830	250 000
Various operational costs	16	5 403 500	7 489 924	4 721 000
Total expenditures		57 094 641	58 478 314	55 570 246
Annual result		3 367 500	6 635 614	-5 558 291
Accumulated as of Jan 1		-7 973 163	-7 973 163	-1 337 549
Accumulated as of Dec 31		-4 605 663	-1 337 549	-6 895 840

Table 1. CMA budget and accounting figures for 2010, and corresponding budget figures for 2011. Negative figures mean income/surplus.

Main conclusions and remarks

The accounts reflect a continuous high level of activity in CMA. The annual deficit of 6,6 MNOK is generated by 2,3 in the core CMA-activity and 4,3 in our project portfolio. The core deficit has two main reasons. First, the Research Council held back 4 million due to causes described in appendix 3, note 1. These funds will come in 2011. Second an overhead expense of 1,7MNOK was (by a mistake) not transferred to our host. These are also included in the 2011 budget. Were these two elements included as they should, the core CMA-activity would give the close-to-zero result that we sought for 2010. Thus we are tightly following plans.

The project portfolio deficit is mainly caused by the large ERC Advanced Grant project of Prof. Øksendal, with no income / high activity in 2010. The next EU-allotment will come in 2011. Also other projects had scheduled income in 2010 which are postponed to 2011. The financial situation of the portfolio is transparent and under good control.

CMA's financial situation still provides a solid foundation for stable and flexible project management and long term research, which in turn make us able to run a healthy and highly competent centre.

The people

Staff and members 2010 – status and statistics

On Jan 1, 2011, CMA counted 80 people. In addition 17 completed their time with CMA during 2010. They are all presented in appendix 1, together with those who are confirmed incoming in early 2011 (2). We present the following statistical details on the 97 members of 2010:

- 23 senior scientists, 36 PhD-students, 18 postdocs, 14 adjunct researchers, 6 other
- 81 men and 18 women (19%)
- 55 native Norwegians and 42 (43%) of foreign nationalities from 22 different countries
- 32 funded/employed by CMA, 35 by the host, 9 by SINTEF, and 28 through associated projects.

Person-years in 2010 and estimates for 2011

Table 2 below provides the person-year figures of 2010 and new estimates for 2011. As in all budget presentations, we use conservative figures; only confirmed new persons and projects are included.

	CMA	UiO funded	Sintef	Other	Total
2010 (actual)					
PhD	8.3	6.8	5.1	5.8	26.0
Postdocs	4.8	0.0	0.7	7.8	13.3
Senior scientists	4.5	12.2	0.4	1.4	18.5
Tech/Adm	2.2	1.5			3.7
Sum	19.8	20.5	6.2	15.0	61.5
International guests				7.0	7.0

2011 (estimates)					
PhD	5.8	7.5	4.8	4.8	22.9
Postdocs	3.4	0.0	1.0	7.1	11.5
Senior scientists	5.7	12.2	0.4	0.1	18.4
Tech/Adm	2.2	1.5			3.7
Sum	17.1	21.2	6.2	12.0	56.5
International guests				7.0	7.0

Table 2. Calculation of person-years in CMA, taking the funding source into account

According to our long term plans we reduced the basic CoE-activity in 2010 and will continue to do so in 2011. The CoE funding will last two more years, and we are no longer hiring new fellows over core funding. However we continue to actively run the project portfolio and are seeking new opportunities. Moreover we also experience that our host is increasing its contributions, mainly through allocations of new PhD-fellows to the CMA research groups.

Technical and administrative staff

Administrative director **Helge Galdal** coordinates the administrative functions and the support staff mentioned below. He also deals with activity reporting, budgets, and new project proposals. From May 2009 **Aslaug Kleppe Lyngra** has held a new full time position, established to guide and help our international members and visitors with all kinds of practical and bureaucratic challenges. In order to strengthen the IT-support functions, **Lucy Karpen** holds a 70% position in the centre. **Andrew McMurry** holds a full time scientific programmer position.

Many daily administrative services are "outsourced". The following persons provide valuable support on reception, IT-maintenance, book-keeping, housing, bureaucracy etc: **Dina Haraldsson, Anita Smeby, Vanitha Marimuthu, Terje Kvernes, and Bård Kristiansen** from the Department of Mathematics. **Grete Andresen** of The Faculty of Mathematics and Natural Sciences is handling personnel matters.

We are running an effective administrative organization. As far as possible, we utilize the existing professional organization at UiO. CMA contributes to the host with financial support. This system has contributed to CMA becoming an integrated part of the larger scientific community.

Guests

It is a privilege for CMA to invite many prominent guest researchers as well as young research talents. In 2010, we have received **9** visitors from abroad who stayed for more than 1 month (see appendix 6). These nine contributed approximately 4 full man years to CMA in 2010. For short term visits at CMA (1-30 days), we received **53** visitors from abroad (presented in appendix 6). Their collective time at CMA corresponds to approx 1,5 full person-years. Finally a total of **78** international participants came to CMA's major conferences/workshops in 2010. Spending ~ one week each, they represented ca 1,5 person-years of international collaboration.

All together, these 140, originating from 21 different countries, spent 7 person years of incoming international collaboration in 2010. Finally, a large number of Norwegian guests have visited us, many of them several times. These are not registered nor counted.

Handwritten mathematical notes and diagrams:

- $$b_t = b_t(z) B_t \sqrt{n} (X - X_n) \rightarrow d = \frac{U''(c)}{U'(c)}$$
- $$\int_0^t \exp\left(\int_0^s r_n dB\right) dW$$
- $$\varphi(x) = E\left[\int_0^x f(x_t) dt + g(x_t)\right]$$
- $$A\varphi + f = 0 \quad \partial D$$
- $$\varphi = g \quad \text{in } \partial D$$
- $$\|f_n - f\|_2$$
- $$\|f_n - f\|_W^2 \leq e^{K_n}$$
- $$\|f_n - f\|_W^2 \leq \lambda + \inf_{Q \in \mathcal{H}} E_{\lambda} |G - f|$$
- $$\|f_n - f\|_W^2 \leq \lambda - \sup_{Q \in \mathcal{H}} E_{\lambda} |G - f|$$
- $$\frac{\partial}{\partial x} f$$
- $$\mathbb{E}_t[\mathcal{H}_t] = 0$$
- $$f_t \in \mathcal{F}_t$$
 (partial obs.)
- $$f_t \in \mathcal{F}_t$$
 (insider)
- $$\text{Try } \lambda(t) \text{ deterministic}$$

Research education

A main goal of CMA is the training of new researchers. On December 31st, 2010, 31 PhD-students and 14 postdoc fellows were active in the CMA. We can report from 7 doctoral defences in 2010:

- December 17, 2010: **André Rigland Brodtkorb** defended his thesis: *"Scientific Computing on Heterogeneous Architectures"* for the PhD-degree. Brodtkorb continues in a researcher position at SINTEF. Tor Dokken, Knut Mørken and Knut-Andreas Lie have been supervisors for Brodtkorb.
- November 29, 2010: **Marcin Krotkiewski** defended his thesis: *"Efficient Implementations of Numerical Models for Geological Applications on Modern Computer Architectures"* for the PhD-degree. Krotkiewski mainly worked at a sister centre of the CMA: "Physics for Geological Processes". Knut Mørken and Knut Andreas Lie have been CMA-appointed supervisors.
- October 22, 2010: **Ujjwal Koley** defended his thesis: *"On hyperbolic evolution equations: Theory and numerics"* for the PhD-degree. Professor Nils Henrik Risebro was main supervisor.
- July 12, 2010: **Øystein Rudjord** defended his thesis: *"Non-Gaussianity in the CMB: Directional analysis and application of needlets"* for the PhD-degree. His main supervisor has been Professor Frode Hansen, and Rudjord now works in a researcher position at "Norsk Regnesentral".
- June 15, 2010: **Nicolaas Ervik Groeneboom** defended his thesis: *"Searching for anomalies in the Cosmic Microwave Background"* for the PhD-degree. Supervisors were associate Professor Hans Kristian Eriksen and Professor Frode K. Hansen. Groeneboom has entered a postdoc position at The Institute of Theoretical Astrophysics, University of Oslo.

- February 5, 2010: **Elise Bergli** defended her thesis: *"Parquet theory in nuclear structure calculations"* for the PhD-degree. Her supervisor has been Professor Morten Hjorth-Jensen, and Bergli has continued in a researcher position at the Dept of Physics, University of Oslo.
- January 10, 2010: **Trygve K. Karper** defended his thesis: *"Convergent finite element approximations and analysis of some viscous compressible flow models"* for the PhD-degree. Main supervisor was Professor Kenneth Karlsen. Karper entered a researcher position at NTNU, Trondheim.

All together 46 doctoral candidates have so far successfully completed their PhDs at CMA. In 2011, we expect that we will have 7-8 new PhD defences at CMA, of which a few are already scheduled.

Three postdoctoral fellows completed (contracts of 2 years duration or more) their CMA-engagement in 2010:

- November 30, 2010: **Håkon Dahle** finished a 2,5-year postdoctoral contract at ITA, and as associated CMA member in the same period.
- October 31, 2010: **Simona Donzelli** finished a 2-year postdoctoral contract at ITA, and as associated CMA member in the same period. Donzelli is now engaged in a postdoc position at University of Milano.
- September 30, 2010: **Solve Selstø** finished a 2-year contract with CMA. He accepted a permanent researcher position the University College of Oslo.

All together 31 postdoctoral fellows have so far completed 2-, 3-, or 4-year contracts with the CMA.

Basic education

CMA is devoted to researcher education, and is not supposed to take major responsibilities at bachelor or master level. Nevertheless, an entire period of study must consist of coherent parts. We are deeply interested in candidates / applicants to our PhD positions with a solid and adequate background with respect to our needs (and our conviction on how modern mathematics should be taught). This is partly why CMA has chosen to let the senior scientists continue to teach at all levels, and not restrict ourselves to do PhD supervision and advanced level teaching. Also our research plan signalizes this attitude. Based on the same philosophy, CMA has chosen to enter the responsibility for the "Computers in Science Education (CSE)" project, see below.

Moreover, rather than establishing separate master programs, CMA wants to influence on the existing programs by our ordinary and frequent teaching duties. This strategy is based on a confidence that the existing programs suit, and will continue to do so, our research profile. However, when important trends and developments in research are verified, this should in time influence undergraduate and graduate teaching as well. The role of mathematics in life sciences, and its focus in our research, now qualifies for such steps to be made, and CMA has taken a leadership role in pursuing these efforts at UiO. A natural initial step has been to establish a brand new bachelor topic covering intersections between mathematics and biology (MAT-BIO 2100) - "Mathematical biology", which is taught for the first time in the spring semester of 2011.

Computers in Science Education

The CSE project was initiated in 2004 by staff from the CMA together with colleagues from the Departments of Informatics, Mathematics and Physics. The aim is to renew the teaching of mathematics and science by including a unified computational

perspective in the elementary courses. The project has had direct support in the strategic plan of the Faculty for Mathematics and Natural Sciences for the period 2005-2009, and the support from the Faculty continues for the foreseeable future.

The CSE-project is well established within the mathematically oriented subjects, and teaching materials for the relevant courses are continuously developed and renewed. There is now considerable interest in extending the CSE-project to the other sciences (biology, chemistry and geosciences) as well. The Department of Geosciences established an elementary programming course for their students already in 2008, with assistance and support from the CSE-project, and this course may now be extended to include students from the two other departments as well.

In June, the Ministry of Education and Research asked the Faculty to establish and lead a national working group which should develop a guide as to why and how the CSE-project could be implemented at relevant Norwegian institutions of higher education. The working group is headed by Knut Mørken with assistance from Anders Malthe-Sørensen, with a total of nine members from industry and different universities and university colleges. The group met during the Autumn and the report will be available in the first quarter of 2011.

The CSE project continues to be governed by Morten Hjorth-Jensen (Department of Physics), Knut Mørken (Department of Informatics) and Øyvind Ryan from the CMA, Anders Malthe-Sørensen from the Department of Physics and the CoE Physics of Geological Processes, Hans Petter Langtangen from the Simula Research Lab and the CoE Center for Biomedical Computing (CBC), together with Dean of Education Annik Myhre and Coordinator of Education Hanne Sølna from the Faculty for Mathematics and Natural Sciences, with assistance from Helge Galdal at the CMA. In 2010, the project was supported financially by the Faculty, the Departments of Informatics and Mathematics, the CMA and the CBC.

Cooperation

Cooperation within the University of Oslo National cooperation

We continue to keep a strong and good relationship to our host, the Department of Mathematics at UiO. Daily cooperation runs smoothly and efficiently. All senior scientists (except the Centre Director) are still closely connected to their home department through teaching duties. This is a conscious strategy on the part of CMA: we want to continue the development (and renewal) of the ordinary teaching in our basic subjects. Moreover, CMA has taken a major responsibility in the internal project "Computers in Science Education", which is outlined under heading "Basic Education" above.

In 2010 CMA took a leadership role at the University of Oslo to develop a new research area in or around "Mathematics for Life Sciences". During the last decades an enormous progression within Life Sciences (Biology, medicine...) has taken place. Among the many challenges that are being created through this development is effective use of quantitative models. Researchers at the CMA therefore took an initiative to establish the new bachelor topic covering intersections between mathematics and biology – see section "Basic education". We have also submitted project proposals to the RCN on these topics. In fact, these topics are central to our research strategy, and therefore we plan to engage in new research proposals in this direction, joint with other research groups from the life sciences at UiO. We also arranged a workshop at CMA on these topics in January 2010, see details under "Main events".

Active Partner, SINTEF

SINTEF is CMA's only active partner (i.e. contracted as a formal Centre of Excellence partner). Chief scientist Tor Dokken and senior scientist Knut-Andreas Lie both hold adjunct positions at CMA. In 2010, SINTEF hired a new postdoc fellow, Jon M. Hjelmervik, who is included in the collaborations. In the EU FP7 Initial Training Network "SAGA", CMA hired a postdoc fellow (Elisa Postinghel), bringing the project to full scale operations. Key parts of their work in 2010 are presented in the Scientific Activity Report. We also co-arranged two major SAGA schools, winter and fall (see appendix 5).

Other ongoing collaborative projects are "Parallel 3D", "Heterogen computing", "Isogeometry", and "Hospital", all listed in appendix 4 (and more extensively presented in earlier reports). Towards the end of 2010 SINTEF also succeeded on a new KMB-proposal (acronym "CloudViz") with The Research Council of Norway, which also will be included in the CMA-cooperation. We expect to hire on PhD-student in this project.

From CMA's point of view, we continue to regard the cooperation with SINTEF as very constructive and fruitful. Most important, the cooperation brings really mutual benefits to the two partners.

We intend to serve as a national resource centre in mathematics and its applications, and we seek to establish national collaborations. The relation to SINTEF, outlined above, is part of this strategy. So is the hiring of top researchers from other Norwegian research institutions, see previous reports. In 2010 we highlight the following achievements:

- We continue our collaboration with the University of Agder on stochastic modelling of electricity markets, a rapidly expanding research area where CMA has taken a leader role. One postdoc and on PhD-fellow are working with Prof. Fred Espen Benth (CMA) and Prof. Steen Koekebakker (Agder) on this. Together Profs Benth and Koekebakker also achieved success with an eVITA-proposal to the RCN on these issues. The "EMMOS" (Electricity markets: modelling, optimization and simulation) project will run for 4 years and includes 2 post doc positions and one PhD.
- CMA's PDE group took the responsibility for the 2010 Abel symposium (See "Selected highlights"), a highly international event, but also bringing together all the central Norwegian researchers in this area

International collaboration

CMA has a large network of international collaborators. First, 42 of CMA's 97 members in 2010 were non-Norwegians, representing 22 different countries. We always receive many international applicants when announcing positions. Moreover, in 2010 we received 139 international guests from 21 different countries (all listed in appendix 6).

All our internally arranged conferences/workshops had international participation (Appendix 5a). CMA-members have been (co)organiser of 37 international conferences in addition to those at CMA (Appendix 5c). Among the 149 refereed articles (128), books (6) and book chapters (15), 99 were written together with international partners (Appendix 7a-c). Out of 218 scientific and popular talks outside CMA (Appendix 8a-c), 183 were given abroad (in 34 different countries, on all continents). Appendix 4 provides a full list of all projects at CMA, many of them with extensive international collaboration, and also some of them coordinated by CMA / CMA-members.

All these works and items point to extensive research collaboration all over the world, showing our international participation and visibility. Most of the daily work is based on contacts established from researcher to researcher, and are not established as formal cooperative agreements. However, as a Centre of Excellence, we also aim at establishing formal agreements with clear mutual obligations. Several examples are listed in previous reports. A full list of current international projects is presented in Appendix 4. We will highlight the following from 2010:

- CMA has entered the role as Norwegian contact point for "The Abel Extraordinary Chair", a project established to promote the temporary incorporation of high level researchers from Spain, into research centres in Norway, Iceland and Liechtenstein, and from these countries into Spanish research institutions. During their stay researchers will collaborate with the local research groups in topics pertaining to the experimental sciences, especially but not only, mathematics and related disciplines, and to any discipline using mathematics. In the 3rd call for this project, launched in 2010, 46 proposals were granted, among these 4 incoming researchers to CMA from Spanish institutions.
- CMA, through its stochastic analysis group, continues to chair the "Southern African Masters Program in Mathematical Modelling", based in Dar es Salaam, Tanzania, and sponsored by "The Norwegian Centre for International Cooperation in Higher Education (SIU)", Norway. This is a 5 year (2007-11) program with a total budget of appr. €1,2M. The purpose of the program is to establish a center for Masters degree studies in mathematics, available for students from the whole Southern African region.
- Through the formalized cooperation with the University of Botswana, we arranged the SAMSA (Southern African Mathematical Sciences Association) 2010 workshop (number 10) in Gaborone, Botswana in late November 2010.
- We continue our collaboration with Oak Ridge National Lab (ORNL) in Tennessee, USA, described in earlier reports. Through

"The Norwegian Centre for International Cooperation in Higher Education (SIU)" we continue the four-year (2008-2011) exchange program for students and researchers, granted with approx. MNOK 1,8 in total.

