CMA

Centre of Mathematics for Applications

ANNUAL REPORT 2003



UNIVERSITY OF OSLO

Senter for fremragende forskning

Norges forskningsråd

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INTRODUCTION

Overall remarks and main impressions of 2003

CMA, Centre of Mathematics for Applications, was established on March 1, 2003. The organization has been adapted into a larger, well established university structure, activity has constantly increased, and new research results are obtained. «We are enthusiastic about CMA». Statements like this are quite often presented to the centre management, and we regard it as a very important factor for an eventual success of CMA. There are obvious reasons to believe that such an attitude contributes to good research. We still have much to prove, but in one sentence: All in all, we have had a good start! We choose to emphasize the following as a main summary of 2003:

- The research plan remains unchanged, and at the start of 2004 the main research goals are the same as originally stated.
- For six months we were without our own premises. Since we entered the 10th floor of the Niels Henrik Abel building at Blindern campus on September 1, and especially since the entrepreneurs and workmen left us in mid-November, activities have accelerated. The colocalization has truly been vital to us.
- Since the very beginning we have focused on establishing new research relations, and we incentively encourage research activities that support our research plan. In fact this is a management strategy of ours which we so far regard as successful. New CMA members have been employed with due preferences to our research plan, and thereafter all the scientific activities of CMA are concentrated on different aspects of the plan.
- Several seminar series and workshops have been arranged, all with international participation. Numerous guests have been received.
- A good relationship to the host departments and faculty is essential, or else we would become alienated. So far we are very pleased with the situation. We have experienced that new positions and resources have been allocated to us, also after the establishment of the centre. Furthermore efficient administrative support is ensured by utilizing the existing university organization.
- We have accumulated a 2003 surplus of MNOK 4, mainly due to late arrival to our premises, and delays in employments.
- Total revenues of 2003 are MNOK 34 (compared to 26 in the original the budget). Estimated (conservatively) revenues of 2004 are adjusted to MNOK 35 (compared to 31 in the original budget), leaving 2004 with an estimated surplus of MNOK 1,8. The activities then ensure that budgets and accounts will balance at the end of 2005.
- A main chapter of this report is dedicated to the main research results of 2003. A brief summary in facts and figures are presented in the right column, and full publication lists are presented in the appendices.

CMA in brief – facts and figures of the 2003 research activities

In 2003, CMA hosted 61 members (32,6 man year). At Dec 31, we count

- 59 members (19 PhD, 13 postdocs, 25 senior scientistis, and 2 T/A)
- 3 PhD-students finished their degrees in 2003

CMA received

- 2 long term visitors (stayed for more than 3 months),
- 76 international guests on short-time (less than 3 months) visits (73 different persons, three persons on two visits), from 17 different countries
- more than 200 unique Norwegian guests (short-time), many of them several times, participating in our events (workshops, conferences, and seminar series) or collaborating with our members.

Total revenues of 2003 were MNOK 34,1 (RCN 9,0 , UiO: 13,3, SINTEF: 0,6, Other: 11,2)

CMA members published:

- 67 refereed articles in international journals,
- 62 scientific reports, preprints, contributions, proceedings etc (not refereed),
- 4 books,

CMA-members gave

- 23 scientific talks in Norway, but outside CMA,
- 78 scientific talks abroad, in 18 different countries

CMA arranged

- 6 conferences/workshops with 221 participants, in which 73 scientific talks were given:
  - 24 by CMA members,
  - 22 by national guests,
  - 27 by international guests,
- 6 seminar series, in which 64 scientific talks were given:
  - 28 by CMA members,
  - 14 by national guests,
  - 22 by international guests.

Finally CMA also co-arranged 8 other international workshops and conferences.

Main challenges at the beginning of 2004

Our first priority and main challenge remain to continue to focus on the interdisciplinary aspects of our research plan and to conduct new research according to this. We will do this essentially by the same strategy as we have used so far, described in the Management section.

A main concern could be the renewal of our project portfolio, especially with respect to individual grants. At present we have a large number of such projects, mainly provided by the RCN (Research Council of Norway). See appendix 4 for details. However, such future grants seem to become harder to achieve, and the academic profile of CMA does not fit the larger programmes of RCN. We will join forces with all mathematical environments of Norway in order to work towards the establishment of a national programme dedicated for mathematics and its numerous applications. Furthermore we are constantly working towards the EU-system and its different Marie Curie Programmes, which also may provide training positions. Training of new researchers is a main goal of CMA, and does not interfere with the core research of CMA. On the contrary, and if we succeed in managing the project; the more fellows entering the CMA community, the more research will be carried out.

We may also apply for more collaborative and comprehensive research projects. However CMA itself is such a project, and the core activity of CMA demands our full attention. Hence we will be very selective on any suggested proposal of this kind, and we will only get involved if a proposed project fully supports the intentions of CMA.

We will also focus on establishing a strategy in order to obtain more attention, which so far has been a weak point of ours.

Finally, we will focus on strengthening our national and international collaborations. We will continue to participate in the international scene, and we are considering to entering international obligations with leading institutions. We will also continue to have numerous researchers visiting us, and a special goal for 2004 is to invite and receive more long-term visitors.

THE RESEARCH PLAN – STATUS, CHANGES

The main focus in 2003, and also for 2004, has been to establish research activities within the frames of the original research plan. This means that we have to inspire, stimulate and build several new relations between researchers and research groups. How we have addressed such challenges is described in the management section.

This also means that we have not yet made any changes or updates in the research plan. A lot of research and research events have taken place in 2003 according to the existing plan, which we outline in the next, main chapter in this report, The Scientific Activity Report.

SCIENTIFIC ACTIVITY REPORT

Introduction, bridging

The main goal of the research activity of CMA is to create a national research centre with an atmosphere where the participants continue to do first rate research in the four main areas of the centre, i.e. geometry, stochastic analysis, differential equations, and applications in physical sciences. The activity in physical sciences is focused around computational astrophysics and computational quantum mechanics. However, in addition to preserving the high level activity in these areas, a central idea behind the establishment of the CMA is to create new interdisciplinary research activity based on the interplay between these areas. Examples are interdisciplinary research activities where we focus on the interplay between:

I computational geometry and algebraic/differential geometry
II computational geometry and differential equations
III stochastic analysis and differential equations
IV stochastic analysis and physical sciences
V differential equations and physical sciences.

Most of the scientific results reported from 2003 are based on activity that had started already before the CMA was created. Therefore, only to a limited extent do these results reflect the research philosophy of the CMA. However, in order to stimulate the research in the desired direction, we have organized a number of conferences and workshops where the main focus has been on interdisciplinary topics. Below we will describe these «main events», and thereafter we outline the main scientific results obtained by CMA members in 2003.

The main events

Workshop: Computational methods for the time-dependent Schroedinger equation, Nov. 17-18

Recent advances in atomic and molecular physics and solid state physics allow now for studies of isolated quantal systems such as single ions in traps of various geometries under the influence of e.g., time-dependent electromagnetic fields from a Laser. Such experiments have important consequences for our basic understanding of quantum mechanics and its theoretical foundations. Furthermore, studies of these isolated systems may have important practical applications, spanning from atomic lasers to the construction of quantum gates and tests of quantum information algorithms. Several methods exist for studying such quantal systems, ranging from partial differential equations to Green's function Monte Carlo methods. The aim of this workshop was to expose possible directions of research based on partial differential equations, discuss eventual limitations and point to links with other methods.

The main topics covered were

- Physical systems which can be studied with partial differential equation techniques
- Finite element methods for time-dependent Hamiltonians
- Limiations due to increasing degrees of freedom
- Coupling to stochastic differential equations and Monte Carlo methods

Workshop: Computational methods in astrophysical problems, Nov. 4-5

The use of computational methods as tools for understanding astrophysical phenomena have become indispensable. This informal workshop was devoted to various numerical aspects of systems of partial differential (and related) equations arising in an astrophysical context, and it brought together researchers in astrophysics (with computational emphasis) and researchers working in the area of partial differential equations and their numerical methods.

The main topics covered were

- Numerical methods for hyperbolic conservation law
- Astrophysical magnetohydrodynamics
- Radiation hydrodynamics
- Radiative transfer problems
- Chromospheric dynamics
- Boundary conditions

Workshop: Mathematics and economics day, Oct 3.

The finance industry is largely exposed to different factors of risk which influence their investment decisions. In markets where the prices show large fluctuations, and where assets tend to move in parallell, it is an important problem to come up with risk measures going beyond the traditional Valueat-Risk based on normality assumptions. Furthermore, the question of optimal investment decisions under different risk preference structures are challenging both from a practical and scientifical point ofview. This years workshop on math and economics focused on risk measures and optimization ofportfolios using utility maximization techniques. The presentations covered theory from statistics,stochastic analysis and partial differential equations.

The main topics covered were

- Wealth-path dependent utility maximization in incomplete markets.
- Correlation as a dependence measure in risk management.
- Optimal risk sharing.
- Utility maximization and American options.
- Are asset managers incoherent?
- A semilinear Black and Scholes partial differential equation for valuing American options.

Workshop: Level Set Methods, Sep. 9-10.

Level set methods (and fast marching type methods) are numerical techniques that are designed to track the evolution of interfaces. They have found numerous applications, including semiconductor manufacturing, shortest path algorithms, collision avoidance of airplanes, robotics, image processing, computer vision, computer graphics, fluid dynamics, and flow in porous media. On the mathematical side there is deep connection between level set methods and the theory of viscosity solutions of nonlinear partial differential equations.

The main topics covered were

- A Brief Introduction to Level Set Methods
- A level set method for solving free boundary problems associated with obstacles
- Multiscale permeability estimation using a level set parameterization
- Computing Geodesic Distance Functions on 3D Triangle Meshes
- A Levelset Model for Constrained Optimization Problems, with Applications to Image Processing
- Level Set Methods for the Solution of First Order PDEs - From Jacobi to Courant and Hilbert
- Fast computation of time-of-flight
- Eulerian-Lagrangian methods for non-linear advection equations
- A variant of the level set method and applications to image segmentation
- Weak boundary conditions for Hamilton-Jacobi equations

The official kick-off conference, Sep. 1-2.

The conference was intended for a broad audience with interests in mathematics and its applications. The idea was to focus on central themes of the research plan for CMA. The intention is to repeat a similar conference in about three years in order to present the progress made at the CMA on these issues.

The conference program covered the following topics:

- Tom J. Bogdan: What Does the Size Distribution of Sunspots Reveal About Their Origins? A Mathematical Detective Story
- Weinan E: Applied Mathematics and Computational Science, Some Personal Perspectives.
- Helge Holden: The Task Ahead and One Example, the Camassa-Holm equation.

- Mark H.A. Davis: Valuation, Hedging and Investment in Incomplete Financial Markets.
- Magne Espedal: CMA and a disciplinary organized University.
- Tom Lyche: Geometric Modeling and Splines.
- Carl de Boor: Ideal interpolation.
- Giulia Di Nunno: Stochastic differentiation and minimal variance hedging.
- Snorre Christiansen: Preconditioning unbounded operators ; the example of Calderon formulas.
- David J. Dean: Quantum many-body problems and their solutions.
- Tom Lindstrøm: CMA and Educational Challenges.
- Per Barth Lilje: The Cosmic Microwave Background: How to see the beginning of the Universe.

The Arctic workshop on Stochastic Analysis and Matehematical finance, Aug. 5-10.
The purpose of this international workshop is to bring together researchers and students in Stochastics and Finance, and to discuss the latest developments in this exciting and rapidly developing area of research.

The CMA seminar Series 2003
This is the official seminar series of CMA It is intended for a rather broad audience with interests in mathematics and its applications. The activity of the seminar aims at keeping a balance between theory, computation, and applications. The seminar brings speakers from inside and outside of the centre, raising issues and exchanging ideas on topics of current interest, mainly connected to the research plan of the CMA. A goal of the seminar is to foster working relationships among mathematicians, computational mathematicians, and scientists from the applied fields and industry.

CMA Guest Lectures, 2003
This seminar at CMA is organized on a non-regular basis, and each speaker is announced here on the web page and by e-mail. The seminar features speakers that are guests of the members of the centre. A presentation, which may be specialized, is usually related to the research plan of CMA.

In addition to what has been mentioned above ordinary weekly seminars have taken place at the CMA, covering topics like stochastic analysis, partial differential equations, and a seminar on topics in geometry and partial differential equations, with focus on connections between the two.

Main Scientific results

Below we give a brief description of the main scientific results obtained by CMA members in 2003. We have chosen to present the results as parts of five main research directions, geometry, stochastic analysis, differential equations, computational astrophysics, and computational quantum mechanics. The descriptions below refer to results given in papers or projects listed in our reference list below. In relation to CMAs ambition to create new interdisciplinary research activity, we emphasize that in the areas of computational geometry-algebraic geometry and stochastic analysis-differential equations, new activities have already been initiated.

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

In mesh based modelling finding a good parametrization is important. Michael Floater has proved a generalization of a classical mathematical result by Tutte on the injectivity of barycentric mappings and constructed a new generalization of barycentric coordinates which has been used to simplify and improve parametrization methods for surfaces. This was a central part of Post Doc fellow Vitaly Surazhsky's remeshing algorithm. Meshes typically come from huge point Clouds and existing algorithms (like marching cubes) produce deficiencies like long thin triangles. Surazhsky's algorithm improves the existing mesh and has received much attention in the computer graphics community. Another new result in computational geometry is due to Martin Reimers and Kai Hormann. They have developed an algorithm for triangulating point clouds based on a «meshless parameterization».

The CMA researchers participating in the EU IST network GAIA II (Tor Dokken, Pål Johansen, Ragni Piene, Jan B. Thomassen) have been working on the use of algebraic methods, in particular algebraic geometry, to solve problems within computer aided geometric design (CAGD). Their results have been presented through lectures and through the deliverables of this project. An important international presentation activity took place with the COMPASS workshop as a meeting place for researchers in Europe working within algebraic geometry and CAGD; proceedings of this workshop will appear in 2004.

Dokken's scientific work has been concentrated around weak approximate implicitization and inversion. The link between approximate and weak approximate implicitization has been established. Most results concerning accuracy and convergence from approximate implicitization carry over to weak approximate implicitization. Work on approximate implicitization has started, and at the end of the year a more general formulation of the problem related to moving lines and surfaces was established. This work is in an initial phase.

Johansen has, together with a GAIA II partner, studied the topological properties of real algebraic curves, using an algorithm to produce examples, based on a computational approach to Viro's gluing method. In addition he has worked on a topological classification of tangent developables of space curves, and on a classification of monoid surfaces of degree four.

Piene's main focus has been the study and classification of real algebraic curves and surfaces of low degree, with a view towards using these objects as approximate implicitizations of parameterized objects, and on the study of the singularities of various types of parameterized surfaces. Part of the work has been in collaboration with Johansen and with GAIA II partners.

Jan B. Thomassen has worked on implementing algorithms for implicitization of curves and surfaces in CAGD. An important application of this is found in intersection algorithms, and he has been doing research on the theoretical basis for this. He has also worked on the use of algebraic geometry in closest point algorithms. Part of this work will be continued in collaboration with Johansen.

The activity in discrete geometry is performed by Geir Dahl and his two Ph.D. students Truls Flatberg and Njål Foldnes. The research activity in this group may be divided into two areas, combinatorial matrix theory, and discrete optimization. In combinatorial matrix theory the focus has been on existence results and extremum problems for certain matrix classes, while the problems in discrete optimization have been motivated from applications in tomography. This latter study has lead to new and efficient optimization algorithms for reconstructing discrete images from given projections. In addition, a basic class of polytopes, a subclass of the so-called knapsack polytopes, have been studied, and some completeness results relevant for integer linear programming are obtained. A motivation for this study was mobile communication problems.

Stochastic analysis

The research at CMA in stochastic analysis is closely related to applications in finance. Focused research topics are stochastic differential equations and stochastic control theory. The development of numerical methods for such problems is planned to be a central issue.

Fred Espen Benth, Giulia Di Nunno, Alberto Lanconelli, Cloud Makasu, Sure Mataramvura, Thilo Meyer-Brandis, Bernt Øksendal and Frank Proske, Jurate Saltyte-Benth are all working in the area of stochastic analysis and applications. More precisely, their research activities include optimal stopping and stochastic control of systems described by stochastic differential equations driven by Brownian motion and - more generally - Lévy processes. There are many applications of this theory, especially in finance. For example, it can be applied to find the optimal portfolio and consumption rate of a trader in a financial market described by such systems. It can also be applied to find explicitly the closest hedge (in the sense of minimal variance) to a given claim in such incomplete markets, or to model energy markets.

Cloud Makasu has been working on solvable stochastic control problems and optimal stopping problems in systems driven by Lévy processes. He has obtained a number of useful explicit results. Moreover, he and Bernt Øksendal have studied optimal control of stochastic delay equations and found explicit solutions in a class of cases. Such equations are very useful for applications, because there is often a delay between the action and reaction in finance (and other) systems. However, these problems are intrinsically difficult, since they are infinite dimensional in general.

Giulia Di Nunno, Bernt Øksendal and Frank Proske have developed a white noise theory for Lévy processes and Poisson random measures and applied the theory to hedging problems in finance and to certain stochastic partial differential equations.

Giulia Di Nunno, Thilo Meyer-Brandis, Bernt Øksendal and Frank Proske have developed a Malliavin calculus for Lévy processes. Then they have used this to study the corresponding optimal portfolio and consumption problem in the case the the trader has more information than what can be observed in the market. Such traders are called insiders. Insider trading is illegal and some of the motivation of this research is to find methods to detect when insider trading has taken place and by whom.

Alberto Lanconelli and Frank Proske have obtained new formulas for the general solution of a stochastic differential equation, using the machinery of white noise analysis and the Wick product.

Bernt Øksendal is also working in the development of the stochastic calculus (including Malliavin calculus) and applications of fractional Brownian motion. This class of processes have many applications, also in finance, for example in connection with weather derivatives.

Sure Mataramvura, Bernt Øksendal and Frank Proske have studied the Donsker delta function and local time for Levy processes, using white noise and the Wick product. The results can be applied to find explicit hedging formulas in markets driven by such processes.

Thilo Meyer-Brandis and Frank Proske have studied nonlinear filtering for systems driven by Lévy processes. The results have applications to estimation and to partial observation control for such systems.

Fred Espen Benth, Jurate Saltyte-Benth and Steen Koekebakker (HiA) have worked on modelling of energy markets. Using Levy processes, spot models for energies have been fitted, along with explicit formulas for forward contracts. Work on average-based forward contracts is under preparatyions, as well as modelling of temperature-based derivatives (weather derivatives). Based on fractional models, a dynamics for arbitrage-free option prices has been caluclated.

Fred Espen Benth, Kenneth Hvistendahl Karlsen and Thilo Meyer-Brandis have worked on minimal entropy martingale measures using the dynamic programming approach. Explicit densities have been calculated for stochastic volatility models driven by Brownian motion and for a jump diffusion model. This work involves solving of nonlinear partial differential equations with possibly an integral term. The minimal entropy martingale measure is of major

importance in the theory of pricing derivatives in incomplete markets.

Fred Espen Benth, Kenneth Hvistendahl Karlsen and Lars Oswald Dahl (Storebrand) have done work on using the Malliavin calculus to derive efficient numerical schemes for the so-called greeks in energy markets. We showed that other efficient algorithms indeed can outperform the Malliavin based methods.

Differential equations

Mathematical modelling and numerical simulations have become an indispensable tool in science and engineering. Partial differential equations are one of the most fundamental tools in constructing such models. The activity in differential equations at CMA is devoted to theoretical aspects of partial differential equations and on the numerical treatment of such problems.