- In the EU FP7 SAGA network, we hired a postdoc fellow in 2010, Mrs. Elisa Postinghel from Italy. See also the SINTEF section for more about SAGA.
- Bernt Øksendal's ERC Advanced Grant (started Sep 2009) gained considerable momentum in 2010, and contributes to extensive international cooperation with partners around the world. Among other things, the project includes a visiting professor program that brought many international researchers to the CMA in 2010 (and will continue to do in the years to come).
- Through the RCN's DAAP-program, members of CMA's PDE group were granted some exchange funds for cooperation with German colleagues during 2009-10.
- CMA's postdoc fellow Simen Kvaal has established a close collaboration with many European colleagues. From October 2010 – March 2011 he agreed to enter a temporary position in Tübingen, Germany, to further strengthen these efforts.
- One new PhD-fellow (Imran Taib) came to the stochastic analysis group at the CMA with a grant from the Malaysian government. He intends to complete a full 3-year PhD education with us.

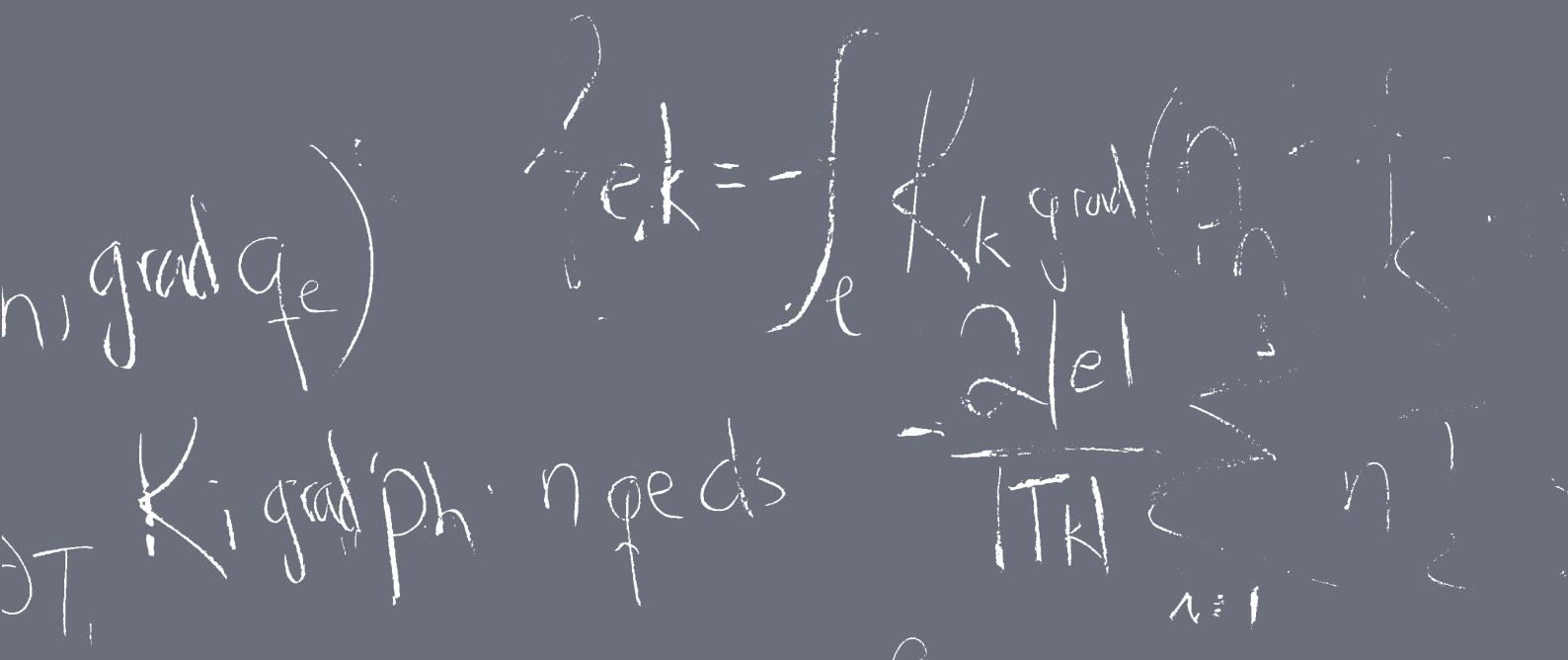
Health, environment and safety

CMA does not cause increased contamination of any nature. No work-related accidents or sick leaves were recorded in 2010.

Public outreach

In 2010, the following items were aimed at a general audience:

- We have registered 25 media appearances, see appendix 9.
- Appendix 8c contains a list of 19 talks presented for a general audience.
- We continued our sponsorship for www.matematikk.org, see description in former reports.



of m a $\left(\underbrace{L(1)}_1, \underbrace{L(0)}_0 \right) \equiv L(0)$

$$b_t(Z) \frac{B_t}{b_t} \sqrt{\ln(X - X_n)} \rightarrow d = \frac{U''(e)}{U'(e)}$$

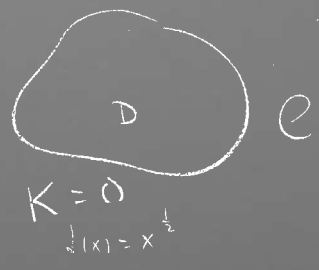
$$\exp\left(\int_0^t \sigma_n^2 dB\right) \int dW \rightarrow \ominus$$

$$\varphi(x) = E^x \left[\int_0^{\tau} f(x_t) dt + g(x_{\tau}) \right]$$

$f_n \rightarrow K_n$

$$A\varphi + f = 0 \text{ in } D$$

$$\varphi = g \text{ on } \partial D$$



$$\|f_n\|$$

Appendix 1 CMA-members, positions and affiliations

The following tables give a total overview of all CMA-members in 2010 and confirmed new names in 2011. More positions will be filled, but if names are not known, these are not included in the lists. Any further speculations or not-yet-confirmed project fellows are also neglected (according to our budget philosophy we do not calculate any new contributions). Any such contributions provided from now on, will appear in the 2011 annual report. The information provides the foundations for the accounts and budget disposals in this report, and also for the statistics on the personnel.

Name	Sex	Nationality	Position	Period	CMA share	Funding (see budget)
Fred Espen Benth	M	Norway	Professor	Mar03-Feb13	75%	Host
Francesca Biagini	F	Italy	Researcher II	Aug10-Jul13	10%	Assoc. project
Mats Carlsson	M	Sweden	Professor	Mar03-Feb13	40%	Host
Snorre Christiansen	M	Norway	Professor	Jan06-Dec10	100%	Assoc. project
				Jan11-Feb13	100%	CMA
Geir Dahl	M	Norway	Professor	Mar03-Feb13	75%	Host
David Dean	M	USA	Researcher II	Jan04-Feb11	10%	CMA
Giulia Di Nunno	F	Italy	Assoc. Prof.	Mar03-Feb13	75%	Host
Tor Dokken	M	Norway	Chief scient.	Mar03-Dec12	20%	SINTEF
			Researcher II	May03-Dec12	20%	CMA
Geir Ellingsrud	M	Norway	Professor	Aug09-Feb13	75%	Host
Hans Kristian Eriksen	M	Norway	Assoc. Prof.	Jul09-Feb13	40%	Host
Michael Floater	M	England	Professor	Nov03-Feb13	75%	Host
Jörg Frauendiener	M	Germany	Researcher II	Feb08-Dec10	10%	CMA
Boris Gudiksen	M	Denmark	Assoc. Prof	Jan08-Feb13	40%	Host
Frode K. Hansen	M	Norway	Professor	Jan08-Feb13	40%	Host
Viggo Hansteen	M	Norway	Professor	Mar03-Feb13	40%	Host
Morten Hjorth-Jensen	M	Norway	Professor	Mar03-Feb13	40%	Host
Helge Holden	M	Norway	Researcher II	May03-Dec12	20%	CMA
Yaozhong Hu	M	China	Researcher II	Jul05-Jun11	10%	CMA
Kenneth Karlsen	M	Norway	Professor	Jul04-Feb13	100%	Host
Rudiger Kiesel	M	Germany	Researcher II	Mar08-Dec12	20%	CMA
Knut-Andreas Lie	M	Norway	Sr. scientist	Sep05-Feb11	20%	SINTEF
			Researcher II		20%	CMA
Per Barth Lilje	M	Norway	Professor	Mar03-Feb13	40%	Host
Tom Lindstrøm	M	Norway	Professor	Mar03-Feb13	75%	Host
Tom Lyche	M	Norway	Professor	Mar03-Feb13	75%	Host
Carlo Mannino	M	Italy	Researcher II	Sep09-Feb13	20%	Host
Siddhartha Mishra	M	India	Professor	Aug11-Feb13	100%	CMA
Knut Mørken	M	Norway	Professor	Mar03-Feb13	75%	Host
Ragni Piene	F	Norway	Professor	Mar03-Feb13	75%	Host
Ewald Quak	M	Germany	Researcher II	Aug03-Jun12	20%	CMA
Xavier Raynaud	M	France	Assoc Prof	Sep09-Aug11	100%	CMA
Martin Reimers	M	Norway	Assoc Prof	Oct08-Feb13	75%	Host
Nils Henrik Risebro	M	Norway	Professor	Sep04-Feb13	75%	Host
Eigil Samset	M	Norway	Researcher II	Jan06-Feb13	20%	Host
Xue-Cheng Tai	M	China	Researcher II	Jun08-May11	10%	CMA
Ragnar Winther	M	Norway	CMA-director	Mar03-Feb13	100%	CMA
Tusheng Zhang	M	China	Researcher II	Aug04-Aug10	20%	CMA
			Professor	Sep10-Dec10	100%	Assoc. project
Bernt Øksendal	M	Norway	Professor	Mar03-Feb13	75%	Host
Knut Aase	M	Norway	Researcher II	Jan04-Feb11	20%	CMA
				Mar11-Dec12	10%	CMA

PhD-students

Name	Sex	Nationality	Period	CMA-share	Funding (see budget)
Patrick Antolin	M	Colombia/France	Oct08-Sep11	40%	Assoc. project
Egil Bae	M	Norway	Nov07-Oct10	100%	Assoc. project
Oliver Barrowclough	M	England	Oct09-Sep12	100%	SINTEF
Sverre Briseid	M	Norway	Jan08-Dec11	100%	SINTEF
André Brodtkorb	M	Norway	May07-Apr 10	100%	SINTEF
Solveig Bruvoll	F	Norway	Sep06-Aug11	100%	Host
Gustav Bårdsen	M	Norway	Aug09-Jul12	100%	CMA
Heidi Dahl	F	Norway	Aug09-Jul12	100%	SINTEF
Marcus Eriksson	M	Sweden	Oct10-Sep14	100%	Host
Heidar Eyjolfsson	M	Iceland	Sep10-Aug13	100%	CMA
Unni Fuskeland	F	Norway	Jan11-Des13	40%	Assoc. project
Leandro Gomez de Jesus	M	Portugal	Jun07-Apr10	40%	Assoc. project
Nicolas Groenebom	M	Norway	Jan08-Dec10	40%	Assoc. project
Sven Haadem	M	Norway	Aug09-Jul12	100%	Host
Gustav Ragnar Jansen	M	Norway	Aug08-Nov11	100%	CMA
Asma Khedher	F	Tunisia	Aug08-Jul11	100%	CMA
Ujjwal Koley	M	India	Oct07-Oct10	100%	CMA
Marcin Krotkiewski	M	Poland	Jan08-Dec10	50%	Host
Eivind Lyche Melvær	M	Norway	Jun07-May10	100%	Assoc. project
Torgunn Karoline Moe	F	Norway	Aug08-Jul12	100%	Host
Torstein Nilssen	M	Norway	Jan10-Dec13	100%	Host
Sigurd Næss	M	Norway	Aug08-Jul12	40%	Host
Kosovare Olluri	F	Norway	Oct08-Sep12	40%	Host
Nicolai Qviller	M	Norway	Aug09-Jul12	100%	CMA
Atle Riise	M	Norway	Jan08-Des11	100%	SINTEF
Peter Dimitris Rippis	M	Norway	Sep06-Jan10	100%	CMA
Petter Risholm	M	Norway	Mai07-Apr10	100%	Assoc. project
Mark Rubzov	M	Ukraina	Sep07-Aug10	100%	CMA
Øystein Rudjord	M	Norway	Aug06-Jul10	40%	Host
Maren Schmeck	F	Germany	Aug09-Jul12	100%	CMA
Dag Sverre Seljebotn	M	Norway	Jan11-Des13	40%	Assoc. project
Bartlomiej Siwek	M	Poland	Jan10-Feb13	100%	Host
Steffen Sjursen	M	Norway	Jan10-Dec12	100%	Assoc. project
Martin Lilleeng Sætra	M	Norway	Mar09-May12	75%	SINTEF
			Mar09-Feb13	25%	Assoc. project
Imran Taib	M	Malaysia	Oct10-Sep13	100%	Assoc. project
Nelly Yazmin Villamizar	F	Colombia	Sep09-Aug12	100%	Assoc. Project
Linda Vos	F	Netherlands	Aug08-Jul 10	100%	Assoc. Project
			Aug10-Jul11	100%	CMA
Agnieszka Wasylewicz	F	Poland	Aug08-Jul12	100%	Host

Postdocs

Name	Sex	Nationality	Period	CMA-share	Funding (see budget)
Iain Alastair Brown	M	UK	Jan10-Dec12	40%	Assoc. project
Håkon Dahle	M	Norway	Feb 08-Nov10	40%	Assoc. project
Simona Donzelli	F	Italy	Nov08-Oct10	40%	Assoc. project
Franz Fuchs	M	Germany	Oct09-Sep11	100%	CMA
Tore G. Halvorsen	M	Norway	Dec09-Jan10	100%	Assoc. project
Jon Hjelmervik	M	Norway	Jan10-Apr12	50%	SINTEF
				50%	Assoc. project
Øyvind Jensen	M	Norway	Dec10-Jun11	100%	CMA
Runhild Aae Klausen	F	Norway	Jan07-Nov11	100%	Assoc. project
Jostein Riiser Kristiansen	M	Norway	Nov10-Oct12	40%	Assoc. project
Simen Kvaal	M	Norway	Dec08-Sep10	100%	CMA
			Oct10-Mar11	100%	Assoc. project
			Apr11-May12	100%	CMA
Jukka Lempa	M	Finland	Feb09-Jan11	100%	CMA
			Feb11-Jan13	100%	Assoc. project
Ilia Musco	M	Italy	Jan09-Dec10	100%	Assoc. Project
			Jan11-Jun11	100%	CMA
Trygve Kastberg Nilssen	M	Norway	May09-Apr11	100%	Assoc. Project
Olivier Menoukeu Pamen	M	South Africa	Nov09-Dec11	100%	Assoc. project
Elisa Postinghel	F	Italy	Oct10-Sep11	100%	Assoc. project
Solve Selstø	M	Norway	Dec08-Sep10	100%	CMA
Jussi Väliviita	M	Finland	Sep09-Sep12	40%	Assoc. project
Sven Wedemeyer-Böhm	M	Germany	Oct07-Sep11	40%	Assoc. project

Other

Name	Sex	Nationality	Position	Period	CMA share	Funding (see budget)
Helge Galdal	M	Norway	Senior adviser	Mar03-Feb13	100%	CMA
Lucy Karpen	F	USA	Computer eng.	Feb07-Apr12	70%	CMA
Aslaug K Lyngra	F	Norway	Adm. officer	May09-Apr12	100%	Host
Andrew McMurry	M	Ireland	Scientific prog	Oct03-Feb13	100%	Host
Øyvind Ryan	M	Norway	Proj researcher	Jul07-Dec11	100%	CMA
An Ta Thi Kieu	F	Vietnam	Proj researcher	Jan10-Feb13	100%	Assoc. proj.