Most of the work of Snorre Christiansen, Runhild Klausen, Xue-Cheng Tai, and Ragnar Winther are related to finite element methods. Christiansen has discussed the electric field integral equation. He has derived new existence-uniqueness results and discussed discretizations by finite elements. In particular, he has derived uniform preconditioners for a related singular perturbation problem, the lowfrequency electromagnetic scattering problem. Klausen has studied the relation between mixed finite element methods and a family of locally conservative finite difference methods. Through this connection she has produced the first rigorous convergence theory for the multi-point flux approximation method on nonrectangular grids. Tai has worked on iterative methods for finite element discretizations of nonlinear variational inequalities, and produced rigorous mesh independent convergence results for such methods. Partly as a joint effort with Tony Chan of UCLA, he has also had several contributions to the theory of level set methods and image processing. Parts of Winther's recent work have been devoted to the construction of stable finite elements for linear elasticity in the mixed stress-displacement formulation. This is joint work with Douglas N. Arnold, University of Minnesota.

A main theme in Per Christian Moans latest work is to develop a general framework for symplectic numerical integrators, i.e. numerical integrators well suited for long time integration, an important topic in multi-scale modeling. R. Kozlov has made a construction of an exact solution of the classical SU(2) Yang-Mills equation in two space dimensions. This work is a part of an ongoing effort by Christiansen, Ellingsrud, Kozlov, and Winther to study the numerical aspects of constrained preservation in Yang-Mills systems.

The work of Holden, Karlsen, Risebro, and Coclite in partial differential equations (PDEs) has one strong component that centers around nonlinear strongly degenerate convection-diffusion equations and their applications. The strong degeneracy lies in the fact that the diffusion coefficient may vanish for certain solution values, which implies that candidate solutions are discontinuous functions and must hence be interpreted in some generalized sense. The well posedness of these type of nonlinear PDEs have been a standing problem for a long time, and it is only in recent 3-5 years that various authors have made significant progress. Continuing our earlier work in this area, during 2003 we have devised new frameworks for deriving explicit estimates for measuring the continuous dependence of the coefficients in such second order PDEs and for deriving error estimates for numerical methods. Parts of this work have been done in collaboration with G.-Q. Chen (Chicago).

Karlsen and Risebro have also suggested a new flexible solution concept for discontinuous and possibly unbounded solutions. They have proved that this new solution concept is well-posed. In collaboration with R. Bürger (Stuttgart) and J. D. Towers (San Diego), they have developed new mathematical models for continuous sedimentation-consolidation processes of flocculated suspensions in clarifier-thickener units. Continuously operated clarifier-thickener units for the solid-liquid separation of suspensions are widely used in chemical engineering, mineral processing, the pulp-andpaper and food industries, and wastewater treatment. A central part of these models are conservation laws and degenerate convection diffusion-equations with discontinuous coefficients. For such PDEs they have developed a new solution concept encompassing discontinuous functions, proved its wellposedness, and developed new numerical solution algorithms and proved that they produce correct solutions. A corresponding theory has also been developed for Hamilton-Jacobi equations with discontinuous Hamiltonians.

As described above there already is an ongoing cooperation between the stochastic analysis group and the differential equations group at CMA. Karlsen has, in collaboration with E. R. Jakobsen (NTNU), studied nonlinear degenerate integro-partial differential equations (integro-PDEs). This study is motivated by previous and current collaboration with F. E. Benth (stochastic differential equations group of CMA) on optimal control of L\'evy (jump-diffusion) processes and applications in mathematical finance. They have formulated and proved a non-local maximum principle for semicontinuous functions in the setting of fully nonlinear degenerate elliptic integro-partial differential equations with integro operators of second order. This result is used to prove comparison/uniqueness results for viscosity solutions of fully nonlinear degenerate elliptic integro-PDEs. Comparison results are important in numerical analysis, as they can be used to give simple convergence proofs for numerical methods of integro-PDEs. Another application is an easy verification that certain value functions in stochastic control theory are solutions of their corresponding Hamilton-Jacobi-Bellman (HJB) equations. Karlsen and Benth, we have studied and solved Merton's classical portfolio optimization problem for an investor who can invest in a risk-free bond and a stock, so that expected utility from terminal wealth is maximized. The special feature of the problem studied is the inclusion of stochastic volatility in thedynamics of the risky asset. The model we use is driven by a superposition of non-Gaussian Ornstein-Uhlenbeck processes and it was recently proposed and intensively investigated for real market data by Barndorff-Nielsen

and Shephard. This gives raise to HJB equations of integro-PDE type, which can solved to give explicit trading strategies and expressions for the value function via Feynman-Kac formulas, at least for power utilities. Along the same lines, we have also suggested a new simple semilinear partial differential equation for pricing American options. Our formulation of the American option valuation problem is novel and constitutes a starting point for designing and analyzing «easy to implement» numerical algorithms for computing the value of an American option.

Computational quantum mechanics

The starting point for all of our 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.

The methods we study are

1. Variational and diffusional Monte Carlo methods. This activity has a strong link with the stochastic analysis group at CMA.
2. Non-perturbative resummation of large classes of diagrams in many-body physics, especially coupled cluster and parquet diagrams techniques.
3. Large scale diagonalization techniques, with special emphasis on the nuclear many-body problem.
4. Many-body perturbative approaches to weakly bound systems.
5. New algorithms for many-body systems based on concepts from quantum computing and quantum information theory. The solution of the time-dependent Schroedinger equation using finite element methods. This activity has a large overlap with the differential equations group at CMA.

1. *Variational (VMC) and diffusional (DMC) Monte Carlo methods.* This work has mainly been done together with 4 Master of Science students at the Department of Physics of the UiO. Tow of then have just finished and have gotten positions as PhD students. We have developed a large versatile program for solving the Schroedinger equation for many interacting particles using both VMC and DMC methods. This program is planned published in Computer Physics Communications. The program includes an efficient algorithm for dealing with trial wave functions for fermionic systems. It has also been parallelized using MPI and we expect large production runs on our supercomputing facilities during the spring of 2004.

   The systems which have been studied are

   a) Ground state of atoms with charge $Z \le 40$. This part has been developed by Simen Reine Sommerfelt. He begins as a PhD student in april 2004 at the Quantum Chemistry group at the UiO.
   b) Ground state properties of quantum dots with up to 20 electrons. This part has been developed by Victoria Popsueva. She begins as a PhD student at the University of Bergen and will continue her work on quantum dots of relevance for nano-technology.
   c) Bose-Einstein condensation of dilute atomic gases with the inclusion of vortices. This work has been done by Jon Kristian Nilsen. He plans to finish his degree towards june 2004 and will most likely continue with a PhD. This work is also done in close collaboration with Prof Artur Polls at the University of Barcelona.
   d) Ground state of light nuclei. This work has been done by Mateusz Marek Røstad. He plans also to finish his degree towards june 2004 and will most likely continue with a PhD.

A workshop on Computational finance and physics, with an emphasis on Monte Carlo methods is planned at CMA 22-23 march 2004. Our future plans involve a development of the above codes in order to handle systems of interest for applications in materials science and nano-technology.

2. *Non-perturbative resummation of large classes of diagrams in many-body physics.*
   This project defines the collaboration between Oak-Ridge national laboratory, UiO, and Michigan State University at East Lansing. The project has already resulted in a Physical Review Letter (Vol 92, spring 2004), a large paper in Physical Review C (Vol 69) and a review article of 80 pages in Progress in Particle and Nuclear Physics (to appear in 2004).

   The project centers on the coupled cluster method and the people involved are:

   1. ORNL : Prof. David Dean (also adjunct professor at CMA), Drs. Thomas Papenbrock, David Bernholt (Computer Science division) and Robert Harrison (Computational Chemistry)
   2. Michigan State University, Department of Chemistry: Prof. Piotr Piecuch and Drs. Karol Kowalski and Marta Wloch.
   3. UiO: Prof. Morten Hjorth-Jensen (CMA), PhD students Maxim Kartamychev (UiO/CMA) and Gaute Hagen (UiB/CMA).

The project was started in the fall of 2003, and we do expect several years of fruitful scientific collaborations with an emphasis on the nuclear many-body problem. Especially, we will in the next two years focus on weakly bound systems, excited states, the role of three-body forces and triples corrections.

The ab initio coupled cluster theory is a particularly promising candidate for studies of nuclei due to its enormous success in quantum chemistry. Our recent Physical Review Letters, by Kowalski, Dean, Hjorth-Jensen, Papenbrock, and Piecuch, describes an application of coupled cluster techniques to nuclear structure. These techniques, which originated in nuclear structure theory, were thoroughly developed and exploited in quantum chemistry for molecular electronic structure calculations. The paper describes an application of quantum-chemistry inspired coupled cluster techniques for nuclear ground-state calculations and, for the first time, uses these methods for the computation of excited states in nuclei. The coupled-cluster methods are very promising, since they allow one to study ground- and excited-state properties

of nuclei with dimensionalities beyond the capability of present shell-model approaches, with a much smaller numerical effort when compared to the more traditional shell-model methods aimed at similar accuracies. For the weakly bound nuclei to be produced by the proposed Rare Isotope Accelerator it is almost imperative to increase the degrees of freedom under study in order to reproduce basic properties of these systems. Judging by the success of coupled cluster theory in chemistry, it is expected that coupled cluster methods will enable the ab initio microscopic calculations for nuclei in the mass 50 region (not possible at this time).

This work is also an example of a successful interdisciplinary collaboration between physicists and chemists. It also shows that coupled-cluster theory provides a rigorous and universal many-body language, which enables one to describe physical systems as small as atomic nuclei and as large as polyatomic molecules with similarly high accuracies. Coupled cluster theory allows one to describe physical systems characterized by the energies that range from millielectronvolts (e.g., binding energies of van der Waals molecules) to Megaelectronvolts (excitation and binding energies of nuclei).

Elise Bergli, PhD student at the UiO and associated with CMA, works on related many-body topics. The focus here is on quantum liquids and studies of superfluidity and superconductivity.

A workshop on Advances in computational aspects in the nuclear many-body problem is planned for 11-13 march 2004 at CMA.

3. *Large scale diagonalization techniques, with special emphasis on the nuclear many-body problem.*
   Here we have continued the development of our shell-model code for diagonalizations of large systems using the Lanczos iteration scheme, of special mention is our recent parallel version of the shell-model code developed in Oslo. Many of the applications are done in close collaboration with experimentalists and theorists in the USA and in Europe. We published a Physical Review Letters article (PRL 91 (2003) 162503) on the r-process, of importance for nucleosynthesis and nuclear astrophysics. This was done in close collaboration with Prof Alex Brown at Michigan State University and several experimental groups in the USA and in Europe. David Dean (ORNL and CMA) and Morten Hjorth-Jensen published also a review paper in Reviews of Modern Physics (vol 75 (2003) 607. In addition, Dean, Engeland, Hjorth-Jensen, Kartamychev and Osnes got accepted a review article in Progress of Particle and Nuclear physics, see also the previous point. Maxim Kartamychev was recently employed as a PhD student at the Department of Physics and will work on this project as well. His thesis project deals with the implementation of three-body interactions in our shell-model code and studies of such interactions for the coupled cluster method mentioned above. He is associated with CMA.

4. *Many-body perturbative approaches to weakly bound systems.*
   Due to the forthcoming large investments in the USA on the Rare Isotope facilities there is a strong need for developing techniques for handling weakly bound systems. The last year, together with PhD student Gaute Hagen from the University of Bergen and associated with CMA, we have developed tools for studying effective interactions for weakly bound systems based on many-body perturbative approaches. These interactions will also be used in our applications of the coupled cluster method discussed above. Eivind Brodal got his Master of Science thesis in 2003 on related topics. He is now a PhD student at the University of Tromsø. Ronny Kjelsberg (NTNU) got his Master of Science thesis on studies of perturbative many-body methods for the emission of neutrinos in neutron stars. He is now associated with the Regional University college of Sør-Trøndelag.

5. *New algorithms for many-body systems based on concepts from quantum computing and quantum information theory.*
   Eirik Ovrum got his Master of Science thesis in 2003 on this subject. He is now a PhD student at CMA. The topic of his thesis is to implement algorithms from quantum information theory in order to study their suitability for dealing with many-body systems. Eirik is also connected with the next project.

The solution of the time-dependent Schroedinger equation using finite element methods.
The application of finite element methods to the solution of the time-dependent Schroedinger equation is currently of great interest due to the developments in ion-trap experiments and the capability to isolate electrons (quantum dots) or atoms in small confined regions of space. This field has important consequences for future development of quantum circuits and our basic understanding of the quantum dynamics of single trapped particles. The influence of time-dependent electro-magnetic fields is highly non-trivial. We have recently studied the role of gauge-transformations for hydrogen-like atoms in two dimensions with strong time-dependent magnetic fields. This work is done by Simen Kvaal who finishes his Master of Science thesis in march 2004. He plans to continue on a PhD at CMA in collaboration with the differential equations group.

Computational 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 estimating correlation-functions of stochastic fields.

One of the major specific goals of the Physical Applications Project in the Research Plan is to «Complete a 3D Radiation-Magneto-HydroDynamic code with non-restrictive boundary conditions». We have expended considerable effort in further developments of the 3D code during 2003. This effort has resulted in both further understanding of wave propagation in the

Sun's chromosphere and in the development of a sophisticated set of boundary conditions that seems to allow the transmission of all wave modes through our upper boundary without reflection. A module for thermal conduction that will allow studies of the solar corona and the coupling between the solar corona and the cooler regions below has been incorporated into the code. On a related project a version of the 3D code has been utilized to study the expansion of the solar wind through a magnetized corona. Finally, a new set of transport equations for fully ionized gases has been developed for use in studies of low density plasmas such as the corona and solar wind.

In the studies of wave propagation numerical simulations in a two-dimensional stratified magnetoatmosphere were conducted for conditions that are representative of the solar photosphere and chromosphere. The calculations show that the coupling between the fast and slow magneto-acousticgravity (MAG) waves is confined to thin quasi-one-dimensional atmospheric layers where the sound speed and the AlfvŽn velocity are comparable in magnitude. Away from this wave conversion zone, the two MAG waves are effectively decoupled because either the magnetic pressure (B2/81) or the plasma pressure (p=NkBT) dominates over the other. The character of the fluctuations observed in the magneto atmosphere depend sensitively on the relative location and orientation of the magnetic canopy with respect to the wave source and the observation point. This work has so far resulted in one publication in the Astrophysical Journal as well as in a Master Thesis (Lars Heggland, «Waves in the chromosphere and corona») completed in September 2003.

By reformulating the MHD equations in characteristic form it is possible to isolate incoming and outgoing characteristics of the waves. In principle, this allows the construction of boundary conditions such that only outgoing characteristics are active, i.e. that outgoing waves propagate out of the computational domain without reflection. A set of these boundary conditions has been formulated and implemented in the 3D code during the course of 2003. The general method and some of the details of the implementation were presented at the CMA Workshop «Computational methods in astrophysical problems» held November 3 - 4. The implementation is now complete and the boundary conditions seem so far to be successfully working as planned.

Thermal conduction is a dominant term in the energy equation for the solar coronal plasma and its inclusion is necessary if one is to model this important solar region successfully. Unfortunately, thermal conduction is a diffusion process that requires prohibitively short time steps if implemented explicitly. We have developed an 3D implicit multi grid solver for the thermal conduction operator, with conduction confined to flowing along the magnetic field, that allows its inclusion in our 3D code with small enough computational overhead to make possible studies of the corona and the corona - chrmosphere interface. This work was also presented at the CMA Workshop «Computational methods in astrophysical problems» held November 3 - 4.

The solar wind is usually found on one of two states: fast - emanating from regions on the sun where the magnetic field is open to interplanetary space, or slow - presumably emanating from regions where originally closed magnetic fields are temporarily forced open. Studies of the slow solar wind, which is inherently time dependent, have until recently bee fairly unsophisticated. In Eirik Endeve's PhD thesis «Helmet Streamers Gone Unstable» numerical studies of the expanding corona, both open and closed, were made using a version of the 3D code described above. Endeve made progress in describing how the nature of the slow, unsteady wind depends on the model used in describing the heat conduction for the expanding plasma.

The importance in describing the transport equations correctly, as found in Endeve's PhD project as well as in studies of the tranport of helium into the corona by the thermal force, has led to a masters thesis being defined to consider the transport equations. Indeed, it was found that changing the basic distribution function that underlies the transport equations will change the relative importance of several terms in these equations - Åse Marit Janse received her masters degree in November 2003 for the thesis «Developing a new set of transport equations for fully ionized gases». PhD student Mari Anne Killie and Janse have (along with Egil Leer and Øystein Lie Svendsen) expanded on the thesis in a paper accepted by the Astrophysical Journal.

The stated goals for cosmology in CMA's Research Plan are the following:

- Improve our current algorithms for determining real space correlation-functions of stochastic fields on a sphere, so that it will be feasible to use them for testing Gaussianity with 10^8 pixels.
- Apply new ideas from geometry and stochastic analysis to device new tests of non-Gaussianity.

In 2003 we have developed new algorithms for fast estimation of N-point correlation functions of pixelized data on a sphere which have been published (Eriksen, Lilje, Banday and Gorski, 2004, ApJS, in press) and applied to the WMAP CMB sky maps. Compared with Monte Carlo simulations based on Gaussian fluctuations, we find significant asymmetries between the northern and southern hemispheres (Eriksen, Hansen, Banday, Gorski and Lilje, 2004, ApJ, in press). These can be caused by systematics in the data or intrinsic non-Gaussianity in the fluctuations in the early Universe.

We have developed a new geometric test for non-Gaussianity which we call «the length of the skeleton». We have applied this, as well as tests based on the classical integral geometric Minkowski functionals of a stochastic two-dimensional scalar field on a sphere (for which we have developed some new algorithms), to the WMAP data and found significant deviations from Gaussianity in the genus Minkowski functional on scales between 5 and 10 degrees on the sky, also showing asymmetry between celestial spheres (Eriksen, Novikov, Lilje, Banday and Gorski, 2004, ApJ, submitted).

STATEMENTS ON THE CENTRE ESTABLISHMENT

CMA is organized at the University of Oslo (UiO) as a part of the Faculty of Mathematics and Natural Sciences. The centre was formally established on March 1, 2003, but were without premises for half a year. We moved into the new premises on September 1, but entrepreneurs and craftsmen worked among us until November 15. However, the result is very satisfactory, and since then, we have had nice, bright and modern facilities.

We would also like to underscore the positive support we have experienced from our host during the establishment phase, from the involved departments, the faculty, the central administration and the official university management. We have so far experienced thorough efforts with respect to optimizing our conditions!

During the year of CMA, several routines and practical matters had to be considered and established. Most of these are described in other sections (management, economy etc.) Hence we areleft with some words about the premises of CMA:

Premises and infrastructure

Offices for participants, guests, students, as well as most of the seminar-activities, etc are localized in the Niels Henrik Abel building on the central campus of the university. This means that the centre is neighboring the Department of Mathematics. CMA has at its full disposal:

- 39 offices with a total of 66 working places, all equipped with computers, net-resources and necessary infrastructure. The main investigators have single-room offices, while PhD-students, postdocs, and long-term guests usually share offices with 2 or 3 working places, still without people feeling squeezed. Two large offices (4 and 5 working places) are dedicated to short time visitors and adjunct researchers. These places are meant to be used by several people that are not with us each day
- One seminar room with 36 seats, equipped with large boards, a silver screen, a front panel computer, and a projector.
- One meeting room with a 12 seat round-table.
- One reading room for master students with 16 seats, each seat has internet and power provided for lap-tops etc.
- One graphics laboratory, equipped with five state-of-the-art computers with high-end graphics cards
- An open and nice lunch area with basic kitchen facilities.

All together, these locations are distributed in parts of the 5th, 9th, and a full 10th floor of the building, whereas the Department of Mathematics disposes all areas in between.

MANAGEMENT AND ADMINISTRATION

Management philosophy

Managing a big project like a Centre of Excellence with 10 year duration (hopefully), a total budget of at least MNOK 350 and more than 60 people, is challenging. We believe that novel research will arise as a result of a combination of a stimulating research environment, focused research activities and academic freedom. The latter is important, but may be problematic due to the nature of the project, wich has clear goals and a limited lifetime.