Handwritten notes and diagrams:

- Arrows pointing from left to right.
- Equation: $\frac{25''(c)}{25''(c)}$
- Text: "dw", "K", "Kv", "dB", "x", "(7-1)", "25", "25"

Appendix 2

Details on accounts and budget

ACCOUNTED ACTIVITY

Main project and basis	Note	Budget 2010	Acc. 2010	Budget 2011
Revenues				
Own share alloc, overhead	1	0	-2,178,496	1,676,619
Proj. indir. costs & terminations	2	-2,000,000	-734,461	-1,896,678
RCN CoE-funding	3	-12,000,000	-8,000,000	-15,000,000
Univ. Oslo funding	4	-3,591,000	-3,541,000	-2,951,000
Sintef funding	5	-1,000,000	-826,333	-1,114,000
RCN other funding		0	0	0
Other public funding	6	0	0	-400,000
International funding	7	0	-16,000	0
Private funding	8	0	0	0
NAV Reimbursements	9	0	0	0
Total revenues		-18,591,000	-15,296,290	-19,685,059
Expenditures				
Salary costs	10	13,830,000	13,126,692	13,500,000
Indirect costs	11	2,400,000	2,255,806	2,000,000
Teaching services	12	100,000	36,423	0
Equipment	13	300,000	76,793	150,000
Guests, traveling, conferences	14	1,560,000	1,779,293	1,400,000
Public outreach	15	250,000	212,830	200,000
Various operational costs	16	240,000	176,517	200,000
Total expenditures		18,680,000	17,664,354	17,450,000
Annual result		89,000	2,368,064	-2,235,059
Accumulated as of Jan 1		-88,443	-88,443	2,279,621
Accumulated as of Dec 31		557	2,279,621	44,562

Other projects summarized	Note	Budget 2010	Acc. 2010	Budget 2011
Revenues RCN	17	-3,595,334	-2,396,888	-2,484,333
Revenues EU	18	-390,000	-263,874	-6,165,145
Other Public funding	19	-2,150,000	-3,280,648	-1,898,000
Total revenues		-6,135,334	-5,941,410	-10,547,478
Salary	20	4,656,000	4,476,166	4,108,448
Own share alloc, overhead	1		375,926	9,120
Proj. indir. costs & terminations	2	1,377,834	734,461	1,896,678
Equipment		0	0	0
Various operational costs	16	3,380,000	4,622,407	2,170,000
Total expenditures		9,413,834	10,208,960	8,184,246
Annual result		3,278,500	4,267,550	-2,363,232
Accumulated as of Jan 1		-7,884,720	-7,884,720	-3,617,170
Accumulated as of Dec 31		-4,606,220	-3,617,170	-5,980,402

Total activity, accounted	Note	Budget 2010	Acc. 2010	Budget 2011
Revenues		-24,726,334	-21,237,700	-30,232,537
Expenditures		28,093,834	27,873,314	25,634,246
Annual result		3,367,500	6,635,614	-4,598,291
Accumulated as of Jan 1		-7,973,163	-7,973,163	-1,337,549
Accumulated as of Dec 31		-4,605,663	-1,337,549	-5,935,840

NON-ACCOUNTED ACTIVITY

	Note	Budget 2010	Acc. 2010	Budget 2011
Revenues				
Univ. Oslo funding	21	-17,128,840	-17,882,000	-18,989,000
RCN funding	22	-2,013,967	-2,601,000	-1,832,000
Sintef funding	23	-5,658,000	-5,460,000	-5,621,000
Other public funding	24	-1,512,500	-1,513,000	-496,000
EU funding	25	-567,500	-410,000	-681,000
Other international funding	26	-2,120,000	-2,739,000	-3,277,000
Private funding	27	0	0	0
Total revenues		-29,000,807	-30,605,000	-30,896,000
Expenditures				
Salary	28	22,396,807	22,998,000	23,797,000
Indirect costs	11	3,734,500	3,930,000	3,990,000
Various operational costs	16	1,783,500	2,691,000	2,311,000
Equipment	13	1,086,000	986,000	798,000
Total expenditures		29,000,807	30,605,000	30,896,000
Annual result		0	0	0
Accumulated as of Jan 1		0	0	0
Accumulated as of Dec 31		0	0	0

TOTAL ACTIVITY, ACCOUNTED AND NON-ACCOUNTED

Total activity	Note, app 3	Budget 2010	Acc. 2010	Budget 2011
Revenues				
Own projects, OH+terminations	1,2	-2,000,000	-2,912,957	-220,059
RCN funding	3,17,22	-17,609,301	-12,997,888	-19,316,333
Univ. Oslo funding	4,21	-20,719,840	-21,423,000	-21,940,000
Sintef funding	5,23	-6,658,000	-6,286,333	-6,735,000
Other public funding	6,19,24	-3,662,500	-4,793,648	-2,794,000
International funding	7,18,25,26	-3,077,500	-3,428,874	-10,123,145
Private funding	8,27	0	0	0
NAV Reimbursements	9	0	0	0
Total revenues		-53,727,141	-51,842,700	-61,128,537
Expenditures				
Salary costs	10,20,28	40,882,807	40,600,858	41,405,448
Indirect costs	11	7,512,334	7,296,193	7,895,798
Teaching services	12	100,000	36,423	0
Equipment	13	1,386,000	1,062,793	948,000
Guests, traveling, conferences	14	1,560,000	1,779,293	1,400,000
Public outreach	15	250,000	212,830	200,000
Various operational costs	16	5,403,500	7,489,924	4,681,000
Total expenditures		57,094,641	58,478,314	56,530,246
Annual result		3,367,500	6,635,614	-4,598,291
Accumulated as of Jan 1		-7,973,163	-7,973,163	-1,337,549
Accumulated as of Dec 31		-4,605,663	-1,337,549	-5,935,840

Appendix 3

Notes on accounting 2010 and budget figures 2011

- Own share allocations and internal overhead estimations.**

Our host runs an accounting system that seeks to include all costs related to all projects. This means that every project is charged for workload contributed by University staff. Moreover every staff member is bought free from their host to contribute to the projects. Finally the various projects contribute overhead rates to the project owner/responsible which is the CMA. In total – over time – this is a zero-sum game. However during the course the system creates unbalanced accountings, both in the involved host departments (of which CMA has four different), in the core CMA-figures, and in the project portfolio.

 - **2010 (x1000):** The core CMA had a surplus of **2.178K** while the project portfolio had a deficit of **376K**. However, by a mistake, our host forgot to charge approx 1.727K which then will be part of the 2011-figures
 - **2011 (x1000):** Estimated sum of these allocations will then be a deficit of **1677K**
- Project termination and indirect costs for EU-projects.**

When subprojects of CMA are closed down, the corresponding surpluses/deficits are transferred to basis. In 2010 we terminated 3 projects with a surplus of **205K**. Ordinary overhead income from the two EU-projects of ours brought a surplus of **529K**. In 2011 we expect the corresponding income figures to be **1.273K** (from three terminated projects) and **624K** in overheads from the EU-projects.
- RCN CoE-funding.** The 2010 contribution from the RCN was scheduled at MNOK 12. However, due to the system described in 1) the RCN read our accounting figures wrong. With only partial information available they believed we headed towards a multi-million surplus and they therefor held back 4 millions. These misunderstandings are cleared, and 2011 is budgeted with these 4 plus the original 11 = 15 million kroner.
- Univ. Oslo funding**
 - **2010 (xNOK 1000):** UiO board, free: 2000, 1 Professorship: 756, 1 PhD-position: -215 (received too much earlier), 1 PhD-position: 800, Project CSE: 200 Total: 3541
 - **2011 (xNOK 1000):** UiO board, free: 2000, 1 Professorship: 751, Project CSE: 200. Total: 2951
- Contributions from SINTEF.**
 - **2010 (xNOK 1000):** One PhD student (75% rate), from the "Parallel 3D" project (M. Sætra), full year: 510. One postdoc 50% from the "Isogeometry" project (J Hjelmervik), 8 months: 266. "Hospital" project is funding various operational costs at CMA: 50. Total: 826.
 - **2011 (xNOK 1000):** One PhD student (75% rate), from the "Parallel 3D" project (M. Sætra), full year: 638. One postdoc 50% from the "Isogeometry" project (J. Hjelmervik), full year: 426, "HOSPITAL": 50. Total: 1114.
- Other public funding.** No income planned or registered in 2010. In 2011 we are allowed to charge Centre for Advanced Studies with 116K, and the Norwegian Mathematical Union with 290K, both for expenses covered by the CMA for the 2010 Abel-syposium.
- International funding.** An international long term visitor (K. Piaskowska) brought a specific host contribution from her Polish grant. We do not expect international revenues in 2011.
- Private funding.** No revenues in 2010, nothing expected in 2011.
- NAV reimbursements.** Public reimbursements due to maternity and sick leaves – no such in 2010, no planned in 2011.
- Salary costs. CoE project and basis activity**
 - **2010 (x1000):** PhDs: 4468, Postdocs: 3207, Researchers: 3850, Adm/Tech: 1602. Total: 13127.
 - **2011 (x1000):** PhDs: 3600, Postdocs: 3650, Researchers: 4600, Adm/Tech: 1650. Total: 13500.
- Indirect costs, per individual.** This item covers offices and infrastructure provided for each individual. The rates for 2010 were 117.000 / 94.000 pr man-year for Phds and postdocs / other. For 2011 these rates are 120.000 / 97.000. We explicitly pay, using these rates, our host for all CMA employees. Indirect costs for UiO funded personell, SINTEF personell and affiliates are represented with the same rates.
- Teaching services.** CMA members are not exempted from teaching. On the contrary, we regard it as important that we keep up with the teaching duties of the scientific community. However, in order to relieve us the most time consuming parts of teaching, we have this specific budget item.
- Equipment.** CMA itself mostly obtains computers and additional accessories (accounted figures at 77K for 2010). The centre members also make use of existing equipment. In the original contracted budget we estimated this to a 2010 amount of KNOK 586 (2011: 598) (Non-accounted). The activity goes on as expected, and we see no reasons to adjust this contribution to the figures. Finally we continue to present an annual (non-accounted) rate of (2010: 400K, 2011: 200K) from large projects of the astrophysicists.
- Guests, Travelling, Conferences.** Appendix 6 and 8 present the results of this extensive bilateral activity. Appendix 5 contains a full list of 2010 conference / workshop events. These items reflect important features of the CMA identity.
- Public outreach.** This item covers publicity efforts, posters, design elements for web and brochures, reports (like this) etc. We also give priority towards society in general, and children specifically. The support of www.matematikk.org is part of this strategy.
- Various operational costs.** This item is meant for the daily needs and actions that are not covered by any other specific item. Operational means for PhDs and postdocs are included. So are all contributions to the internal project "Computers in Science Education".
- RCN projects**
 - **2010 (xNOK 1000):** EURYI project Christiansen: 1267, eVITA-project "MATMED": 1130. Total: 2397
 - **2011 (xNOK 1000):** EURYI project Christiansen: 633, eVITA-project "MATMED": 565. DAADppp-project Norway-Germany: 90, NEW eVITA-project "EMMOS": 1196. Total: 2484
- EU contributions**
 - **2010 (xNOK 1000):** FP7 ERC Advanced Grant "INNOSTOCH": 0, FP7 Marie Curie ITN "SAGA": 0, FP6 Marie Curie TOK "CENS-CMA": 170, ESF-project AMaMeF: 93. Total: 263
 - **2011 (xNOK 1000):** FP7 ERC Advanced Grant "INNOSTOCH": 5318, FP7 Marie Curie ITN "SAGA": 847. Total: 6165

19. **Other public funding**
 - **2010** (xNOK 1000): SIU "North-America cooperation": 500, SIU "NOMA South Africa": 2781. Total: 3281
 - **2011** (xNOK 1000): SIU "North-America cooperation": 500, SIU "NOMA South Africa": 1398. Total: 1898
20. **Salary costs. Other projects**
 - **2010** (x1000): PhDs: 1551, Postdocs: 2063, Researchers: 862, Total: 4476.
 - **2011** (x1000): PhDs: 1698, Postdocs: 2354, Researchers: 56, Total: 4108.
21. **Univ. Oslo funding.** This item covers salary items of all senior researchers and fellows, additional areas and existing equipment provided by the host institution. And, also a major contribution to our CSE project is financially run by the Faculty of Mathematics and Natural sciences.
22. **RCN funding.** Projects funded by RCN, associated to CMA, accounted by the host
23. **Sintef funding.** Personell and projects associated to CMA, but accounted by Sintef
24. **Other public funding.** One PhD fellow and one postdoc at Univ. Of Agder. One PhD partly covered by "Norsk Meteorologisk institutt".
25. **EU funding.** Projects funded by EU, associated to CMA, accounted by the host
26. **International funding.** One PhD-fellow (I. Taib) started with a grant from the Malaysian government. Moreover, two CMA-fellows (Ø. Ryan and S. Kvaal) are funded by international institutions (Tübingen and Paris, respectively), three months each in both 2010 and 2011. The value of 4 (2010) and 3 (estimated 2011) person-years long-term international guests are also included in this item.
27. **Private funding.** No items in 2010, and no items estimated in 2011
28. **Salary costs.** Non-accounted persons
 - **2010** (x1000): PhDs: 8092, Postdocs: 2501, Researchers: 9794, Adm/Tech: 611, Guests: 2000. Total: 22998.
 - **2011** (x1000): PhDs: 8693, Postdocs: 2220, Researchers: 10186, Adm/Tech: 698, Guests: 2000. Total: 23797.

$$\bar{f}^m = f^0 + \bar{g}^0 + \bar{g}^1 + \dots + \frac{1 - \bar{g}^{m-1}}{c}$$

$$\frac{d}{dt} e^{ct} \bar{f}^m = e^{ct} \bar{f}^m = \sum_{p=0}^{m-1} (c^p - c^{p+1})$$

$$T \int_{V_h} \eta_e ds \quad V_h - \eta_e ds$$

Appendix 4

List of associated projects 2010

INDIVIDUAL				
Name	Source	Proj. #	Project leader	Period
PhD-student Martin Sætra	Meteorologisk institutt		Tor Dokken	2009 - 2013
PhD-student Linda Vos	University of Agder		Fred Espen Benth	2008 - 2010
PhD-student Imran Taib	Malaysian Gov.		Fred Espen Benth	2010 - 2013
Postdoc Trygve Kastberg Nilsen	University of Agder		Fred Espen Benth	2009 - 2011
Postdoc Runhild Aae Klausen	VISTA fellowship		Ragnar Winther	2007 - 2011
Postdoc Håkon Dahle	NFR individual grant		Per Lilje	2008 - 2010
Postdoc Sven Wedemeyer-Böhm	EU/EIF individual grant		Mats Carlsson	2007 - 2011
Postdoc Simen Kvaal	University of Tübingen		Simen Kvaal	2010 - 2011
Project fellow Øyvind Ryan	SUPELEC, Paris		Øyvind Ryan	2010 - 2011

COLLABORATIVE				
Title	Source	Proj. #	Project leader / Node	Period
Solar Atmospheric Modelling (SAM)	NFR / SUP	146467/420	Mats Carlsson	2006 - 2010
Utrecht-Stockholm-Oslo	EU FP6 / RTN		Mats Carlsson	2008 - 2010
Studying the early universe with non-gaussianities	NFR / YFF		Frode Hansen	2007 - 2012
Planck m.m.	NFR		Per Lilje	2006 - 2012
Numerical Analysis and Simulation of Geometric Wave Equations	ESF/NFR EURYI	173453/V00	Snorre Christiansen	2006 - 2010
Advanced Mathematical Methods in Finance (AMaMeF)	ESF/NFR Network	170415/V30	Bernt Øksendal	2005 - 2010
Mathematical and Computational Methods (MATMED)	NFR / eVITA	176892/V30	Eigil Samset	2006 - 2010
Winter schools in computational mathematics	NFR		Knut-Andreas Lie	2005 - 2012
Nordic Network of Astrophysics and Cosmology (NNAC)	NordForsk		Håkon Dahle	2008 - 2010
Shapes, Geometry, and Applications (SAGA)	EU FP7 / ITN	PITN-GA-2008-214584	Ragni Piene	2008 - 2012
Innovations in stochastic Analysis with emphasis on Stochastic control and Information (INNOSTOCH)	EU FP7 / ERC Adv Grant	ERC-2008-AdG-228087	Bernt Øksendal	2009 - 2014
Mathematics and its Applications in Southern Africa	SIU	2207/10057	Bernt Øksendal	2006 - 2012
North America Exchange Program	SIU	NNA-2008/10010	Morten Hjorth-Jensen	2008 - 2011
Norway - Germany exchange	NFR / DAADppp		Nils Henrik Risebro	2009 - 2010
The anisotropic universe – a reality or fluke?	EU FP7 / ERC Starting Grant		Hans Kristian Eriksen	2010 - 2015
Electricity markets: modelling, optimization and simulation (EMMOS)	NFR / eVITA	205328/V30	Fred Espen Benth	2011 - 2014

INTERNAL				
Title	Source	Proj. #	Project leader	Period
Computers in Science Education	University of Oslo		Knut Mørken, Morten Hjorth-Jensen	2004 - ...