However, we have chosen an angle of attack which we feel covers all three perspectives. We call it «indirect management», which has two main implications:

- We are focused when we produce descriptions of scientific positions for announcements, and in ranking of applicants. We emphasize the interdisciplinary nature of CMA, both with respect to the different scientific fields, but also with respect to the balance between theoretical, applied, and computational experience and interests of the applicants.
- We use our financial resources incentively, and we only grant research activities (seminars, workshops, guest researchers, travelling) that are founded on our research plan.

We believe, and so far we regard this as a successful strategy, that we are filling our positions with candidates that have «the right» academic profile. The daily research activities then «force» all new (and old) CMA members to pursue research in the direction of our stated goals in the research plan.

Daily leadership

CMA is on the daily basis run by the manager, Professor Ragnar Winther, the deputy manager, Professor Geir Ellingsrud, and senior adviser and administrative leader Helge Galdal. These three constitute the leading group who have the power of attorney to make running decisions on practical matters, financial transactions, research activities within the frames of the budget and the research plan.

For more principal decisions and commitments, the leading group is extended to a group of principal investigators consisting of 10 senior scientists of CMA. These are, in addition to the leading group: Tom Lyche, Ragni Piene, Tor Dokken, Bernt Øksendal, Fred Espen Benth, Helge Holden, Morten Hjorth-Jensen, and Mats Carlsson. This group has meetings when necessary, typically every second month. The groups have a broad representation among the research groups, and serves as a consensus and advisory council for the leading group, ensuring democratic and good decisions in important choices of paths. Topics that are typically addressed in this group are:

- Descriptions of scientific positions for announcement texts
- Appointing evaluation committees
- Final ranking of applicants for scientific positions
- Budget disposals
- Participation (or not) in boundary research actions wrt. the CMA research plan

Board

At the end of 2003 the board of CMA has the following members:

- Kjell Bendiksen, chair, Managing Director of Institute of Energy Tecnology
- Suzanne Lacasse, co-chair, Managing Director of Norwegian Geotechnical Institute
- Trygve U. Helgaker, Professor at the Department of Chemistry, UiO
- Birger Kruse, Managing Director of the Faculty of Mathematics and Natural Sciences, UiO
- Svein Longva, Managing Director of Statistics Norway

Originally, Jessica Kathle (Assistant Director of the Faculty of Mathematics and Natural Sciences, UiO), and Knut Fægri (Professor at the Department of Chemistry, UiO) were appointed as the University representatives. Fægri was in June 2003 appointed dean of the Faculty, which then was irreconcilable with a position in a subordinate board. Trygve U. Helgaker replaced him. Jessica Kathle resigned her position at the Faculty in October 2003, and was replaced by Birger Kruse.

The CMA-board aims at being a professional administrative board, emphasizing strategic and control functions, and with clear instruction to handle budgets, accounts, and annual reports. An important subject for the board will be the evolution of the research plan. Helping the CMA leadership and the board to make wise decisions in that matter, a scientific advisory board is constituted – see the next section.

The board reports to the Faculty management. It met twice in 2003, on May 20 and November 5. For 2004, 3 meetings are planned.

Scientific Advisory Board

A scientific advisory board was appointed late 2003 in accordance with original plans, and according to a right specified in the general contract with The Research Council of Norway. So, CMA has chosen to distinguish between the businesslike and the scientific content of the board activity. However, the board is still responsible overall for the research plan, the advisory board is appointed by the board without any power to pass resolutions.

The main subject for the advisory board will to critically investigate and compare our research plan with our actual work and progress, and to guide and suggest when changes or additions are implemented. They should know us, but at the same time they should be courageous in challenging our scientific missions and disposals. Hence we need experts at the forefront of international research activities within our fields, willing and capable of challenging us in this work.

Professor Douglas N. Arnold is chosen because he is CEO of the most prominent and, to us, comparable environent in the US, namely the Institute of Mathematics and its Applications (IMA) at University of Minnesota.

Professor Tom Bogdan (High Altitude Observatory, National Center for Atmospheric Research, Boulder, USA) is a central collaborator of the astrophysisists in CMA, and he was among the main speakers at the official Kick-off conference of CMA. He also has important experience as a councellor of the National Science Foundation in USA.

Professor Ivar Ekeland is presently holding a position of mathematical finance at the University of British Columbia, Vancouver, Canada. He chaired the international panel that very recently evaluated all mathematical research conducted in Norway.

Professor Helmut Pottmann at Vienna University of Technology, Austria is the fourth member. He chairs a research group in «industrial geometry», organized as part of Institute of Discrete Mathematics and Geometry.

Administrative support

CMA has one administrative employee, senior adviser Helge Galdal. He is a member of the centre management, acting as Ragnar Winther's right hand preparing general correspondence, reporting, board papers, budget and accounting figures, communications etc. Another important role of his is to inspire and help the centre researchers to write proposals for external funding. Finally he is responsible for coordinating all other administrative functions which are «outsourced» as follows:

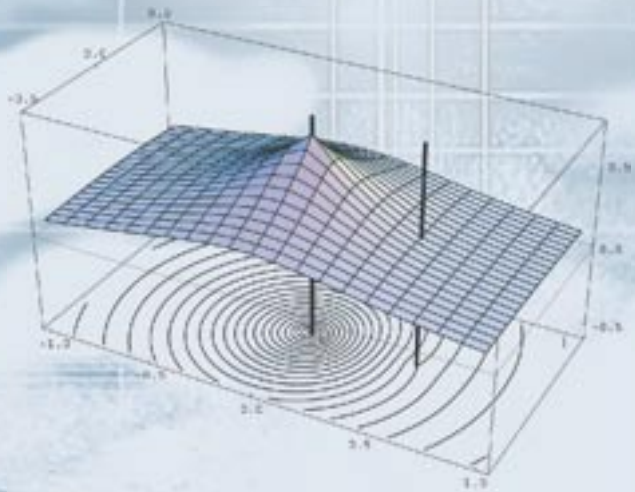
- The «first line services», meaning incoming telephones, faxes, mail, reception etc are provided by the secretaries of The Department of Mathematics. They also cover CMA with

accessories, minor equipment and so on, and CMA uses the channels and customer relations of the department for more extensive purchases and consultancies.

- All financial transactions are authorized by Ragnar Winther and Helge Galdal in common. The resolutions are executed by the secretary of economy at the Department of Mathematics, and he also provides help with budget and accounting analysis, reports etc.
- IT-support is essential, and CMA again share the resources of our host department
- The Department of Mathematics has employed one person dedicated to deal with nonscientific matters for guest researchers, exchange students and international doctoral or post doctoral fellows. She helps with housing, contact with bureaucracy, kindergarten arrangements and so on.
- PhD-students must apply and be admitted to the official PhD-program of the Faculty of Mathematics and Natural Sciences. During the three-year training period they regularly have to report on the progress. Upon dissertation there are several needs, appointing and organizing the evaluation committee as well as executing the event itself. All this requires administrative support, which are fully covered by the «closest» department in each case (Mathematics, Informatics, Physics, or Astrophysics).
- In order to provide secure and efficient handling of personnel matters (contracts, payment routines etc), we are totally dependent of the professional personnel administration provided by The Faculty Administration. They have dedicated one person who is responsible for all CMA-matters.
- CMA is also covered by the Faculty Administration to ensure a secure archive system.

One scientific programmer is funded by the host. Andrew McMurry was employed in this position on October 1, 2003. His main function is to support the members of CMA with computer implementations of research ideas and results.

All together it is our experience that we have established an effective administrative organization, not least with respect to cost issues. As far as possible we utilize the existing professional organization. CMA contributes to the surrounding host units with financial support due to the extra load of work and services in the host organization. This system is cost-effective (much cheaper than building a separate CMA-administration to cover the same services). We are also confident that such a system helps CMA becoming an integrated part of a larger scientific community.



ECONOMY

Statement on the accounting and budgetary principles

CMA represents a new organizational unit within the university. In some matters, the centre is just another basic unit, adapted smoothly to the structure. In other matters, the CMA-structure represents a challenge to the established surroundings. An example of the latter is how to handle the economy. The official accounting systems are not perfectly fit for the totality of systems like ours.

The RCN-part (the main centre funding) is straight-forward, because these means represent net income, and are disposed on the specific CMA-account. Here the system provides us with accurate information, and we regard the presented figures as the complete and fully true picture.

The CMA budget also has a large UiO contribution. Most of this comes from percentage parts of the ordinary wages and indirect costs of the senior scientists, but does not involve any transactions through the CMA account. The scientists remain employed with different departments, and they contribute to CMA with different percentages, and different periods. CMA has also been granted new positions where the funding is directly placed to our credit. Other parts of the UiO-funding are generously given at our free disposal, also placed to our credit. The system is not constructed to provide us with exact host funding figures. If one trimmed the system to do so, it would cause problems for the involved departments. We will use this opportunity to mention that the central economysection of UiO has been eager to make serious attempts to adjust the systems for the purposes of the centre. The preliminary conclusion is, however, that a good solution for us will generate big problems for others. Hence we have calculated the UiO funding manually, using individual person information, and standard rates for indirect costs. This is a detailed puzzle, but nevertheless it contains very accurate pieces. Hence we regard the figures to be as precise as ever possible.

The SINTEF-part of the budget is out of reach of the UiO-system, but this is a quite surveyable and relatively small part of the total budget, containing only a few variables. However, we have to make estimates on the CMA-shares of big, collaborative projects, where only parts of the projects are relevant to CMA (see next paragraph). The estimated figures represent our genuine comprehension of what is correct.

The same conclusion is hereby drawn on the sum of all affiliated projects of CMA. CMA does not handle the accounts, except for those which will be generated by CMA itself as time goes along. Some projects are formally managed by other institutions. Unconditional of the funding source, the project portfolio is closely related to the research activity of CMA. Some of the projects are fully integrated in CMA, some are only partially relevant. We can divide these projects in two categories:

- The individual grants are mostly RCN-funded, but there are also fellows with other funding. We have consequently based the figures on standard rates for PhD- and postdoc grants. Thus we are confident that the sum is very close to accuracy.
- The collaborative projects are more difficult, and we have to make use of estimates to calculate the CMA-parts. The EU/FET project GAIA II provides an example of the uncertainties with respect to the CMA accountings. GAIA II has six international partners (SINTEF and UiO being two), and a total budget of € 2,3M over three years from 2002-2005. The project is coordinated by SINTEF, and its CMA member Tor Dokken, who holds a 20% position in CMA in addition to his part of the SINTEF-commitment in CMA. Furthermore the University of Oslo has one PhD-student, Pål H. Johansen, in the project. He works full time in the CMA-community, comparable to all other individually granted PhD-students. Then there are different GAIA- II-events where CMA-members participate, from which we may report real research results for the benefit of CMA.

All together we hereby state that we have conscientiously investigated and calculated each part of the accounts, and it is our firm belief that the presented figures represent the real activity of CMA in 2003.

The same conclusion is applied to the adjusted budget for 2004, however with one additional remark: Only existing and confirmed activities, contributions, and projects are counted. We are constantly working on new proposals and ideas, both towards EU, RCN and and other sources as well as our own host. Sometimes, we also are positively «surprised» from external initiatives with economical implications for CMA, for example young European fellows applying for individual Marie Curie grants. CMA has been invited to provide host institutional responsibilities for such fellows. For good and relevant proposals, we are pleased to fulfil these inquiries. But neither our own nor any external proposals that are not yet (as of April 1, 2004) confirmed granted, are included in the following budget figures.

Total revenue and expenditure figures

Below the main figures are presented. The elements in this presentation are based on the original financial and cost plan of the CoE-contract. Hence we distinguish between the four main funding sources (even though number 4 is rather a collection of sources). Furthermore we present the expenditures as salary costs (meaning wages and costs thereof), indirect costs, teaching services, equipment, and running costs. More details, together with all notes, are presented in appendix 2 and 3.

Table 1. *The main figures of revenues and expenditures, 2003 accounts and 2004 budget (x1000)*

Revenues	Budget 2003	Account 2003	Orig. budget 2004	New budget 2004
RCN	9 000	9 000	10 500	10 500
UiO funding	11 276	13 319	12 132	13 108
SINTEF	433	566	530	770
Affiliates	5 691	11 237	8 638	10 923
Total revenues	26 400	34 122	31 800	35 301
Expenditures				
Salary Costs	11 728	16 769	15 491	23 129
Indirect costs	2 172	3 326	2 925	4 431
Teaching Services	173	35	216	200
Equipment	5 833	1 075	7 140	1 720
Running costs	6 494	6 357	6 028	4 871
Collab. Projects *	X	2 550	X	3 122
Total expenditure	26 400	30 112	31 800	37 473

** New item. See the notes in appendix 3.*

Hence 2003 brought a surplus of MNOK 4,010 which will be transferred to 2004. Moreover the 2004 budget estimates that the aggregated activity so far and throughout 2004 will result in an accumulated reduced surplus at MNOK 1,838 at the end of 2004. Further activity acceleration does not seem plausible. We have calculated (without argumentation in this report) the subsequent budget figures for the following years, reaching a zero balance between estimated budgets and accounts at the end of 2005.

Table 2. *Resolution on the 2003 surplus and estimated result 2004 (x1000)*

		Revenues	Expenditures	Surplus
2003	From table 1	34 122	30 112	4 010
2004	Transferred	4 010		
	From table 1	35 301	37 473	1 838
2005	Estimated result 2004	1 838		

Outlooks on associated projects

We would like to tie some short comments to the associated projects of CMA, also named «Affiliates». The amount of existing projects was only approximately estimated in the original budgets, loosely based on existing activity in the spheres of the CMA senior scientists. In fact we have spent considerable time during 2003 to consolidate this portfolio. At the end of 2003 we can conclude that the original estimates have in fact been much too conservative. We are obviously boosting our original figures. At first this may seem as a solely pleasant surprise, and it surely is for the CMA community. This fact has brought us more centre participants, activity and results, and we can conclude that CMA fulfils a role as a «power station» for applied mathematical research in our scientific community.

However, several projects expire in 2004, especially among the individual RCN-grants, and we are anxious about the general possibilities for such grants in the future. It seems as if there is a tendency towards larger and more compound programmes. We will compete on every relevant area, and we hope to succeed. But we also have to be realistic. The centre activity itself is (and must be) the dominating project activity of the senior scientists themselves. However, we have the capacity to do training activities, which is why individual RCN-grants fit perfectly. Such projects seem to become more rare in RCN. At the beginning of 2004 we are involved in numerous application processes towards the EU-system, especially within the different Marie Curie actions that mainly focus research training.

However, and most important in this connection, together with all four mathematical university communities, we have inititiated a proposal to the RCN, in which we argue for a new, broad mathematical research programme in mathematics. We hereby strongly emphasize the importance of a success for this initiative.

THE PEOPLE

Status and some statistics, employments 2003

At the beginning of 2004, including confirmed employments with starting dates in 2004, CMA consists of 65 people. They are all presented in appendix 1. In fact, appendix 1 contains 67 names. Only two persons have actually left our scientific community since the start one year ago. Torgeir Engeland retired on August 31, and Arne Løkka defended his PhD-thesis as our first candidate on September 15. Shortly thereafter he was granted a postdoc position at King´s College, London.

We use the following system to present the totality of our staff and members. Out of the 65 there are

- 20 senior scientists in full positions, 23 PhD-students, 13 postdocs, 7 adjunct positions, 1 scientific programmer, and 1 administrative officer
- 54 men and 11 women
- 44 native Norwegians and 21 with foreign birthcountries (representing at least 10 different countries)
- 24 employed by CMA, 29 by the host, 3 by SINTEF, and 28 through affiliated projects.

Man Year «production» 2003 and estimates for 2004

The careful reader will notice that the content of the latter bullet point above sums up to 84, which indicates that several members are tied to CMA through different funding sources. In fact 17 people have two or more official relations to CMA, either through parallel contributions (like the SINTEF personnel), or through subsequent engagements (the host postpones affiliated projects, or CMA employs former affiliates and so on). Appendix 1 provides the details. Table 3 below is calculated with respect to all these deatails, providing the exact man year production figures of 2003, and the estimates for 2004 (only confirmed positions taken into consideration).

Table 3. *Calculation of man year production in CMA, taking the fiunding source into account*

2003	CMA	UiO funded	SINTEF	Other	Total
Phd	1,75	0,50		10,28	12,53
Postdocs	1,06	1,58		5,07	7,71
Researchers	1,73	9,06	0,47		11,26
Administrative	0,83	0,25			1,08
Sum	5,37	11,39	0,47	15,35	32,58
2004					
Phd	6,58	1,35	0,42	8,22	16,57
Postdocs	4,76	1,50		5,40	11,66
Researchers	3,37	10,65	0,40		14,42
Administrative	1,00	1,00			2,00
Sum	15,71	14,50	0,82	13,62	44,65

Plans for 2004

By December 31, 2003, we were 59 members. The last six members counted at the beginning of this chapter (specifically: David Dean, Inga Eide, Knut Aase, Åse Marit Janse, Maxim Kartamyshev, and An Thi Kieu) have started, or have confirmed to start during spring 2004. Furthermore we plan to employ at least 3 new PhD-students, 1 postdoc, and 2 adjunct professors. These positions are calculated into both table 3 above as well as the budget in table 1 and appendix 2. However, we have not estimated any other possible positions that we might receive through new projects or agreements.

Other contributors

As described in the Statements on the centre establishment, most of the daily administrative services are «outsourced». We utilize the exisiting organization as optimal as we find possible. The following persons are most directly affected by this system, and are specifically mentioned.

- Executive officer Dina Haraldsson and secretary Anita Smeby at the reception desk of Department of Mathematics
- Senior executive officer Diana Holand of Department of Mathematics, providing help with Norwegian bureaucracy etc.

- Senior executive officer Jørg Gjestvang of Department of Mathematics is the book-keeper of CMA and also provides service on reports and analysis.
- Computer engineers Terje Kvernes and Bård Kristiansen of Department of Mathematics who are responsible for technical support
- Senior executive officer Grete Andresen of The Faculty of Mathematics and Natural Sciences is handling all formalities wrt. personnel matters

Several other people could have been mentioned, in the four host departments, the faculty, and in the central administration.

Guests

It is a privilege of ours to invite prominent guest researchers and –speakers as well as close collaborators of our group. Appendix 6 contains the full list of the 2003 international CMA guests. In addition to the 76 sepecified in that list, we estimate that more than 200 unique national guests have been received, many of them several times.

RESEARCH EDUCATION

A main goal of CMA is the training of new rearchers. With 30-35 PhD-students and postdocs among us in our research environment with several training activities, we believe that CMA has a significant chance of being successful in this matter. However, as earlier stated, we are concerned about the possibilities of relevant programmes and actions within the RCN system in the future.

On the request of the Ministry of Educational Affairs, «The Norwegian Council for Higher Education» has discussed some guidelines for a future system of «Researcher Schools» in Norway. The formal foundations for such a system still seem unclear, but CMA has signalled a positive attitude.

In 2003, three members of CMA defended their doctoral thesis:

- Arne Løkka defended his thesis «White Noise Calculus for Pure Jump Processes with Application to Mathematical Finance - Incomplete Equlibrium Markets» for the dr. sceint.-degree on September 15. He has been working under the supervision of Professor Fred Espen Benth. Arne is currently a postdoc of Mathematical finance at King´s College in London.
- Runhild Aae Klausen defended her thesis «On Locally Conservative Numerical Methods for Elliptic Problems; Application to Reservoir Simulation» for the dr.scient.-degree on September 29. Her supervisor was Professor Ragnar Winther. After the defence, Runhild immediately entered a position as postdoc at CMA through a cooperation agreement with another Centre of Excelllence, CIPR, in Bergen.
- Eirik Endeve defended his thesis «Helmet Streamers Gone Unstable» for the dr. scient.-degree on December 15. He has been working under the supervision of Professor Egil Leer. Upon defence Eirik actually had approximately 6 months left of his PhD-grant, so he is still working with us, and will apply for postdoctoral positions abroad as from the summer of 2004.