THROUGH SINTEF PARTNERSHIP				
Title	Source	Proj. #	Project leader	Period
Parallel 3D	NFR / KMB	180023/S10	Tor Dokken	2007 - 2011
Heterogen Computing			Tor Dokken	2008 - 2010
Isogeometry	NFR / KMB	183183/S10	Tor Dokken	2007 - 2010
Health Planning (HOSPITAL)	NFR / KMB	182610/I40	Truls Flatberg	2007 - 2011
Shapes, Geometry and Applications (SAGA)	EU FP7 / ITN	PITN-GA-2008-214584	Tor Dokken	2008 - 2012

Appendix 5 List of CMA Events 2010

5a. Workshops and conferences arranged at/by CMA			Internat.	Nat.	CMA	Total
School	Topics in Nuclear Many-Body Theory, from Lattice QCD to Nuclei	Participants:	30	15	5	50
Jan 4-9	Org. by Morten Hjorth-Jensen	Talks:	25	0	0	25
Workshop	Mathematics and Life Science	Participants:	0	10	10	20
Jan 26	Org. By Ragnar Winther	Talks:	0	5	1	6
Workshop	Time Dependent Quantum Mechanics - Analysis and Numerics	Participants:	12	19	10	41
April 26-28	Org. By Sølve Selstø, Simen Kvaal, Snorre Christiansen	Talks:	10	1	3	14
Workshop	A CMA-CTCC Workshop on Computational Quantum Mechanics	Participants:	3	17	5	25
June 17-18	Org. By Morten Hjorth-Jensen and Trygve Helgaker	Talks:	4	6	3	13
Conference	The 2010 Abel Symposium: Nonlinear Partial Differential Equations	Participants:	37	28	10	75
Sep28 - Oct1	Org. By Helge Holden, Nils Henrik Risebro, and Kenneth Karlsen	Talks:	19	0	0	19

5b. Seminar and Lecture Series at CMA			Internat.	Nat.	CMA	Total
Spring+Fall	The CMA seminar series 2010	Talks:			14	14
Spring+Fall	The PDE seminar series 2010	Talks:	3	3	1	7
Spring+Fall	The Stochastic Analysis seminar 2010	Talks:	6	1	8	15
Spring+Fall	The CMA Guest Lectures 2010	Talks:	8	4		12
Spring+Fall	Geometry seminar series 2010	Talks:	4	2	3	9

5c. International workshops and conferences, (co-)organized by CMA		Place	CMA person
Feb 11-12	FOCUS K3D conference on Semantic Media and Content	Sophia-Antipolis, France	T. Dokken, E. Quak
Mar 15-19	SAGA Winter School	Auron, France	R. Piene
Mar 25-26	Industry Challenges in Geometric Modeling, CAD, and Simulation	Darmstadt, Germany	E. Quak
Apr 12-14	Stochastics, Control and Finance in honor of Professor Mark H.A. Davis	London, UK	G. Di Nunno
May 5-7	ComIMAGE 2010: Computational Modeling of Objects Presented in Images: Fundamentals, Methods and Applications	New York, USA	X-C. Tai
May 17-20	The International Conference on Imaging Theory and Applications (IMAGAPP)	Angers, France	X-C. Tai
May 20-21	Workshop on Nonlocal aspects in PDEs and Applications	Besançon, France	K. Karlsen
May31-Jun4	Joint SIAM/RSME-SCM-SEMA Meeting, Emerging Topics in Dynamical Systems and Partial Differential Equations - DSPDEs'10	Barcelona, Spain	K. Karlsen
Jun 5-8	International conference on singular perturbation theory and applications	Shanghai, China	X-C. Tai
Jun 8-10	China-Norway-Sweden Workshop on Computational Mathematics	Bergen, Norway	X-C. Tai
Jun 15-19	13th Int Conference on Hyperbolic problems, theory, numerics and applications (HYP2010)	Beijing, China	K. Karlsen
Jun 21-25	Summer School on Techniques in Radiative Transfer	Oslo, Norway	V. Hansteen
Jun 21-23	Conference Shape Modeling International 2010	Aix-en-Provence, France	E. Quak
Jun 23-26	CCP2010: Conference on Computational Physics	Trondheim, Norway	M. Hjorth-Jensen
Jun 24-30	Seventh International conference on Curves and Surfaces	Avignon, France	T. Lyche
Jul 4-9	Jaen Conference on Approximation Theory	Ubeda, Jaen, Spain	T. Lyche
Jul 4-9	INPC2010: International Nuclear Physics Conference 2010	Vancouver, Canada	M. Hjorth-Jensen
Aug 8-13	NS2010: Nuclear Structure 2010	Berkeley, CA, USA	M. Hjorth-Jensen
Aug 9-13	IMS 2010	Gothenburg, Sweden	F. E. Benth
Aug 25-27	Workshop on Unstructured Meshes in Dynamical Spacetimes	Jena, Germany	S. Christiansen
Sep 6	Kavli symposium on astrophysics	Oslo, Norway	M. Carlsson
Sep 6-10	Workshop on multivariate approximation and interpolation with applications	Edinburgh, UK	T. Lyche
Sep 13-16	Young scientists towards the challenges of modern technology	Warsaw, Poland	K. Piaskowska
Sep 20-22	MEPS 2010	Wroclaw, Poland	F. E. Benth
Sep 27-30	Workshop on Advanced Mathematical Methods for Finance	Berlin, Germany	G. Di Nunno, B. Øksendal
Sep28-Oct1	The Abel Symposium 2010: Nonlinear Partial Differential Equations	Oslo, Norway	H. Holden, N.H. Risebro, K. Karlsen
Oct 4-7	2nd EAST meeting, Science with Synoptic Solar Telescopes	Tatranska Lomnica, Slovakia	M. Carlsson
Oct 4-8	SAGA Fall School	Kolympari, Greece	T. Dokken, R. Piene, E. Quak, E. Samset
Oct 6-8	Energy Finance	Essen, Germany	R. Kiesel
Oct 11-15	Hinode-4: The 4th Hinode Science Meeting	Mondello, Italy	M. Carlsson
Oct 16-18	The 3rd International Congress on Image and Signal Processing (CISP'10)	Yantai, China	X-C. Tai
Oct 21-22	Autumn School 2010: Mathematical methods in risk management and finance	Munich, Germany	F. Biagini
Oct 29-31	KoMiN 2010 - Conference for students of mathematics in Norway	Oslo, Norway	T. K. Moe
Nov 8-13	Euromed 2010 Conference on Digital Heritage	Lemesos, Cyprus	E. Quak
Nov29-Dec4	SAMSA 2010	Gaborone, Botswana	G. Di Nunno, B. Øksendal
Dec 7-9	New Zealand Mathematical Society Colloquium	Dunedin, New Zealand	J. Frauendiener
Dec 13-14	LMUexcellent Symposium 2010: Workshop on risk measures and attitudes	Munich, Germany	F. Biagini

Appendix 6

International guests of CMA 2010

Longer research visits (> 1 month)

- Sep 9 - Dec 15: Prof. **José Manuel Corcuera**, University of Barcelona, Spain
- Aug 23 - Sep 26: Dr. **Juan Gerardo Alcázar Arribas**, University of Alcalá, Spain
- Jul 1 - Mar 31, 2011: PhD-student **María-Cruz Fernández-Fernández**, University of Sevilla, Spain
- Jun 5 - Jul 5: Professor **Piergiulio Tempesta**, Universidad Complutense Madrid, Spain
- Jun 1 - Aug 1: Dr. **Imran Habib Biswas**, TIFR Centre Bangalore, India
- May 19, 2010 - Jul 31, 2011: Dr. **Chica Kawada**, University of Hyogo, Japan
- January 1 - December 31: Dr. **Paul Carlisle Kettler**, Chicago, USA
- Aug 1, 2009 - Feb 28, 2011: PhD student **Katarzyna Piaskowska**, Warsaw University of Technology, Poland
- July 1, 2009 - Apr 30, 2010: PhD-student **Dante Kalise**, University of Bergen, Norway

Short term guests (<1 month)

- Dec 27-30: Professor **Luigi Coraggio**, University of Naples, Italy
- Dec 6-10: PhD-student **Stephan Ebbeler**, University of Ulm, Germany
- Dec 4-9: PhD-student **Katrin Jensen**, University of Ulm, Germany
- Dec 3-17: Dr. **Rodwell Kufakunesu**, University of Zimbabwe
- Nov 30 - Dec 26: Dr. **Gaute Hagen**, Oak Ridge National Laboratory, USA
- Nov 22-26: Dr. **David Cohen**, University of Basel, Switzerland
- Nov 7-15: Dr. **Pekka Matomäki**, Turku School of Economics, Finland
- Oct 29 - Nov 2: Professor **Kai Hormann**, Lugano, Switzerland
- Oct 26-31: Professor **Alexander Guterman**, Moscow State University, Russia
- Oct 20-24: Dr. **Magnus Svärd**, University of Edinburgh, Scotland
- Oct 17-30: Dr. **Francisco J. Cao Garcia**, Universidad Complutense Madrid, Spain
- Oct 9-16: Prof. **Elaine Cohen**, University of Utah, USA
- Sep 24-29: Professor **Stefano De Marchi**, University of Padova, Italy
- Sep 22-24: Prof. **Takaharu Yaguchi**, University of Tokyo, Japan
- Sep 19-30: Prof. **Raquel Mallavibarrena**, Universidad Complutense, Madrid, Spain
- Aug 24-26: PhD-student **Heidar Eyolfsson**, Göteborg, Sweden
- Aug 23 - Sep 18: Dr. **John Hosking**, INRIA, France
- Aug 19-20: PhD-student **Anna Nazarova**, University of Ulm, Germany
- Aug 1-15: Dr. **Thilo Meyer-Brandis**, Ludwig Maximilian University Munchen, Germany
- June 30-Jul 1: Dr. **Carlo Barbieri**, Riken, Tokyo, Japan
- Jun 27 - Jul 2: Professor **Francesco Pederiva**, University of Trento, Italy
- Jun 17-18: Professor **Ludwik Adamowicz**, University of Arizona, USA

- Jun 16-19: Professor **Niels Walet**, University of Manchester, UK
- Jun 15-21: Professor **Andreas Ekström**, Lund University, Sweden
- Jun 13-16: Dr. **Elisa Postinghel**, Rome, Italy
- Jun 7-26: Dr. **Gaute Hagen**, Oak Ridge National Laboratory, USA
- June 6-30 Dr. **Bart De Pontieu**, Lockheed Martin Solar and Astrophysics Laboratory, USA
- Jun 2-4: Postdoc fellow **Almut Veraart**, University of Aarhus, Denmark
- May 26- Jun 2: Professor **Jean-Louis Merrien**, INSA Rennes, France
- May 25-28: Dr. **Hilde Sande**, NTNU, Norway
- May 10-31: PhD-student **Katrin Jensen**, University of Ulm, Germany
- May 2 - 29: Professor **Giuseppe Maria Coclite**, University of Bari, Italy
- Mar 23-29: Postdoc fellow **Magnus Wobben**, University of Münster, Germany
- Mar 18 - Apr 6: Postdoc **Tore G Halvorsen**, NTNU, Norway
- Mar 17-18: Professor **Vidar Thomee**, Chalmers University, Sweden
- Mar 8-10: Prof. **Alvaro Cartea**, University of Madrid, Spain
- Mar 8-10: Dr. **Carlo Gonzales-Pedraz**, University of Madrid, Spain
- Mar 3-9: Dr. **Giuseppina Orlandini**, University of Trento, Italy
- Mar 3-9: Dr. **Winfried Leidemann**, University of Trento, Italy
- Feb 18 - 19, 2010: Dr. **Mostafa Bendahmane**, Université de Franche-Comté, Besançon, France
- Feb 9: Dr. **Sascha Desmettre**, University of Kaiserslautern, Germany
- Feb 3-7: Dr. **Merouane Debbah**, SUPELEC Paris, France
- Jan 31 - Feb 4: PhD-student **Joachim Gahungu**, University of Louvain, Belgium
- Jan 25 - Feb 12: Dr. **Siddhartha Mishra**, ETH Zürich, Switzerland
- Jan 18-20: Professor **Chun Liu**, Penn. State University, USA
- Jan 4-14: Dr. **Carlo Barbieri**, Riken, Tokyo, Japan
- Jan 4-12: Professor **Alex Brown**, Michigan State University, USA
- Jan 4-10: Dr. **Thomas Papenbrock**, University of Tennessee and Oak Ridge National Lab, USA
- Jan 4-10: Dr. **Witek Nazarewicz**, University of Tennessee and Oak Ridge National Lab, USA
- Jan 4-10: Dr. **Tom Luu**, Lawrence Livermore National Laboratory, USA
- Jan 4-9: Dr. **Thomas Duguet**, Université de Paris Sud and Saclay, Paris, France
- Jan 4-10, 2010: Dr. **Knut Waagan**, National Centre for Atmospheric Research, Boulder, USA
- Dec 16, 2010 - Jan 11: Dr. **Gaute Hagen**, Oak Ridge National Laboratory, USA
- January 4-9: International participants at "School on Topics in Nuclear Many-Body Theory, from Lattice QCD to Nuclei": **Andrew Ayres** USA; **Carlo Barbieri** Japan; **Brent Barker** USA; **Rodolfo Id Betan** USA; **Anders Billander** Sweden; **Alex Brown** USA; **Juan Burgos** USA; **Thomas Duguet** France; **Andreas Görgen** France; **Gaute Hagen** USA; **Jason Holt** USA; **Anna Karlsson** Sweden; **Markus Kortelainen** USA; **Thomas Lesinski** USA; **Thomas Luu** USA; **David Miller** USA; **Witold Nazarewicz**

USA; **Erik Michael Olsen** USA; **Stephen William Padgett** USA; **George Papadimitriou** USA; **Thomas Papenbrock** USA; **Mustafa M. Rajabali** USA; **Emil Ryberg** Sweden; **Daniel Sääf** Sweden; **Jeremy Sadoudi** France; **Kyle Thomas Schmitt** USA; **Michael Scott** USA; **Angelo Signoracci** USA; **Vittorio Sòma** France; **Emily Wang** USA;

■ April 28-30: International participants at "Time Dependent Quantum Mechanics - analysis and numerics":

Sergey Antipov Sweden; **Luca Argenti** Sweden; **Sergio Blanes** Spain; **Alberto Castro** Spain; **Adam Etches** Denmark; **Katharina Kormann** Sweden; **Henriette Astrup Leth** Denmark; **Christian Lubich** Germany; **Douglas McGrath** USA; **Nimrod Moiseyev** Israel; **Anna Nissen** Sweden; **Wim Vanroose** Belgium;

■ Sep 28 - Oct 1: International participants at "The 2010 Abel Symposium - Partial Differential Equations":

Luigi Ambrosio Italy; **Boris Andreianov** France; **Francois Bouchut** France; **Yann Brennier** France; **Alberto Bressan** USA; **Luis Cafarelli** USA; **José A. Carillo** Spain; **Gui-Qiang Chen** UK; **Rinaldo M. Colombo** Italy; **Constantine M. Dafermos** USA; **Camillo De Lellis** Switzerland; **Björn Engquist** USA; **Maria J. Esteban** France; **Eduard Feireisl** Czech Republic; **Hermano Frid** Brazil; **François Golse** France; **Gerhard Huisken** Germany; **Carlos Kenig** USA; **Alex Kiselev** USA; **Sergiu Klainerman** USA; **Robert V. Kohn** USA; **Pierre-Louis Lions** France; **Andrew J. Majda** USA; **Piero Marcati** Italy; **Igor Rodnianski** USA; **Laure Saint-Raymond** France; **Denis Serre** France; **Endre Süli** UK; **Nils Svanstedt** Sweden; **Eitan Tadmor** USA; **Edriss Titi** USA; **Konstantina Trivisa** USA; **Juan Luis Vázquez** Spain; **Cédric Villani** France; **Zhouping Xin** Hong Kong; **Takaharu Yaguchi** Japan;

Handwritten mathematical notes in red ink:

- $B_t \sqrt{\ln(X - X_n)} \rightarrow d$
- $b_t(Z) \int dt$
- $\exp\left(\int_0^t \ln dB\right)$
- dW
- $\varphi(x) = E^x \int_0^x f(x_t) dt + g(x_t)$
- $A\varphi + b = 0$
- $\varphi = g$ on ∂D
- $K = 0$
- $\varphi(x) = x$