In 2004, we expect that we will have approximately 5 PhD defences in CMA. For comparison, our ambitions were that 10 PhD-students should defend their work during the first five years of CMA, and 25 during all 10 years (see the research plan).

COOPERATION

Active Partner, SINTEF

CMA has one active partner which originally was named SINTEF Applied Mathematics (SAM). Due to restructuring operations within the SINTEF system, SAM is now a part of the SINTEF ICT division. However, this does not affect the agreement or the actual cooperation that CMA and SINTEF have entered. SINTEF and the University of Oslo have signed an agreement on this issue, stating someboundary conditions for the cooperation. This agreement is now an appendix to the general CoE agreement that UiO has with RCN.

We are pleased to report that from CMA´s point of view, we regard the cooperation so far as very constructive and fruitful. As the accounting figures showed, we outperform the estimates. More important is that we are directly involved with each other in many ways.

- We had a common industrial day in connection with our Kick-off conference
- CMA benefits from the project activity of SINTEF. In 2003 this was especially applied to MINGLE and GAIA II. From

2004, MINGLE has expired, but a new Network of Excellence, AIM@SHAPE was at the same time initiated. CMA members participate in different actions of these projects, research are conducted and results obtained. In appendix 7 – f, several items are connected to the MINGLE and GAIA II-projects.

- For another project, recently granted to SINTEF (The RCN-funded Strategic Institute Programme «Graphics hardware as a high-end computational resource»), SINTEF will actually forward one full time PhD-student to CMA.
- Finally, we would also like to mention that Dr. Ewald Quak has been very helpful with EUproposals of ours. So far he has advised and revised on a couple of occasions. In 2004 he will, on behalf of CMA, lead the work of another proposal, a Transfer of Knowledge program towards an Estonian Centre of Excellence.

National cooperation

In the research plan of CMA, we state «As a national centre in applied mathematics our intention is to cooperate with a variety of research groups in Norway which are in need of such expertise. The cooperation with SINTEF Applied mathematics will provide the centre with an open channel to industrial problems. If our capacity permits, the centre may also be involved in other joint projects, forexample in basic petroleum research or neuroscience».

The relation to SINTEF is outlined above. Another important goal was to hire some of the best researchers of other institutions in Norway, who are closely related to our research. So we have done, and

- Helge Holden, Norwegian University of Science and Technology,
- Knut Aase, Norwegian School of Economy and Business Administration,
- Xue-Cheng Tai, University of Bergen and CIPR (see below), and
- Stein Arild Strømme, University of Bergen,

are all employed by CMA in adjunct positions.

Together with another Centre of Excellence, Centre for Integrated Petroleum Research (CIPR), we have entered a formal agreement of cooperation. The intention is to cooperate on certain projects where the two centres have complementary competence. One instrument is to use joint positions, and Runhild Aae Klausen is now working in a two-year postdoc position, one year paid by CMA, the next by CIPR. Her project within this CMA-CIPR alliance is related to mathematical problems in reservoir simulation, in particular analysis of discretization methods which are well adopted to reservoir problems.

Professor Xue-Cheng Tai is also included by the agreement. He, however, was an intended member of CMA in any case, from the proposal process and forward. But when both CIPR and CMA were appointed, this was a very natural consequence. At CIPR Professor Tai is mostly responsible for the activity on inverse problems, while his research towards CMA covers several central areas of partial differential equations such as finite element methods, discrete solution algorithms, and level set methods.

Mathematics is the language of science, and there are numerous other possibilities of cooperative actions with other scientific environments. We have loosely discussed some possibilities with other groups, but the CIPR agreement still remains the one that is formalized.

Finally, during 2003 CMA has received more than 200 unique national guests for our events or for the purpose of general research collaboration.

International collaboration

In our COE proposal, we named approximately 50 international collaborators, and they were only the very most important ones. In 2003 we received 76 international guests (see appendix 6) and every research event had international participation. Among the 67 published papers in refereed journals, 42 were written together with international partners. Out of 103 scientific talks outside CMA, 78 were given abroad! CMA has a large circle of international collaborators and networking.

However, as a Centre of Excellece we also aim at establishing some formal and obliging institutional cooperation. During 2003 we have not entered any such agreements.

PUBLIC OUTREACH

It is important to make the general population more aware of the importance of mathematics in society, and CMA intends to contribute. However, these efforts were rather limited in 2003, and not in the bull's eye of our attention in the establishing phase of the centre. In addition, Norway has no tradition of great mathematical publicity, so any progression in this matter will not just happen by itself. From 2003, we may mention the following:

- Appendix 7c lists a few written publications, meant for a general audience.
- Also a few of the 101 scientific talks of 2003 were meant for a more general audience.
- CMA has agreed with the organization www.matematikk.org to contribute as a five-year sponsor from 2003-2007. This organization aims at being a national net-resource for children, teachers, and parents, and was established in the autumn 2001. During these years, they have constantly extended and improved their content, and they recently won the «Rosing Prize» for internet based information. They have thousands of users, and for CMA we regard this sponsorship as a safe bet. Our contribution will reach much further here than if we established something similar on our own.

In 2004 we aim at establishing a more targeted strategy for media attention and public outreach in general. Our deputy manager, Professor Geir Ellingrud, will be in charge of this.

LIST OF APPENDICES

Appendix 1 CMA-members, positions and affilations

Appendix 2 Details on accounting and budget

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Appendix 4 List of associated projects

Appendix 5 A full list of research events, arranged or co-arranged by CMA

Appendix 6 Guests of CMA 2003

Appendix 7a Scientific articles in refereed journals

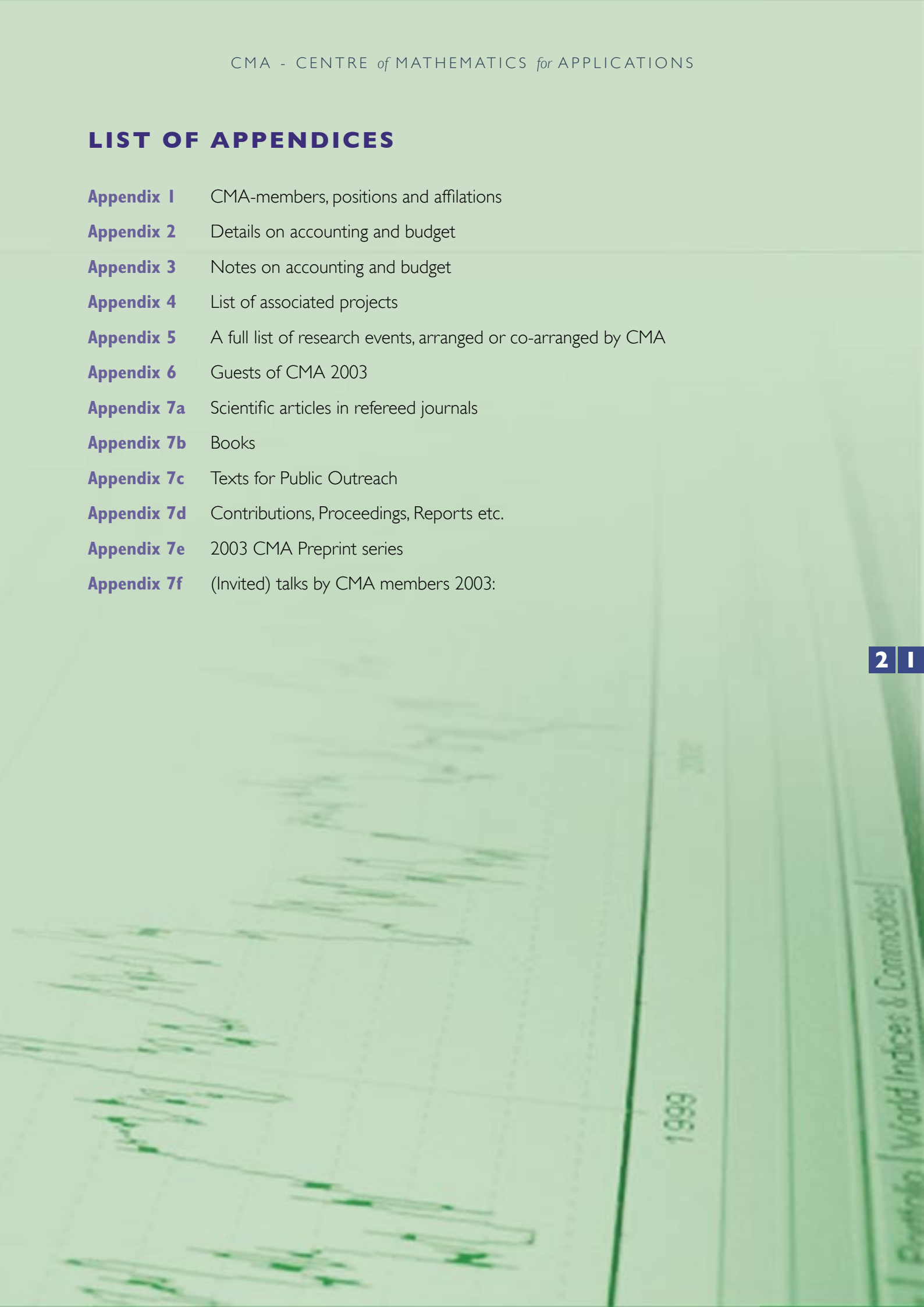
Appendix 7b Books

Appendix 7c Texts for Public Outreach

Appendix 7d Contributions, Proceedings, Reports etc.

Appendix 7e 2003 CMA Preprint series

Appendix 7f (Invited) talks by CMA members 2003:



APPENDIX 1

CMA-members , positions and affilations

The table below gives a total overview of all CMA-members in 2003 and in the foreseeable future. Only persons who already have been or are with us, and those who have confirmed to join us during 2004 are counted. Several positions will be announced during 2004, but these are not specified in this list. Neither are any further commitments from the host institution. Any such contributions provided from now on, will appear in the 2004 annual report.

The information provides the foundations for the accounts and budget disposals in this report, and also for the statistics on the personnel.