Appendix 7

Publications 2010

7a. Scientific articles in refereed journals, published 2010

1. **Antolin, Patrick;** Shibata, K. *The role of torsional Alfvén waves in coronal heating.* The Astrophysical Journal 2010;712(1):494-510
2. **Antolin, Patrick;** Shibata, K; Vissers, GJM. *Coronal rain as a marker for coronal heating mechanisms.* The Astrophysical Journal 2010;716(1):154-166
3. Yuan, J; **Bae, Egil; Tai, Xue-Cheng;** Boykov, Yuri. *A Continuous Max-Flow Approach to Potts Model.* European Conference on Computer Vision (ECCV 2010), Lecture Notes in Computer Science 2010:6316:379-392
4. **Barrowclough, Oliver; Dokken, Tor.** *Approximate Implicitization of Triangular Bézier Surfaces.* Spring conference on Computer graphics 2010:153-160
5. **Benth, Fred Espen;** Groth, M; Lindberg, C. *The implied risk aversion from utility indifference option pricing in a stochastic volatility model.* International Journal of Applied Mathematics and Statistics 2010;16(M10):11-37
6. **Benth, Fred Espen;** Groth, M; Wallin, O. *Derivative-free Greeks for the Barndorff-Nielsen and Shephard stochastic volatility model.* Stochastics: An International Journal of Probability and Stochastic Processes 2010;82(3):291-313
7. Erlwein, C; **Benth, Fred Espen;** Mamon, R. *HMM filtering and parameter estimation of an electricity spot price model.* Energy Economics 2010;32(5):1034-1043
8. Frestad, D; **Benth, Fred Espen;** Koekebakker, S. *Modeling Term Structure Dynamics in the Nordic Electricity Swap Market.* Energy Journal 2010;31(2):53-86
9. Saltyte-Benth, J; **Benth, Fred Espen.** *Analysis and modelling of wind speed in New York.* Journal of Applied Statistics 2010;37(6):893-909
10. **Biswas, Imran Habib;** Jakobsen, ER; **Karlsen, Kenneth.** *Viscosity Solutions for a System of Integro-PDEs and Connections to Optimal Switching and Control of Jump-Diffusion Processes.* Applied mathematics and optimization 2010;62(1):47-80
11. **Biswas, Imran Habib;** Jakobsen, Espen Robstad; **Karlsen, Kenneth.** *Difference-quadrature schemes for nonlinear degenerate parabolic integro-PDE.* SIAM Journal on Numerical Analysis 2010;48(3):1110-1135
12. **Briseid, Sverre; Dokken, Tor; Hagen, Trond Runar.** *Heterogeneous Spline Surface Intersections.* Spring Conference on Computer Graphics 2010:161-168
13. **Brodtkorb, Andre R;** Dyken, C; **Hagen, Trond Runar; Hjelmervik, Jon M;** Storaasli, OO. *State-of-the-Art in Heterogeneous Computing.* Scientific Programming 2010;18(1):1-33
14. **Bruvold, Solveig; Floater, Michael.** *Transfinite mean value interpolation in general dimension.* Journal of Computational and Applied Mathematics 2010;233(7):1631-1639
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12. Ashraf, M; **Lie, Knut-Andreas**; Nilsen, HM; Nordbotten, JM; Skorstad, A. *Impact of heterogeneity on early-stage CO2 plume migration*. XVIII International Conference on Water Resources (CMWR 2010), J. Carrera (Ed), CIMNE, Barcelona, 2010.
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14. **Mørken, Knut**. *MAT-INF1100: Numerical Algorithms and Digital Representation*, November 2010
15. **Quak, Ewald** et.al. *FOCUS K3D, Roadmap for Future Research*, EU project, February 2010

7e. The CMA collected preprint series 2010

1. **Bae, Egil**; Yuan, J; **Tai, Xue-Cheng**. *Global Minimization for Continuous Multiphase Partitioning Problems Using a Dual Approach*. To appear in International Journal of Computer Vision
2. **Bae, Egil**; Shi, J; **Tai, Xue-Cheng**. *Graph Cuts for Curvature based Image Denoising*. To appear in IEEE Transactions on Image Processing
3. **Bae, Egil**; Yuan, J; **Tai, Xue-Cheng**; Boykov, Y. *A fast continuous max-flow approach to non-convex multilabeling problems*. Technical report CAM10-62, UCLA, USA
4. Yuan, J; **Bae, Egil**; **Tai, Xue-Cheng**; Boykov, Y. *A Study on Continuous Max-Flow and Min-Cut Approaches*. Technical report CAM10-61, UCLA, USA
5. Wan, M; Wang, Y; **Bae, Egil**; **Tai, Xue-Cheng**; Wang, D. *Reconstructing open surfaces via graph-cuts*. Technical report CAM10-29, UCLA, USA
6. **Bae, Egil**; Juan, S; **Tai, Xue-Cheng**. *Graph cuts for curvature based image denoising*. Technical report CAM10-28, UCLA, USA
7. **Benth, Fred Espen**; **Kettler, Paul C**. *Dynamic copula models for the spark spread*. To appear in Quantitative Finance 2011
8. **Benth, Fred Espen**; **Di Nunno, Giulia**; **Khedher, Asma**. *Robustness of option prices and their deltas in markets modelled by jump-diffusions*. Math Preprint Series 2010;2
9. **Benth, Fred Espen**; **Di Nunno, Giulia**; **Khedher, Asma**. *Computation of Greeks in multi-factor models with applications to power and commodity markets*. Math Preprint Series 2010;5
10. **Benth, Fred Espen**; **Di Nunno, Giulia**; **Khedher, Asma**. *A note on convergence of option prices and their Greeks for Lévy models*. Math Preprint Series 2010;18
11. **Benth, Fred Espen**; Nazarova, A; **Kiesel, Rüdiger**. *A critical empirical study of two electricity spot price models*. January 2010
12. **Benth, Fred Espen**; Bauer, D; **Kiesel, Rüdiger**. *Modeling the forward mortality surface*. January 2010
13. **Benth, Fred Espen**; Barndorff-Nielsen, O; Veraart, A. *Modelling energy spot prices by Levy semistationary processes*. March 2010
14. **Benth, Fred Espen**; Saltyte-Benth, J. *Weather derivatives and stochastic temperature modeling*, July 2010
15. **Benth, Fred Espen**; Saltyte-Benth, J. *A critical view on temperature modeling for application in weather derivatives markets*, July 2010
16. **Benth, Fred Espen**; Barndorff-Nielsen, O; Veraart, A. *Modelling electricity forward markets by ambit fields*, August 2010

7d. Scientific reports, contributions, proceedings etc. (not refereed), published 2010

1. **Antolin, Patrick**; Shibata, K; Kudoh, T; Shiota, D; Brooks, D. *Signatures of Coronal Heating Mechanisms*. Astrophysics and Space Science Proceedings 2010
2. Yuan, J; **Bae, Egil**; **Tai, Xue-Cheng**. *A Study on Continuous Max-Flow and Min-Cut Approaches*. Proc. IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2010.
3. **Bae, Egil**; Weickert, J. *Partial differential equations for interpolation and compression of surfaces*. Proc. Seventh International Conference on Mathematical Methods for Curves and Surfaces (MMCS 2008), Lecture Notes in Computer Science, Springer, Berlin, 2010:1-14.
4. **Dokken, Tor**; **Quak, Ewald**; Skytt, V. *Requirements from Isogeometric Analysis for Changes in Product Design Ontologies*. FOCUS K3D, 2010:11-15
5. **Dokken, Tor**; Kvamsdal, T.; Pettersen, KF; Skytt, V. *Isogeometric analysis*, Proceedings of NSCM-23, 2010:1-4
6. **Klausen, Runhild Aae**; Stephansen, AF. *On Rough Grids – Convergence and Reproduction of Uniform Flow*. Proceedings from 12th European Conference on the Mathematics of Oil Recovery, Oxford, UK, Sep 6-9, 2010.
7. **Lie, Knut-Andreas**; Krogstad, S; Ligaarden, IS; Natvig, JR; Nilsen, HM; Skaflestad, B. *Discretisation on complex grids - Open-source MATLAB implementation*. Proceedings of ECMOR XII, Oxford, UK, Sep 6-9, 2010.
8. Hauge, VL; **Lie, Knut-Andreas**; Natvig, JR. *Flow-based grid coarsening for transport simulations*. Proceedings of ECMOR XII, Oxford, UK, Sep 6-9, 2010.
9. **Lie, Knut-Andreas**; Ligaarden, IS; Nilsen, HM. *Accurate discretization of vertically-averaged models of CO2 plume migration*. Proceedings of ECMOR XII, Oxford, UK, Sep 6-9, 2010.
10. Ligaarden, I; **Krotkiewski, Marcin**; **Lie, Knut-Andreas**; Schmid, DW; Pal, M. *On the Stokes-Brinkman equations for modeling flow in carbonate reservoirs*. Proceedings of ECMOR XII, Oxford, UK, Sep 6-9, 2010.
11. Ashraf, M; **Lie, Knut-Andreas**; Nilsen, HM; Skorstad, A. *Impact of geological heterogeneity on early-stage CO2 plume migration: sensitivity study*. Proceedings of ECMOR XII, Oxford, UK, Sep 6-9 2010.

17. **Benth, Fred Espen;** Barth, A. *The forward dynamics in energy markets – infinite dimensional modeling and simulation*, November 2010
18. **Benth, Fred Espen; Lempa, Jukka;** Nilsen, T. *On optimal exercise of swing options in electricity markets*, December 2010
19. **Benth, Fred Espen;** Klüppelberg, C; **Vos, Linda.** *Forward pricing in electricity markets based on stable CARMA spot models.*
20. **Biagini, Francesca;** Fuschini, S; Klueppelberg, C. *Credit contagion with long range dependent macroeconomic factor model.* To appear on Special AMAmEF Volume, Springer, Berlin
21. **Biagini, Francesca;** Widenmann J. *Pricing of unemployment insurance products with time-homogeneous Markov chains*
22. **Biagini, Francesca; Hu, Yaozhong;** Meyer-Brandis, T; **Øksendal, Bernt.** *Insider Trading Equilibrium in a Market with Memory*
23. **Biagini, Francesca;** Rheinlaender T; Widenmann J; *Hedging mortality claims with longevity bonds*
24. **Brodtkorb, André; Hagen, Trond Runar; Lie, Knut-Andreas;** Natvig, JR. *Simulation and visualization of the Saint-Venant system using GPUs.* To appear in *Comput. Visual. Sci.*
25. **Brodtkorb, André; Sætra, Martin;** Altinakar, M. *Efficient Shallow Water Simulations on GPUs: Implementation, Visualization, Verification, and Validation*
26. **Christiansen, Snorre H.** *On variational eigenvalue approximation of semidefinite operators.* ArXiv 2010:14
27. **Christiansen, Snorre H; Halvorsen, Tore Gunnar.** *A simplicial gauge theory.* arXiv:1006.2059v3
28. **Bernt, F; Dahl, Geir; Mannino, Carlo.** *Computing optimal recovery policies for financial markets*
29. **Di Nunno, Giulia; Sjursen, Steffen.** *Information and optimal investment in defaultable assets.* Math Preprint Series 2010;17
30. **Thompson, RT; Frauendiener Jörg.** *A completely covariant approach to transformation optics.* To appear in *Journal of Optics* 2011
31. **Thompson, RT; Cumber, SA; Frauendiener, Jörg.** *Covariant Transformation Optics of Linear Materials,* arXiv:1006.3364v1
Müller, T; Frauendiener, Jörg. *Studying null and time-like geodesics in the classroom,* accepted at *European Journal of Physics*
32. **Fuchs, Franz; McMurry, Andrew; Mishra, Siddhartha;** Waagan, K. *Well-balanced high resolution finite volume schemes for the simulation of wave propagation in three-dimensional non-isothermal stratified magneto-atmospheres*
33. **Fuchs, Franz; McMurry, Andrew; Mishra, Siddhartha; Risebro, Nils Henrik;** Waagan, K. *Explicit and implicit finite volume schemes for radiation MHD and the effects of radiation on wave propagation in stratified atmospheres.*
34. **Fuchs, Franz; McMurry, Andrew; Mishra, Siddhartha;** Waagan, K. *Simulating waves in the upper solar atmosphere with SURYA: A well-balanced high-order finite volume code.* To appear in *Astrophysical Journal*
35. **Grunert, K; Holden, Helge; Raynaud, Xavier Marcel.** *Lipschitz metric for the periodic Camassa-Holm equation.* To appear in *Journal of Differential Equations* 2011
36. **Holden, Helge; Raynaud, Xavier Marcel.** *Global semigroup of conservative solutions of the nonlinear variational wave equation.* To appear in *Archive for Rational Mechanics and Analysis* 2011
37. **Frid, H; Holden, Helge; Karlsen, Kenneth H.** *Solutions for a model of polytropic gas flow with diffusive entropy.*
38. **Hu, Yaozhong;** Nualart, D; Song, X. *Malliavin calculus for backward stochastic differential equations and application to numerical schemes.*
39. **Hu, Yaozhong;** Nualart, D. *Central limit theorem for the modulus of continuity of the Brownian local time in $L^3(R)$.*
40. **Hu, Yaozhong.** *Multiple integrals and expansion of solution to differential equations driven by rough path and by fractional Brownian motion.*
41. **Hu, Yaozhong;** Nualart, D; Song, J. *Feynman-Kac formula for spde driven by fractional Brownian fields.* To appear in *Annals of Probability.*
42. **Jensen, Øyvind;** Hagen, G; **Hjorth-Jensen, Morten;** Vaagen, JS. *Closed-shell properties of \mathbb{S}^2 with ab initio coupled-cluster theory* <http://arxiv.org/abs/1012.5678v1>
43. **Andreianov, B; Bendahmane, M; Karlsen, Kenneth;** Pierre, C. *Convergence of discrete duality finite volume schemes for the cardiac bidomain model.*
44. **Bendahmane, M; Karlsen, Kenneth.** *A note on entropy solutions for degenerate parabolic equations with data.*
45. **Betancourt, F; Bürger, R; Karlsen, Kenneth.** *Well-posedness and travelling wave analysis for a strongly degenerate parabolic aggregation equation.* (Proc. HYP 2010)
46. **Cifani, S; Jakobsen, ER; Karlsen, Kenneth.** *The discontinuous Galerkin method for fractional degenerate convection-diffusion equations.*
47. **Coclite, GM; Karlsen, Kenneth.** *Hamiltonian approximation of entropy solutions of the Burgers equation.* Submitted (Proc. HYP 2010)
48. **Coclite, GM; Karlsen, Kenneth.** *On an initial-boundary value problem for the hyperelastic rod wave equation.*
49. **Karlsen, Kenneth; Koley, Ujjwal; Risebro, Nils Henrik.** *An error estimate for the finite difference approximation to degenerate convection - diffusion equations.*
50. **Andreianov, B; Karlsen, Kenneth; Risebro, Nils Henrik.** *A theory of -dissipative solvers for scalar conservation laws with discontinuous flux.* *Arch. Ration. Mech. Anal.*, to appear.
51. **Betancourt, F; Bürger, R; Karlsen, Kenneth.** *A strongly degenerate parabolic aggregation equation.* *Comm. Math. Sci.*, to appear.
52. **Betancourt, F; Bürger, B; Karlsen, Kenneth; Tory, EM.** *On nonlocal conservation laws modeling sedimentation.* *Nonlinearity*, to appear.
53. **Kettler, Paul Carlisle;** Proske, FN; **Rubtsov, Mark.** *Sensitivity with respect to the yield curve: duration in a stochastic setting.* Math Preprint Series 2010;10. To appear in *Springer Series in Statistics* 2011
54. **Kiesel, Rüdiger;** Scherer, M. *Dynamic credit portfolio modelling in structural models with jumps*
55. **Grüll, G; Kiesel, Rüdiger.** *Pricing CO2 permits using approximation approaches*
56. **Mundal, SS; Klausen, Runhild Aae;** Dahle, HK. *On Corner Velocity Interpolation and Mixed Finite Elements .* Math Preprint Series 2010;15
57. **Klausen, Runhild Aae;** Stephansen, AF. *Convergence of the MPFA O-method on general grids.* Math Preprint Series 2010;1
58. **Lempa, Jukka;** Matomäki, P. *A Dynkin game with information asymmetry,* Math Preprint Series 2010;24
59. **Lempa, Jukka.** *On exogenously restricted bounded variation control of Ito diffusions,* Math Preprint Series 2010;6
60. **Lempa, Jukka.** *Irreversible investment decisions under return and time uncertainty: optimal timing with a Poisson clock,* Math Preprint Series 2010;23
61. **Lempa, Jukka.** *Optimal stopping with information constraint,* Math Preprint Series 2010;22
62. **Nortvedt, GA; Elvebakk, G; Lindstrøm, Tom.** *Norsk matematikkråds forkunnskapstestet 2009.* Norsk matematikkråd Oslo/Tromsø, Math Preprint Series 2010;12
63. **Cohen, E; Lyche, Tom; Riesenfeld, RF.** *A B-spline-like basis for the Powell-Sabin 12-split based on simplex splines*

64. **Mannino, Carlo;** Mattia, S; Sassano, A. *Wireless Network Design by Shortest Path*, to appear in Computational Optimization and Application
65. **Mannino, Carlo;** Nilssen, E; Nordlander, TE. *A pattern based, robust approach to cyclic master surgery scheduling*
66. D'Andreagiovanni, F; **Mannino, Carlo;** Sassano, A. *Power-Indexed formulations for Wireless Network Design*
67. Holte, M; **Mannino, Carlo.** *The implementor/adversarial algorithm for robust and cyclic scheduling problems in health care*
68. **Muntingh, Georg; Floater, Michael.** *Divided Differences of Univariate Implicit Functions*. To appear in Mathematics of Computation 2011
69. **Menoukeu Pamen, Olivier.** *A General Theorem for Portfolio Generating Functions*, to appear in Communication on Stochastic Analysis.
70. **Menoukeu Pamen, Olivier; Di Nunno, Giulia, Øksendal, Bernt;** Proske, F. *A General Maximum Principle for Anticipative Stochastic Control and Applications to Insider Trading*. To appear as book chapter in Advanced Mathematical Methods for Finance.
71. **Menoukeu Pamen, Olivier; Di Nunno, Giulia, Øksendal, Bernt;** Proske, F. *Uniqueness of Decompositions of Skorohod-Semimartingales*, to appear in Infin. Dimens. Anal. Quantum Probab. Relat. Top.
72. **Menoukeu Pamen, Olivier;** Meyer-Brandis, T; Proske, F; Salleh, HB. *Malliavin Calculus Applied to Optimal Control of Stochastic Partial Differential Equations with Jumps*
73. **Menoukeu Pamen, Olivier;** Meyer-Brandis, T; Proske, F. *A Gelfand triple approach to the small noise problem for discontinuous ODE's*. Math Preprint Series 2010;25
74. **Mishra, Siddhartha;** Schwab, C. *Sparse tensor multi-level Monte Carlo finite volume methods for hyperbolic conservation laws with random initial data*.
75. Fjordholm, US; **Mishra, Siddhartha.** *Accurate Numerical discretizations of non-conservative hyperbolic systems*
76. Fjordholm, US; **Mishra, Siddhartha;** Tadmor, E. *Energy preserving and energy stable schemes for shallow water equations with bottom topography*
77. **Mishra, Siddhartha.** *Robust finite volume schemes for simulating waves in the solar atmosphere*, SAM report 2010;37.
78. **Mishra, Siddhartha;** Svärd, M. *Entropy stable schemes for initial-boundary-value conservation laws*
79. Fjordholm, US; **Mishra, Siddhartha;** Tadmor, E. *An entropy stable ENO scheme*
80. **Postinghel, Elisa.** *Secant Degree of Toric Surfaces and Delightful Planar Toric Degenerations*. <http://arxiv.org/abs/1012.2454>
81. **Postinghel, Elisa;** Di Biagio, L. *Apolarity, Hessian and Macaulay polynomials*. <http://arxiv.org/abs/1007.4891>
82. **Qviller, Nikolay.** *The Di Francesco-Itzykson-Göttsche Conjectures for Node Polynomials of P^2*
83. **Raynaud, Xavier;** Cohen, D. *Geometric finite difference schemes for the generalised hyperelastic-rod wave equation*. To appear in Journal of Computational and Applied Mathematics 2011
84. **Rubtsov, Mark.** *Pricing of Margrabe Options for Large Investors with Application to Asset-Liability Management in Life Insurance*. Math Preprint Series 2010;20
85. **Rubtsov, Mark.** *An Explicit Representation of Solutions of Forward SDE's with Reflections via White Noise Analysis*. Math Preprint Series 2010;21
86. **Selstø, Sølve;** Birkeland, T; **Kvaal, Simen;** Nepstad, R; Førre, M. *The role of final state correlation in double ionization of helium: a master equation approach*, arXiv:1006.1984v2, 2010
87. **Sætra, Martin; Brodtkorb, André.** *Shallow Water Simulations on Multiple GPUs*, Proceedings of the Para 2010 Conference, To appear in Lecture Notes in Computer Science, Springer
88. **Ta, An Thi Kieu;** Proske, F; **Rubtsov, Mark.** *Risk Indifference Pricing of Functional Claims of the Yield Surface in the Presence of Partial Information*. Math Preprint Series 2010;19
89. **Ta, An Thi Kieu; Øksendal, Bernt.** *A Maximum Principle for Stochastic Differential Games with g -Expectations and Partial Information*. Math Preprint Series 2010;4. To appear in Stochastics and Stochastics Report.
90. Yuan, J; Shi, J; **Tai, Xue-Cheng.** *A Convex and Exact Approach to Discrete Constrained TV-L1 Image Approximation*, Technical report CAM10-51, UCLA, USA
91. **Tai, Xue-Cheng;** Hahn, J; Chung, GJ. *A Fast Algorithm for Euler's Elastic Model Using Augmented Lagrangian Method*, Technical report CAM10-47, UCLA, USA
92. Rosman, G; **Tai, Xue-Cheng;** Dascal, L; Kimmel, R. *Polyakov Action Minimization for Efficient Color Image Processing*, Technical report CAM10-46, UCLA, USA
93. Hahn, J; Wu, C; **Tai, Xue-Cheng.** *Augmented Lagrangian Method for Generalized TV-Stokes Model*, Technical report CAM10-30, UCLA, USA
94. Rosman, G; Dascal, L; **Tai, Xue-Cheng;** Kimmel, R. *On Semi-Implicit Splitting Schemes for the Beltrami Color Image Filtering*, Technical report CAM10-23, UCLA, USA
95. Mardal, KA; **Winther, Ragnar.** *On the construction of preconditioners for systems of partial differential equations*
96. **Øksendal, Bernt;** Bagheri, F; **Haadem, Sven;** Turpin, I. *Optimal stopping and stochastic control differential games for jump diffusions*. Math Preprint Series 2010;3
97. **Øksendal, Bernt;** Sulem, A. *Robust stochastic control and equivalent martingale measures*. Math Preprint Series 2010;8
98. **Øksendal, Bernt;** Sulem, A. *Singular stochastic control and optimal stopping with partial information of jump diffusions*. Math Preprint Series 2010;9
99. **Øksendal, Bernt.** *Mathematics and Finance: The Black-Scholes Option Pricing Formula and Beyond*. Math Preprint Series 2010;11
100. **Øksendal, Bernt;** Sulem, A.; **Zhang, Tusheng.** *Optimal control of stochastic delay equations and time-advanced backward stochastic differential equations*. Math Preprint Series 2010;16
101. **Øksendal, Bernt;** Corcuera, JM; Farkas, G; **Di Nunno, Giulia.** *Kyle-Back's model with Lévy noise*. Math Preprint Series 2010;26
102. **Aase, Knut.** *Pareto Optimal Insurance Policies in the Presence of Administrative Costs*. Discussion Paper, 2010:7 NHH
103. **Aase, Knut;** Bjuland, T; **Øksendal, Bernt.** *An anticipative linear filtering equation*. Discussion Paper 2010:8 NHH and Math Preprint Series 2010;13
104. **Aase, Knut K.;** Bjuland, T; **Øksendal, Bernt.** *Strategic Insider Trading Equilibrium: A Filter Theory Approach*. Discussion Paper 2010:9 NHH and Math Preprint Series 2010;14

Appendix 8

Talks outside CMA by CMA members in 2010

8a. Invited Scientific talks 2010

1. **Benth, Fred Espen.** *Modeling energy markets by ambit processes*, Conference on Ambit processes, non-semimartingales and applications, Thiele Center and CREATES, University of Aarhus, Denmark, Jan 24-28 2010
2. **Benth, Fred Espen.** *Weather derivatives: modeling and pricing*, Weather Derivatives and Risk, Workshop, CASE, Humboldt University of Berlin, Germany, Jan 27-28, 2010
3. **Benth, Fred Espen.** *Pricing energy forward contracts - the risk premium*, School of Economics, NHH, Bergen, Norway, Jun 2, 2010
4. **Benth, Fred Espen.** *Robustness issues in risk management*, IMS/Chalmers University, Gothenburg, Aug 9-13, 2010
5. **Benth, Fred Espen.** *The information premium in electricity markets: theory and empirics*. Faculty seminar in risk, Georgia State University, Atlanta, USA, Oct 1, 2010
6. **Benth, Fred Espen.** *Ambit fields and stochastic partial differential equations*, Workshop in honour of Ole Barndorff-Nielsen's 75th birthday, CREATES, University of Aarhus, Denmark, Oct 13-14 2010
7. **Biagini, Francesca.** *Pricing of catastrophe insurance options under immediate loss reestimation*, 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
8. **Brodtkorb, André.** *Simulation and Visualization of the Saint-Venant System Using GPUs*, National Center for Computational Hydroscience and Engineering, University of Mississippi, USA, Mar 3, 2010.
9. **Brodtkorb, André.** *State-of-the-art in Heterogeneous Computing*, Computer Science Seminar Series, University of Mississippi, USA, Apr 21, 2010
10. **Carlsson, Mats.** *Future space missions*. USO-SP International Graduate School in Solar Physics, Tammsvik, Sweden, Jan 11-13, 2010
11. **Carlsson, Mats.** *Numerical modelling of the chromosphere*. Solar-C Science definition meeting, Tokyo, Japan, Mar 8-12, 2010
12. **Carlsson, Mats.** *Future needs for elnfastructure in Astrophysics*. Open seminar on future needs for elnfastructure for Norwegian research, Oslo, Norway, Mar 19, 2010
13. **Carlsson, Mats.** *New Frontiers in Solar Chromospheric Physics*. European Solar Telescope meeting, Meudon, France, May 18-21, 2010
14. **Carlsson, Mats.** *New Frontiers in Solar Chromospheric Physics*. AAS/SPD meeting, Miami, USA, May 22-29, 2010
15. **Carlsson, Mats.** *Modeling the Magnetic Chromosphere*. CLASP meeting, Mondello, Italy, Oct 16, 2010
16. **Carlsson, Mats.** *Modelling the Magnetic Chromosphere*. Bifrost meeting, Palo Alto, USA, Nov 8-13, 2010
17. **Carlsson, Mats.** *Multi_3d*. Bifrost meeting, Palo Alto, USA, November 8-13, 2010
18. **Christiansen, Snorre.** *A construction of minimal finite element spaces of differential forms on polyhedra*. Third Chilean Workshop on Numerical Analysis of Partial Differential Equations (WONAPDE), Concepcion, Chile, Jan 11-15, 2010
19. **Christiansen, Snorre.** *Coupling Maxwell with Schrödinger equations using Lattice Gauge Theory*. Maxwell's Equations: Theoretical and Numerical Issues with Applications, Shanghai, China, Jun 26-30, 2010
20. **Christiansen, Snorre.** *Éléments finis mixtes minimaux sur les polyèdres*. Séminaire EDP et Analyse numérique, Nice, France, Mar 3, 2010
21. **Christiansen, Snorre.** *Éléments finis mixtes minimaux sur les polyèdres*. Séminaire d'analyse appliquée, Marseilles, France, Mar 9, 2010
22. **Christiansen, Snorre.** *Gauge invariant discretizations of Schrödinger equations in an electromagnetic field*. BIT 50 conference, Lund, Sweden, Jun 17-30, 2010
23. **Christiansen, Snorre.** *Introduction to mixed finite elements*. Seminar of the Department of Mathematical Sciences and Technology, Ås, Norway, Oct 6, 2010
24. **Christiansen, Snorre.** *Introduction to Regge calculus and its linearization*. Seminar of the Department of Mathematics and Natural Sciences, Stavanger, Norway, Nov 26, 2010
25. **Christiansen, Snorre.** *Lattice gauge theory meets finite elements*. SAM colloquium, Zürich, Switzerland, May 19, 2010
26. **Christiansen, Snorre.** *Mixed finite elements as inverse systems of differential forms*. Workshop on Non-Standard Numerical Methods for PDE's, Pavia, Italy, Jun 29 – July 2, 2010
27. **Dahl, Geir.** *Majorization and related combinatorial matrix classes*, University of Maryland, Institute of Systems Research, USA, May 10, 2010
28. **Dahl, Geir.** *Majorization, $A(R,S)$ and related matrix classes*. Coimbra Meeting on 0-1 Matrix Theory and Related Topics, Coimbra, Portugal, June 17-19, 2010
29. **Dahl, Geir.** *Majorization permutahedra and $(0,1)$ -matrices*. 16th conference of the Internat. Linear Algebra Soc. Pisa, Italy, June 21-25, 2010
30. **Dahle, Håkon;** et.al. *Microbial community structure of biomats and chimney walls of the Loki's Castle hydrothermal field at 73°N*. 8th International conference on extremophiles, Ponta Delgada, The Azores, Portugal, Sep 12-16, 2010
31. **Di Nunno, Giulia.** *Time Consistent Convex Price Systems in L_p* . 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
32. **Di Nunno, Giulia.** *Information in optimal portfolio choices*. IMS 2010, Gothenburg, Sweden, Aug 9-13, 2010
33. **Di Nunno, Giulia.** *Minimal Variance Hedging in incomplete markets*. Stochastic differentiation and the Clark-Ocone formula. SAMSA 2010, Botswana, Nov 29 – Dec 4, 2010
34. **Di Nunno, Giulia.** *Minimal Variance Hedging in incomplete markets:stochastic differentiation and the Clark-Ocone formula*. Workshop on Malliavin Calculus for Jump Processes, Paris, France, Nov 18-20, 2010
35. **Di Nunno, Giulia.** *Price and sensitivity robustness to model risk*. Seminari di Finanza Matematica. Politecnico di Milano, Italy, Oct 12, 2010
36. **Di Nunno, Giulia.** *Time consistent linear and convex price systems in L_p* . Stochastic Analysis and Applications, Linnæus University, Vaxjo, Sweden, May 20-21, 2010

$$\frac{\partial}{\partial t} \left(\frac{\partial \psi(x,t)}{\partial x} \right) = - \frac{\partial^2 \psi(x,t)}{\partial x^2}$$
$$B^H(x,t) := \sum_{n=1}^{\infty} c_n$$

37. **Dokken, Tor.** *Challenges of Isogeometric Representation for CAD.* ME 2010 International Mechanical Engineering, Vancouver, Canada, Nov 12-18, 2010
38. **Dokken, Tor.** *Locally Refined Splines.* Non-Standard Numerical Methods for PDE's, Pavia, Italy, Jun 29 – Jul 2, 2010
39. **Dokken, Tor;** Barrowclough, Oliver Joseph David. *Approximate Implicitization and Approximate Null Spaces.* The 16th Conference of the International Linear Algebra Society (ILAS), Pisa, Italy, Jun 21-25, 2010
40. **Dokken, Tor;** Kvamsdal, T; Pettersen, KF; Skytt, V. *Isogeometric Analysis.* 23rd Nordic Seminar on Computational Mechanics, Stockholm, Sweden, Oct 21, 2010
41. **Dokken, Tor;** Skytt, V. *Locally Refined Splines.* IV European Conference on Computational Mechanics, Paris, France, May 16-21, 2010
42. **Floater, Michael.** *A piecewise polynomial approach to analyzing interpolatory subdivision.* Workshop, Multivariate Approximation and Interpolation with Applications, Edinburgh, Scotland, Sep 1-6, 2010
43. **Floater, Michael;** Hormann, K. *Barycentric rational interpolation with no poles and high rates of approximation.* Conference on New Trends in Applied Geometry, Bad Herrenalb, Germany, Feb 14-19, 2010
44. **Floater, Michael S.;** Kosinka, Jiri. *Barycentric interpolation and mappings on smooth convex domains.* SPM 2010, 14th ACM Symposium on Solid and Physical Modeling, Technion University, Haifa, Israel, Sep 1-3, 2010
45. **Frauenhofer, Jörg.** *Local twistors and the conformal field equations,* AMS Meeting, San Francisco, Jan 2010
46. **Frauenhofer, Jörg.** *Discrete geometric structures in General Relativity,* Workshop on unstructured meshes, Jena, Germany, Aug 25-27, 2010
47. **Frauenhofer, Jörg.** *Some properties of wave maps on 2+1 dimensional Minkowski space,* Australian Math Society meeting, Brisbane, Australia, Sep 2010
48. **Fuchs, Franz.** *The Effects of Radiation on Wave Propagation in the Solar Atmosphere,* Trondheim, Norway, May 11, 2010
49. **Fuchs, Franz.** *The Effects of Radiation on Wave Propagation in the Solar Atmosphere,* AIMS, Dresden, Germany, May 26, 2010
50. **Hansteen, Viggo.** *Numerical Flux Emergence into a realistic Chromosphere/Corona.* Flux Emergence Workshop MSSL Holmbury St Mary, Surrey, UK, Mar 22-26, 2010
51. **Hansteen, Viggo.** *Numerical Simulations of the Chromosphere & Transition Region.* SPD Miami 2010, USA, May 24-28, 2010
52. **Hansteen, Viggo.** *Numerical Simulations of the Chromosphere and Transition Region.* IRIS Workshop, Palo Alto, USA, Nov 8-12, 2010
53. **Hansteen, Viggo.** *Solar Wind Models from the Chromosphere to 1 AU.* ISSI Workshop on Solar Wind Acceleration, Bern, Switzerland, Jan 25-29, 2010
54. **Hjorth-Jensen, Morten.** *From few to many nucleons; a tale on recent advances (and challenges) in nuclear many-body theory.* Spiral2 week 2010, GANIL, Caen, France, Jan 25-29, 2010
55. **Hjorth-Jensen, Morten.** *8 lectures: 1) Deriving nuclear forces. 2) Many-body methods for nuclear structure studies. 3) Many-body theory for exotic nuclei and coupled-cluster theory. 4) Overview of nuclear forces. 5) Renormalizing nuclear forces. 6) Role of many-body forces in nuclei. 7) Role of the tensor force in nuclear spectra. 8) Theory of shell-model studies for nuclei.* CERN/Isolde course on nuclear structure theory, Geneva, Switzerland, Mar 1-4, 2010
56. **Hjorth-Jensen, Morten.** *High-performance computing and quantum mechanical problems.* Future needs for eInfrastructure for Norwegian research, Oslo, Norway, Mar 19 2010
57. **Hjorth-Jensen, Morten.** *Computers in Science Education.* Institute seminar at the university of Trento, Italy, May 5, 2010
58. **Hjorth-Jensen, Morten.** *Shell structure and modern effective interactions.* International Nuclear Physics Conference 2010, Vancouver, Canada, Jul 4-9, 2010
59. **Hjorth-Jensen, Morten.** *From few to many nucleons; a tale on recent advances (and challenges) in nuclear many-body theory.* Institute seminar, University of Naples, Italy, Jul 22, 2010
60. **Hjorth-Jensen, Morten.** *Modern theory of effective interactions.* Zakopane Conference On Nuclear Physics 2010, Poland, Aug 30 – Sep 5, 2010
61. **Hjorth-Jensen, Morten.** *Many-body interactions and nuclear structure.* New faces of atomic nuclei. Tokyo University and Okinawa Institute of Science and Tech., Okinawa, Japan, Nov 15-17, 2010
62. **Holden, Helge.** *Convergence of operator splitting for the KdV equation,* University of Parma, Italy, Feb 1-28, 2010
63. **Karlsen, Kenneth.** *Unifying theory of well-posedness for conservation laws with discontinuous flux,* Nonlinear PDE's @ IMPA, Rio de Janeiro, Brazil, Aug 2-6, 2010
64. **Karlsen, Kenneth.** *Analysis of discontinuous Galerkin methods for fractional conservation laws and related equations,* Workshop on Nonlocal PDE, Besançon, France, May 20-21, 2010
65. **Karlsen, Kenneth.** *Unifying theory of well-posedness for conservation laws with discontinuous flux,* International Conference on Nonlinear Partial Differential Equations and Related Analysis/Applications, Northwestern University, Evanston, IL, USA, Mar 20-24, 2010
66. **Kettler, Paul C.** *Sensitivity with respect to the yield curve: duration in a stochastic setting,* Annual Meeting and Research Conference of the Nordic Chapter of Sigma Xi, Copenhagen, Denmark, May 18, 2010
67. **Kettler, Paul C.** *Sensitivity with respect to the yield curve: duration in a stochastic setting,* Annual Meeting and Research Conference of Sigma Xi, Raleigh, North Carolina, USA, Nov 13, 2010.
68. **Kiesel, Rüdiger.** *Pricing CO2 permits using approximation approaches.* Workshop "Mathematics and Industry", Beijing, China, Mar 2010
69. **Kiesel, Rüdiger.** *Pricing CO2 permits using approximation approaches.* 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
70. **Kiesel, Rüdiger.** *Pricing CO2 permits using approximation approaches.* EURO XXIV Conference, Lisbon, Portugal, Jun 2010
71. **Kvaal, Simen.** *Adaptive time-dependent coupled cluster method for wave-packet propagation of many-fermion systems.* 10th annual meeting of SPP 1324, Phillips-Universität Marburg, Eisenach, Germany, Oct 27-29, 2010
72. **Kvaal, Simen.** *Variational Principles for Coupled-Cluster Methods.* 9. Berlin-Leipzig Numerik Seminar, Technical University of Berlin, Germany, Dec 10, 2010
73. **Kvaal, Simen;** Jarlebring, E; Michiels, W. *A numerical method for computing the radius of convergence of Rayleigh Schroedinger Perturbation theory without the need for the terms in the series.* Resonance Phenomena and their Applications, Technion University, Haifa, Israel, May 30 - Jun 4, 2010
74. **Lilje, Per.** *Institutt for teoretisk astrofysikk ESA-prosjekter.* SPACE@UiO, University of Oslo, Norway, Jan 12, 2010
75. **Lyche, Tom; Dokken, Tor;** Pettersen, KF. *Locally refined B-splines; recent progress.* Workshop on Isogeometric Analysis: Integrating Design and Analysis, University of Texas at Austin, USA, Jan 13-15, 2010
76. **Menoukeu Pamen, Olivier.** *A General Theorem for Portfolio Generating Functions,* University of the Witwatersrand, Johannesburg, South Africa, May 12, 2010

77. **Menoukeu Pamen, Olivier.** *A General Theorem for Portfolio Generating Functions*, Ludwig Maximilian University of Munich, Germany, Jul 1, 2010
78. **Menoukeu Pamen, Olivier.** *A General Maximum Principle for Anticipative Stochastic Control and Applications to Insider Trading*. AMaMeF Workshop, Berlin, Germany, Sep 29, 2010
79. Mishra, Siddhartha. *High-resolution simulations of the solar atmosphere*, Applied Mathematics colloquium, Tel Aviv university, Israel, Jan 10, 2010
80. Mishra, Siddhartha. *Robust schemes for the numerical approximation of ideal MHD equations*, Swiss Numerics day, Zürich, Switzerland, Apr 19, 2010
81. Mishra, Siddhartha. *Well-balanced numerical schemes for systems of conservation laws*, Numerics seminar, University of Zurich, Switzerland, Apr 23, 2010
82. Mishra, Siddhartha. *Simulating waves in the sun*, Research seminar, PMOD-WRC, Davos, Switzerland, Apr 30, 2010
83. Mishra, Siddhartha. *Arbitrarily high-order accurate entropy stable non-oscillatory schemes for systems of conservation laws*, 13th Intl. Conf. on Hyperbolic problems, theory, numerics and applications, Beijing, China, Jun 18, 2010
84. Mishra, Siddhartha. *Robust numerical schemes for shallow water equations: Entropy stability, well-balancing and uncertainty quantification*, Modeling and computations of shallow water coastal flows, College Park, Maryland, USA, Oct 19, 2010
85. Mishra, Siddhartha. *Robust methods for quantifying uncertainty in solutions of systems of conservation laws*, Conference on Non-standard methods in CFD, Leonhard Euler center, Zurich, Oct 29, 2010
86. Mishra, Siddhartha. *Multi-level Monte Carlo methods for quantifying uncertainty in systems of conservation laws*, Focus seminar on conservation laws, Stuttgart, Germany, Nov 25, 2010
87. Mishra, Siddhartha. *Arbitrarily high-order entropy stable schemes for systems of conservation laws*, ANAMAT seminar, University of Malaga, Spain, Dec 9, 2010
88. **Musco, Ilia.** *New perspective on primordial black hole formation*. Astronomy Unity Queen Mary University of London, UK, Apr 28, 2010
89. **Musco, Ilia.** *New perspective on primordial black hole formation*. Institute of Cosmology and Gravitation, University of Portsmouth, UK, Apr 29, 2010
90. **Musco, Ilia.** *New perspective on primordial black hole formation*. Cosmology seminar, ITA, University of Oslo, Norway, Oct 18, 2010
91. **Piaskowska, Katarzyna.** *On Some New Model of Turbulent Fluid Flow*. University of Kansas, USA, May 3-10, 2010
92. **Piene, Ragni.** *Curve counting and generating functions*. Colloquium di Dipartimento. Università degli Studi di Roma Tor Vergata, Roma, Italy, Feb 26 2010.
93. **Piene, Ragni.** *Classification des polytopes entiers par fibrations toriques*. Université de Versailles Saint-Quentin-en-Yvelines, France, Apr 15, 2010.
94. **Piene, Ragni.** *Inflection loci of projective varieties*. Harvard/MIT Algebraic Geometry seminar, Harvard University, Cambridge, USA, Nov 9, 2010.
95. **Piene, Ragni.** *Some Counting Problems and Their Generating Functions*. Women in Mathematics Lecture Series, Cambridge, USA, Nov 10, 2010.
96. **Quak, Ewald.** *The Potential of Currents for Environmental Management of the Baltic Sea*. Humboldt Kolleg, Kiev, Ukraine, Aug 5-8, 2010
97. **Quak, Ewald.** *Green Marine Highways: Towards the use of properties of currents for environmental management*. Ulm Universität, Germany, Dec 17, 2010
98. **Risebro, Nils Henrik.** *Towards high resolution methods for the solar atmosphere*. Complex analysis, differential equations and Applications, NTNU, Trondheim, Norway, Sep 2-4, 2010.
99. **Risebro, Nils Henrik.** *Simulation of the solar atmosphere*. China-Norway-Sweden workshop on computational mathematics, Bergen, Norway, Jun 8-10, 2010
100. **Raynaud, Xavier.** *Metric for nonlinear partial differential equations*. Manifolds and Geometric Integration Colloquium - Magic 2010, Ustaoset, Norway, Mar 2-5, 2010
101. **Selstø, Solve; Kvaal, Simen.** *Absorbing boundary conditions for dynamical many-particles systems*. Resonance Phenomena and their Applications, Technion University, Haifa, Israel, May 30 - Jun 4, 2010.
102. **Sætra, Martin Lilleeng.** *CUDA by Example*. Computer Science Seminar Series (CSSS), University of Mississippi, USA, Apr 28, 2010
103. **Sætra, Martin Lilleeng; Brodtkorb, André.** *Shallow Water Simulations on Multiple GPUs*. VERDIKT Program Conference, RCN Norway, Nov 1-2, 2010
104. **Ta, An Thi Kieu.** *Optimal consumption and constrained portfolio in a market with jumps*. AMaMeF conference Bled, Slovenia, May 4-8, 2010.
105. **Tai, Xue-Cheng.** *Augmented Lagrangian Method, Dual Methods and Split Bregman Iteration for ROF Model*. Workshop Korea Mathematical Methods for Curves and Surfaces (CGIV), Dongseo, Korea, Jan 6- 12, 2010
106. **Tai, Xue-Cheng.** *A Fast Algorithm for Euler Elastica Model Using Augmented Lagrangian Method*. International Workshop on Numerical Mathematics: Theory, Methods and Applications, Nanjing, China, Aug 24-29, 2010.
107. **Tai, Xue-Cheng.** *Level set methods and inverse problems*. Workshop Inverse Problems, Computation, and Applications, CIRM Luminy, France, May 31 - June 4, 2010.
108. **Tai, Xue-Cheng.** *A fast algorithm for Euler elastica model using augmented Lagrangian method*. PDEs Workshop, University of Oklahoma, USA, Oct. 9-10, 2010.
109. **Tai, Xue-Cheng.** *A Fast Algorithm for Euler Elastica Model Using Augmented Lagrangian Method*. Workshop on Computational Mathematics and Scientific Computing, Beijing, China, Sep 9-11, 2010
110. **Tai, Xue-Cheng.** *Global Minimization for Continuous Multiphase Partitioning Problems Using a Dual Approach*. Summer Program on Image Processing, Park City Mathematics Program (PCMI), Princeton University, USA, Jun 27 - Jul 17, 2010.
111. **Villamizar, Nelly.** *Dimension of $C1$ Spline Spaces in the Plane*. INRIA Sophia-Antipolis Méditerranée, France, Nov 19, 2010
112. **Vos, Linda.** *Forward pricing in electricity markets based on stable CARMA spot models*, PhD-student seminar, NTNU, Trondheim, Norway, Nov 19, 2010
113. **Winther, Ragnar.** *Finite element exterior calculus - from Hodge theory to numerical stability*. Runge - Herglotz seminar, University of Göttingen, Germany, May 3-4, 2010
114. **Winther, Ragnar.** *Cochain projections in finite element exterior calculus*. Workshop on Non-standard numerical methods for partial differential equations, Pavia, Italy, Jun 29 - Jul 2, 2010
115. **Winther, Ragnar.** *Introduction to finite element exterior calculus*. IMA tutorial: Some novel discretization techniques, University of Minnesota, USA, Oct 30-31, 2010
116. **Zhang, Tusheng.** *Stochastic partial differential equations with reflection*. Workshop on Stochastic Partial Differential Equations, Cambridge, UK, Jan 4-8, 2010
117. **Zhang, Tusheng.** *Boundary value problems for semilinear elliptic equations with singular coefficients*. Workshop on Stochastic Control in Finance, Roscoff, France, Mar 19-23, 2010

118. **Zhang, Tusheng.** *Stochastic partial differential equations with reflection.* Workshop on Markov Processes and Related Topics at Beijing Normal University, Beijing, China, Jul 19-23, 2010
119. **Zhang, Tusheng.** *Boundary value problems for semilinear elliptic equations with singular coefficients,* The 4th International Conference in Stochastic Analysis, Osaka, Japan, Aug 30-Sep 4, 2010
120. **Zhang, Tusheng.** *Reflected Stochastic Partial Differential Equations,* SAMSA 2010, Botswana, Nov 29- Dec 3, 2010
121. **Øksendal, Bernt.** *Backward stochastic differential equations with respect to general filtration and applications to insider finance.* Bachelier Workshop in Metabief, France, Jan 25-29, 2010
122. **Øksendal, Bernt.** *BSDEs and risk minimization.* The University of Tunis, Tunisia, Mar 8-12, 2010
123. **Øksendal, Bernt.** *Backward stochastic differential equations with respect to general filtration and applications to insider finance.* The University of Warwick, UK, Mar 24, 2010
124. **Øksendal, Bernt.** *Backward stochastic differential equations with respect to general filtration and applications to insider finance.* The University of Swansea, Wales, Mar 25, 2010
125. **Øksendal, Bernt.** (4 lectures) *Malliavin Calculus and Applications to Finance.* St Andrews University, Scotland, Apr 7, 2010
126. **Øksendal, Bernt.** *Backward stochastic differential equations with respect to general filtration and applications to insider finance.* Mark Davis Workshop, Stochastics, Control and Finance at Imperial College, London, Apr 12-14, 2010
127. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced backward stochastic differential equations.* 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
128. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced BSDEs.* Workshop on Stochastic Analysis and Applications at the Linnæus University, Växjö, Sweden, May 20-21, 2010
129. **Øksendal, Bernt.** (8 lectures) *Malliavin Calculus and Applications to Finance.* Prague Summer School in Quantitative Finance, Prague, Czech Republic, Jun 7-8, 2010
130. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced BSDEs.* The 9th Workshop on Stochastic Analysis and Related Fields, Telecom ParisTech, Paris, Jun 14-15, 2010
131. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced BSDEs.* Workshop on New Advances in BSDEs for financial engineering applications, Tamerza, Tunisia, Oct 25-28, 2010
132. **Øksendal, Bernt.** *The chaos expansion approach.* Workshop on Malliavin Calculus for Jump Processes, University of Marne-la-Vallée, Paris, Nov 18-20, 2010
133. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced BSDEs.* SAMSA 2010, Gaborone, Botswana, Nov 29-Dec 3, 2010
134. **Øksendal, Bernt.** *Optimal control of stochastic delay equations and time-advanced BSDEs.* The Quantum mathematical Finance (QMF) Conference, Sydney, Australia, Dec 15-18, 2010
135. **Aase, Knut.** *The investment horizon problem: A resolution.* FIBE 2010, NHH, Norway, Jan 7-8, 2010
136. **Aase, Knut.** *The investment horizon problem: A resolution.* Geilo Seminar, Norway, Mar 10-12, 2010
137. **Aase, Knut.** *Pareto Optimal Insurance Policies in the Presence of Administrative Costs.* Risk and Stochastics day 2010, London School of Economics and Political Science, UK, Mar 23, 2010
138. **Aase, Knut.** *The Equity Premium and the Risk Free Rate in a Production Economy: A new Perspective.* Quantitative Methods in Finance (QMF 2010), Sydney, Australia, Dec 15-18, 2010
139. **Aase, Knut.** *Long Dated Life Insurance and Pension Contracts.* Practitioner Workshop: Long Dated Insurance and Pension Contracts, Sydney, Australia, Dec 14, 2010

8b. Contributed scientific talks, posters etc 2010

1. **Antolin, Patrick.** *A new view on coronal rain with the SST,* USO-SP Final Meeting, Tammsvik, Sweden, Jan 9-11, 2010
2. **Antolin, Patrick.** *Coronal rain: the 6th coronal heating constraint?* Asia Oceania Geosciences Society Meeting, Hyderabad, India, Jul 5-9, 2010
3. **Antolin, Patrick.** *A sharp look on coronal rain with Hinode/SOT and CRISP of SST.* Hinode 4 meeting: Unsolved problems and recent insights, Mondello, Palermo, Italy, Oct 11-15, 2010
4. **Bae, Egil.** *A Study on Continuous Max-Flow and Min-Cut Approaches.* IEEE Conference on Computer Vision and Pattern Recognition (CVPR), San Francisco, USA, 2010
5. **Bae, Egil.** *Efficient Global Minimization for the Multiphase Chan-Vese.* Model of Image Segmentation SIAM Conference on Imaging Science, Chicago, USA, 2010
6. **Bae, Egil.** *Global Minimization for Continuous Multiphase Partitioning Problems.* Using a Dual Approach SIAM conference on Imaging Science, Chicago, USA, 2010
7. **Briseid, Sverre.** *Heterogeneous Spline Surface Intersections.* Spring Conference on Computer Graphics, Budmerice, Slovakia, May 13-15, 2010
8. **Brodtkorb, André.** *Live demonstration of GPU-accelerated shallow water simulation,* National Oceanic and Atmospheric Administration - National Weather Service, Washington DC, USA, Apr 19, 2010
9. **Brodtkorb, André.** *State-of-the-art in Heterogeneous Computing,* Para 2010: State of the Art in Scientific and Parallel Computing, Reykjavik, Iceland, Aug 8, 2010
10. **Brodtkorb, André.** *GPU Acceleration of Image Processing Algorithms,* 5th ADABTS Meeting, Stockholm, Sweden, Sep 17, 2010
11. **Brodtkorb, André.** *Evacuate Now? Faster than Real-Time Shallow Water Simulation,* NVIDIA GPU Technology Conference, San Jose, USA, Sep 21, 2010
12. **Carlsson, Mats; Hansteen, Viggo; Gudiksen, Boris.** *3D MHD modeling of the solar chromosphere.* Hinode 4 meeting: Unsolved problems and recent insights, University of Palermo, Italy, Oct 11-15, 2010
13. **Christiansen, Snorre.** *On the linearization of Regge Calculus in 3D.* Workshop on unstructured meshes in dynamical spacetimes, Jena, Germany, Aug 25-27, 2010.
14. **Dokken, Tor.** *Compact Shape Representations for Improved Performance of 3D Networked Immersive Media.* Consultation Workshop on Networked Media, Brussels, Belgium, Jan 19, 2010
15. **Dokken, Tor.** *The emerging pipe junction challenge.* Fall School SAGA Marie Curie Initial Training Network, Kolymari, Crete, Greece, Oct 4-8, 2010
16. **Dokken, Tor.** *The history of CAD and examples of its use in industry.* Fall School SAGA Marie Curie Initial Training Network, Kolymari, Crete, Greece, Oct 4-8, 2010
17. **Floater, Michael.** *A piecewise polynomial approach to analyzing interpolatory subdivision.* Jaen Conference on Approximation Theory, Ubuda, Spain, Jul 4-9, 2010
18. **Floater, Michael; Kosinka, Jiri.** *Barycentric interpolation and mappings on smooth convex domains.* Seventh International Conference on Curves and Surfaces, Avignon, France, Jun 24-30, 2010
19. **Floater, Michael; Kosinka, Jiri.** *Barycentric interpolation and mappings on smooth convex domains.* SPM 2010, 14th ACM Symposium on Solid and Physical Modeling, Haifa, Israel, Sep 1-3, 2010

20. **Fuchs, Franz.** *The Effects of Radiation on Wave Propagation in the Solar Atmosphere*, ETH Zurich, Switzerland, Mar 22, 2010
21. **Fuchs, Franz.** *The Effects of Radiation on Wave Propagation in the Solar Atmosphere*, HYP 2010, Beijing, China, Jun 15-19, 2010
22. **Hansteen, Viggo.** *Numerical 3D models, differential emission measures and red-shifts in the transition region*. Hinode 4: Unsolved problems and recent insights, University of Palermo, Italy, Oct 11-15, 2010
23. **Jansen, Gustav Ragnar.** *Two particle attached (EOM-CC)*. Advances in Coupled-cluster theory, CTCC, Oslo, Norway, Jun 17-18, 2010
24. **Khedher, Asma.** *A Note on convergence of option prices and their Greeks for Lévy models*. 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
25. **Khedher, Asma.** *Robustness of option prices and their deltas in markets modelled by jump diffusion*, Bachelier Finance Society, Toronto, Canada, Jun 22-26, 2010
26. **Khedher, Asma.** *Computation of the Greeks in multi-factor models with applications to power and commodity market*, Amamef Workshop, Berlin, Germany, Sep 27-30, 2010
27. **Khedher, Asma.** *Computation of the delta in multidimensional jump-diffusion setting with applications to stochastic volatility models*. SAMSA 2010, Botswana Nov 29 - Dec 4, 2010
28. **Klausen, Runhild Aae; Stephansen, AF.** *On Rough Grids – Convergence and Reproduction of Uniform Flow*. 12th European Conference on the Mathematics of Oil Recovery Oxford, UK, Sep 6-9, 2010.
29. **Kvaal, Simen.** *Time-dependent Coupled Cluster for Many-Body Quantum Dynamics*. CCP 2010, Trondheim, Norway, Jun 23-26, 2010
30. **Lempa, Jukka.** *On optimal exercise of swing options on electricity markets*, Conference Energy Finance / INREC, Essen, Germany, Oct 6-8, 2010
31. **Lempa, Jukka.** *Irreversible investment decisions under return and time uncertainty*, 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
32. **Lempa, Jukka.** *A Dynkin game with asymmetric information*, Finnish Mathematical Days 2010, Jyväskylä, Finland, Jan 4-5, 2010
33. **McMurry, Andrew.** *Simulation of turbulence in Magnetic Fields*. HYP 2010, Beijing, China, Jun 15-19, 2010
34. **McMurry, Andrew.** *Simulation of turbulence in Magnetic Fields*. IAU Symposium 274: Advances in Plasma Astrophysics, Giardini Naxos, Italy, 6-10 Sep 2010
35. **Moe, Torgunn Karoline.** *Rational cuspidal plane curves*, SAGA Winter School, Auron, France, Mar 2010.
36. **Menoukeu Pamen, Olivier.** *A general maximum principle for anticipative stochastic control and applications to insider trading*. Third SMAI European Summer School In Financial Mathematics. Paris, France, Aug 24, 2010
37. **Menoukeu Pamen, Olivier.** *A Gelfand triple approach to the small noise problem for discontinuous ODE's*, SAMSA 2010 Conference, Gaborone, Botswana, Nov 29, 2010
38. **Musco, Ilia.** *New perspective on primordial black hole formation*. Britgrav 2010 meeting, Dublin, Ireland, Apr 6-7, 2010
39. **Musco, Ilia.** *New perspective on primordial black hole formation*. Meeting "Relativistic Whirlwind" celebrating the 65 birthday of Marek Abramowicz, Chalmers, Sweden, Jun 3, 2010
40. **Musco, Ilia.** *New perspective on primordial black hole formation*. Workshop Unstructured Meshes in Dynamical Spacetimes, Jena, Germany, Aug 25-27, 2010
41. **Olluri, Kosovare; Hansteen, Viggo; Gudiksen, Boris.** *Non-equilibrium ionization of transition region elements in 3D numerical models*. Hinode 4: Unsolved problems and recent insights, University of Palermo, Italy, Oct 11-15, 2010
42. **Piaskowska, Katarzyna.** *On some linear model of a turbulent fluid flow*. Workshop Polish Academy of Sciences, Jurata, Poland, Mar 18-28, 2010
43. **Piaskowska, Katarzyna.** *On some properties of a new turbulent flow model*. Joint SIAM/RSME-SCM-SEMA Meeting on 'Emerging Topics in Dynamical Systems and Partial Differential Equations', Barcelona, Spain, May 31 - Jun 4, 2010
44. **Piaskowska, Katarzyna.** *On a new turbulent fluid flow model: physical interpretation, properties of solutions and numerical discretization*. 13th International Conference on 'Hyperbolic Problems: Theory, Numerics and Applications', Beijing, China, Jun 15-19, 2010
45. **Raynaud, Xavier.** *Global semigroup of conservative solutions to the nonlinear variational wave equation*. 13th International Conference on "Hyperbolic Problems: Theory, Numerics and Applications", Beijing, China, Jun 15-19, 2010
46. **Riise, Atle.** *Parallel Local Search for Permutations*, Collab. workshop, Asker, Norway, Apr 12-13, 2010
47. **Hasle, G; Kloster, O; Riise, Atle; Schulz C; Smedsrud, M.** *Using Heterogeneous Computing for Solving Vehicle Routing Problems*. Seventh Triennial Symposium on Transportation Analysis (TRISTAN VII), Tromsø, Norway, Jun 20-25, 2010
48. **Ryan, Øyvind.** *On general criteria for when the spectrum of a combination of random matrices depends only on the spectra of the components*. Seminar SUPELEC, Paris, France, May 10, 2010
49. **Ryan, Øyvind.** *On the optimal stacking of noisy observations*. Seminar SUPELEC, Paris, France, Jun 4, 2010
50. **Ryan, Øyvind.** *On general criteria for when the spectrum of a combination of random matrices depends only on the spectra of the components*. Workshop on Large Random Matrices, Telecom Paris, France, Oct 11, 2010
51. **Schmeck, Maren.** *Stability of Stochastic Controls*. 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
52. **Schmeck, Maren.** *Stability of Stochastic Controls*. Summer School on Levy Processes, Braunschweig, Jul 22-24, 2010
53. **Selstø, Sølve; Førre, M; Kvaal, Simen; Nepstad, R; Birkeland, T.** *Describing double photo-ionization of helium by means of absorbing boundaries*. CCP 2010 Conference on Computational Physics, Trondheim, Norway, Jun 23-26, 2010.
54. **Selstø, Sølve; Kvaal, Simen; Nepstad, R; Førre, M.** *Non-sequential double ionization of helium: Extracting the cross section*. 10th European Conference on Atoms Molecules and Photons, Salamanca, Spain, Jul 4-9, 2010.
55. **Sjursen, Steffen.** *Optimal investment problems under default risk and asymmetric information*, 5th General conference in Mathematical Methods in Finance, Bled, Slovenia, May 4-8, 2010
56. **Sjursen, Steffen.** *Anticipating integration with respect to Lévy processes*. Sixth International Conference on Lévy Processes: Theory and Applications, Dresden, Germany, Jul 26-30, 2010
57. **Sjursen, Steffen.** *Information and optimal investment in defaultable assets*, SAMSA 2010, Botswana Nov 29 - Dec 4, 2010
58. **Villamizar, Nelly.** *Dimension of C1 Spline Spaces in the Plane* Fall School Shapes, Geometry, and Algebra, Kolympari, Greece, Oct 4-8 2010
59. **Vos, Linda.** *Forward pricing in electricity markets based on stable CARMA spot models*. Conference Energy Finance / INREC, Essen, Germany, Oct 6-8, 2010
60. **Wasylewicz, Agnieszka.** *Positivity-preserving numerical schemes for a phase-field model of infiltration*. SAMSA 2010, Botswana Nov 29 - Dec 4, 2010

8c. Talks for general audiences, public outreach 2010

1. **Antolin, Patrick.** *A rainy day on the Sun*, University of Oslo, Norway, Nov 12, 2010
2. **Benth, Fred Espen.** *Energy Finance - seen from the east side of the t-bane* SFI2 lunch seminar, University of Oslo, Norway, Oct 27 2010
3. **Galdal, Helge.** *An overview of the CMA research*. NILS meeting, Universidad Complutense, Madrid, Spain, Jan 23-25, 2010
4. **Lindstrøm, Tom.** *Matematikk i sport og spill*. Faglig-pedagogisk dag, Jan 8, 2010
5. **Lindstrøm, Tom.** *Hvilken matematikkompetanse har dagens nye studenter - og hvilken burde de ha?*. Sinus-seminar, Cappelen, Oslo, Norway, Feb 11-12, 2010
6. **Lindstrøm, Tom.** *Fermats siste teorem*. Sinus-seminar, Cappelen, Oslo, Norway, Feb 11-12, 2010
7. **Lindstrøm, Tom.** *Norsk matematikkråd*. NTNU's 100 Year's anniversary, Sep 17, 2010
8. **Lindstrøm, Tom.** *Fra videregående til universitet - kontinuitet eller sprang?*. Holmboedagen, Oslo Handelsgymnasium, Norway, Nov 24, 2010
9. **Lindstrøm, Tom.** *Er'e no' vits å lære matte a, lærer?*. Novemberkonferansen 2010, Trondheim, Norway, Dec 1-2, 2010
10. **Mørken, Knut.** *Simulering - realfagenes tredje bein. Nye muligheter for å rekruttere morgendagens forskere?* MNT-konferansen 2010: Kunnskap for fremtiden, Bergen, Norway, Feb 9-10, 2010
11. **Mørken, Knut.** *CSE (Computers in Science Education)-prosjektet*. Avdelingsseminar, Voss, Norway, Apr 8-9, 2010
12. **Mørken, Knut.** *CSE (Computers in Science Education)-prosjektet ved Universitet i Oslo*. Møte med studieledere, Oslo, Norway, Apr 27, 2010
13. **Mørken, Knut.** *Beregninger med (stykkevise) polynomer*. KOMIN 2010, Oslo, Norway, Oct 29-31, 2010
14. **Mørken, Knut.** *CSE (Computers in Science Education)-prosjektet og nasjonal spredning*. Det nasjonale fakultestmøte for realfag, Trondheim, Norway, Nov 21-23, 2010
15. **Quak, Ewald.** *Some things that went wrong due to bad numerical computing*, Summer School, Scientific Computing, Tallinn University of Technology, Estonia, Aug 5-10, 2010
16. **Quak, Ewald.** *Experiences as an Evaluator*, BIONET Project seminar, Succeeding in framework programme - not just a dream, Archimedes Foundation, Tallinn, Estonia, Oct 28-29, 2010
17. **Quak, Ewald.** *Some remarks on Intellectual Property Rights*, SAGA Project Fall School, Kolympari, Greece, October 4-8, 2010
18. **Quak, Ewald.** *10 issues for IAPP*, Workshop IAPP project proposals, EU FP7 PEOPLE program, Norwegian Research Council, Oslo, Norway, Nov 8, 2010
19. **Øksendal, Bernt.** *Mathematics and Finance: The Black-Scholes option pricing formula and beyond*. University of Agder, Kristiansand, Norway, Sep 9, 2010

Appendix 9

Media appearances 2010

9a. TV

- NRK TV "Skavlan" (01.10.2010) Interview with **Cédric Villani**, invited speaker in the 2010 Abel Symposium

9b. Radio

- NRK P2 "Verdt å vite" (07.01.2010) **Carlsson, Mats**. Interviewed on: "Koronaoppvarmingens røtter oppdaget"
- NRK P2 "Verdt å vite" (09.05.2010) **Tom Lindstrøm**. Contribution.
- NRK P1 "Naturens verden" (12.05.2010) **Lilje, Per**. Contribution.
- NRK P3 "Banden" (19.05.2010) **Tom Lindstrøm**. Contribution.
- NRK P2 "Verdt å vite" (01.12.2010) **Hans Kristian Eriksen**. Interview.

9c. Newspapers

- Dagbladet (08.01.2010) **Carlsson, Mats**. Interviewed on: "Er solas største mysterium løst?"
- De Standaard (Newspaper, Netherlands) (10.01.2010) **Carlsson, Mats**. Interviewed on: "De hete Adem van de zon".
- Otago Daily Times (23.04.2010) **Frauendiener, Jörg**. Frontpage article: "Speed of light not fast enough".
- Dagbladet (14.05.2010) **Eriksen, Hans Kristian; Lilje, Per**. Interviewed on: "Nordmenn skal granske skapelsen av universe".
- Dagbladet (06.07.2010) **Hans Kristian Eriksen**. Interviewed on: "Kan gi svar på hvordan universet ble til".
- Dagens næringsliv (11.08.2010) **Fred Espen Benth** Reader's letter: "Sikrer jeg, eller er det spekulering?"
- Aftenposten (17.08.2010) **Lindstrøm, Tom**. Interviewed on: "Norsk matematikkråds forkunnskapstest".
- Adresseavisen (18.08.2010) **Lindstrøm, Tom**. Interviewed on: "Norsk matematikkråds forkunnskapstest".
- Morgenbladet (24.12.2010) **Lilje, Per Barth**. Interviewed on: "Tiårets forskningsgjennombrudd: Presisjonskosmologi".

9d. Magazines

- ICWM Newsletter (18.08.2010) **Piene, Ragni**. Interviewed on: "Mathematics ought to be a subject very suited for women".
- Uniformum (22.10.2010) **Hans Kristian Eriksen**. Interviewed on: "Kan endra verdsbiletet vårt".

9e. Internet

- American Physical Society News (04.01.2010) **Morten Hjorth-Jensen**. Article: "Implications of old physics simplify the understanding of nuclei". <http://physics.aps.org/articles/v3/2>
- Aftenposten, Web TV (28.04.2010), **Hansteen, Viggo; Carlsson, Mats**. Interviewed on "SDO oppskytning" og "first light" <http://www.aftenposten.no/nyheter/iriks/article3627678.ece>
- Science News (26.05.2010) **Morten Hjorth-Jensen**. Article: "UTK-ORNL-Oslo theorists pin down the proton-halo state in Flourine-17". [http://esciencenews.com/...](http://esciencenews.com/)
- <http://plus.maths.org/> (22.08.2010) **Piene, Ragni**. Interviewed: "And who chooses the winners?"
- utdanning.no (10.10.2010) **Snorre Christiansen**. Work interview: "Matematiker"
- Highbeam Research (21.10.2010) **Morten Hjorth-Jensen** Article: "Isotope Near 'Doubly Magic' Tin-100 Flouts Conventional Wisdom" <http://www.highbeam.com/doc/1P3-2169633741.html>
- Nature News (10.12.2010) Wehus, IK; **Eriksen, Hans Kristian**. Interviewed on: "No evidence of time before Big Bang".
- BBC internet (26.12.2010) Wehus, IK; **Hans Kristian Eriksen**. Interviewed on: "Bangs big and small in cosmic origins debate".

Handwritten mathematical notes and diagrams:

- $b_t = b_t(z) B_t \sqrt{n}(X - X_n) \rightarrow d = \frac{U''(\epsilon)}{U'(\epsilon)}$
- $\int \phi(t) \exp(\int_0^t \lambda_n dB) \int dW \rightarrow \ominus$
- $\varphi(x) = E \int_0^x f(x_1) dx + g(x_2)$
- $A\varphi + f = 0 \quad \text{in } D$
- $\varphi = 0 \quad \text{on } \partial D$
- $K = 0$
- $\int_{\mathbb{R}^d} \varphi(x) dx = x^{\frac{1}{2}}$
- $K_n = \frac{1}{\sqrt{2\pi}}$
- $\|f_n - f\|_{L^2(\mathbb{R})} \rightarrow 0$
- $\|f_n - f\|_{L^2(\mathbb{R})}^2 = \|f_n - f\|_{L^2(\mathbb{R})}^2$
- relative index of refraction
- $K_n = \log_2 b_n$
- $\int_{\mathbb{R}^d} \chi_{(0,1)} \chi_{(1,2)} dB(x)$
- $x = \sup_{t \in \mathbb{H}} \{a(t) - \int_0^t (c(s)) ds\}$
- $= \sup_{t \in \mathbb{H}} \{a(t) - E_a(X-G)\}$
- $\int_{\mathbb{R}^d} \varphi(x) dx = x^{\frac{1}{2}}$
- $K_n = \frac{1}{\sqrt{2\pi}}$



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