The columns describe the CMA-relationships as follows:

- Name and position
- The period and share are only related to the expected CMA-involvement. Notice that two persons have start dates before March 2003 (when CMA officially started). Those two were contributions from the host institution as a direct consequence of the centre appointment. That is why we have counted their full periods.
- The funding column sorts all members with respect to the four different financial income categories.
- Primary affilation indicates the home department of each member, independent of financial source. CMA is stated for those employed by CMA itself, and for direct contributions to CMA by the host.

Name	Position	Period	CMA-share	Funding (see budget)	Primary affilation
Fred Espen Benth	Professor	Mar03-Feb08	75%	Host	Mathematics
Elise Bergli	PhD-student	Mar03-Jul05	40%	Ass. project	Physics
		Aug05-Jul06	40%	Host	
Trond Brenna	PhD-student	Mar03-Jan04	100%	Ass. project	Informatics
		Feb04-May04		Host	
Steinar Børve	Postdoc	Mar03-Dec03	40%	Ass. project	Astrophysics
		Jan04-Jun04	100%	CMA	CMA
Mats Carlsson	Professor	Mar03-Feb08	40%	Host	Astrophysics
Snorre Christiansen	Postdoc	Nov02-Oct06	100%	Host	CMA
Giuseppe Maria Coclite	Postdoc	Nov03-Oct05	100%	CMA	CMA
Geir Dahl	Professor	Mar03-Feb08	75%	Host	Informatics
Håken Dahle	Postdoc	Mar03-Jan05	40%	Ass. project	Astrophysics
David Dean	Professor II	Jan04-Feb08	10%	CMA	CMA
Giulia Di Nunno	Assoc. Prof.	Mar03-Feb08	75%	Host	Mathematics
Tor Dokken	Research Dir	Mar03-Feb08	20%	SINTEF	CMA
	Professor II	May03-Feb08	20%	CMA	
Erik Christopher Dyken	PhD-student	Jul03-Jun06	100%	Ass. project	Informatics
Inga Baadshaug Eide	PhD-student	Feb04-Jan07	100%	CMA	CMA
Geir Ellingsrud	Professor	Mar03-Feb08	75%	Host	Mathematics
Eirik Endeve	PhD-student	Mar03-Jun04	40%	Ass. project	Astrophysics
Torgeir Engeland	Professor	Mar03-Aug03	40%	Host	Physics

Name	Position	Period	CMA-share	Funding (see budget)	Primary affilation
Hans Kristian Kamfjord Eriksen	PhD-student	Jul03-Jun06	40%	Ass. project	Astrophysics
Truls Flatberg	PhD-student	Mar03-Mar04	100%	Ass. project	Informatics
Michael Floater	Professor II	Mar03-Jul03	20%	Host	Informatics
		Aug03-Oct03	30%	Host	Informatics
			30%	CMA	CMA
	Res. Scientist	Mar03-Oct03	20%	SINTEF	CMA
	Professor	Nov03-Feb08	75%	Host	Informatics
Njål Foldnes	PhD-student	Mar03-Mar04	100%	Ass. project	Informatics
Helge Galdal	Senior adviser	Mar03-Feb08	100%	CMA	CMA
Gaute Hagen	PhD-student	Mar03-Jul04	40%	Ass. project	Physics
Viggo Hansteen	Professor	Mar03-Feb08	40%	Host	Astrophysics
Morten Hjorth-Jensen	Professor	Mar03-Feb08	40%	Host	Physics
Helge Holden	Professor II	May03-Feb08	20%	CMA	CMA
Klara Hveberg	PhD-student	Mar03-Oct04	100%	Ass. project	Mathematics
Åse Marit Janse	PhD-student	Feb04-Jan08	40%	Host	Astrophysics
Pål Hermunn Johansen	PhD-student	Mar03-Jun05	100%	Ass. project	Mathematics
Kenneth Karlsen	Professor	Feb03-Sep03	80%	Host	Informatics
		Oct03-Jun04	100%	CMA	CMA
		Jul04-Feb08		Host	
Maxim Kartamyshev	PhD-student	Jan04-Dec07	40%	Host	Physics
Paul Kettler	PhD-student	Aug03-Jul06	100%	Ass. project	CMA
An Thi Kieu	PhD-student	May04-Apr07	100%	Ass. project	Mathematics
Mari Anne Killie	PhD-student	Mar03-Jan06	40%	Ass. project	Astrophysics
Runhild Aae Klausen	PhD-student	Mar03-Sep03	100%	Host	Informatics
	Postdoc	Oct03-Sep04		CMA	CMA
		Oct04-Sep05		Ass. project	
Roman Kozlov	Postdoc	Mar03-Feb04	100%	Ass. project	Informatics
		Mar04-Jun04		CMA	CMA
Alberto Lanconelli	PhD-student	Mar03-Oct03	100%	Ass. project	Mathematics
		Nov03-Oct04		CMA	CMA
Egil Leer	Professor	Mar03-Feb08	40%	Host	Astrophysics
Per Barth Lilje	Professor	Mar03-Feb08	40%	Host	Astrophysics
Tom Lindstrøm	Professor	Mar03-Feb08	75%	Host	Mathematics
Tom Lyche	Professor	Mar03-Feb08	75%	Host	Informatics
Arne Løkka	PhD-student	Mar03-Sep03	100%	Ass. project	Mathematics
Cloud Makasu	Postdoc	Mar03-Jan05	100%	Ass. project	Mathematics
Sure Mataramvura	PhD-student	Mar03-Jul04	100%	Ass. project	Mathematics
Andrew McMurry	Postdoc	Mar03-Sep03	40%	Ass. project	Astrophysics
	Scientific prog	Oct03-Feb08	100%	Host	CMA

Name	Position	Period	CMA-share	Funding (see budget)	Primary affilation
Thilo Meyer-Brandis	PhD-student	Mar03-Feb05	100%	Ass. project	Mathematics
Per Christian Moan	Postdoc	Sep03-Aug04	75%	Host	Mathematics
		Sep04-Aug05	100%	CMA	CMA
Knut Mørken	Professor	Mar03-Feb08	75%	Host	Informatics
Eivind Osnes	Professor	Mar03-Feb08	40%	Host	Physics
Eirik Ovrum	PhD-student	Oct03-Sep06	100%	CMA	CMA
Ragni Piene	Professor	Mar03-Feb08	75%	Host	Mathematics
Frank Proske	Postdoc	Mar03-May04	100%	Ass. project	Mathematics
		Jun04-May06		CMA	CMA
Ewald Quak	Res. scientist	Mar03-Feb08	20%	SINTEF	CMA
	Professor II	Aug03-Feb08	20%	CMA	
Atgeirr Flø Rasmussen	PhD-student	May03-Apr06	100%	CMA	CMA
Martin Reimers	PhD-student	Mar03-Dec03	100%	Ass. project	Informatics
		Jan04-Mar04		Host	
Nils Henrik Risebro	Professor	Mar03-Aug03	100%	Host	Mathematics
		Sep04-Feb08			
Jurate Saltyte-Benth	Postdoc	Mar03-Jun03	100%	Host	Mathematics
		Jul03-Jun05		Ass. project	
Stein Arild Strømme	Professor II	Oct03-Feb08	10%	CMA	CMA
Tatiana Suraszhsky	Postdoc	Jul03-Jun05	100%	Ass. project	Informatics
Vitaly Suraszhsky	Postdoc	Jul03-Jun05	100%	Ass. project	Informatics
Xue-Cheng Tai	Professor II	Nov03-Feb08	20%	CMA	CMA
Jan Brede Thomassen	Postdoc	May03-Apr05	100%	CMA	CMA
Ragnar Winther	CMA-director	Mar03-Feb08	100%	CMA	CMA
Knut Waagan	PhD-student	May03-Apr06	100%	CMA	CMA
Evgeny Zabrodin	Researcher	Nov03-Jun04	100%	CMA	CMA
Bernt Øksendal	Professor	Mar03-Feb08	75%	Host	Mathematics
Knut Aase	Professor II	Jan04-Feb08	20%	CMA	CMA

APPENDIX 2 Details on accounting and budget

	Note	Total 1)				CMA Disposals 2)				Note	UiO FUNDING 3)		SINTEF FUNDING 4)		OTHER FUNDING 5)	
											(NB! All items have identical in and outs. Stated once in order to fit the page)					
		2003 Accounts		2004 Budget		2003 Accounts		2004 Budget			2003 Acc	2004 Budget	2003 Acc	2004 Budget	2003 Acc	2004 Budget
		Revenues	Expenditures	Revenues	Expenditures	Revenues	Expenditures	Revenues	Expenditures							
CASH REVENUES																
RCN-funding	6	-9 000 000		-10 500 000		-9 000 000		-10 500 000		6						
UiO board, free disposals	7			-2 000 000				-2 000 000		7		2 000 000				
Cash trasfers to CMA	8	-32 000		-230 000		-32 000		-230 000		8					32 000	230 000
Internationalization	9			-25 000				-25 000		9		25 000				
Transferred surplus 2003	10			-4 010 472				-4 010 472		10						
Sum Cash Revenues		-9 032 000		-16 765 472		-9 032 000		-16 765 472				2 000 000			32 000	
EXPENSES																
Salary expenses																
* PhD-positions	11	-4 460 925	5 092 468	-4 096 887	6 455 737		631 543		2 358 850	11	203 438	512 774		223 000	4 257 487	3 361 113
* postdoc positions	12	-3 379 010	3 874 731	-3 416 633	5 653 234		495 721		2 236 601	12	726 832	706 604			2 652 178	2 710 029
* Researchers	13	-5 967 219	7 207 811	-6 996 523	9 317 741		1 240 592		2 321 218	13	5 687 219	6 756 523	280 000	240 000		
* Admin. And technicians	14	-125 598	593 695	-502 391	1 064 107		468 097		561 716	14	125 598	502 391				
* Estimated increase of wages: 4%	15			-339 132	638 267				299 135	15		339 132				
SUM Salary Expenses		-13 932 752	16 768 705	-15 351 566	23 129 086		2 835 953		7 777 520		6 743 087	8 817 424	280 000	463 000	6 909 665	6 071 142
Indirect costs																
* Per individual, given rates	16	-2 435 346	2 895 921	-2 495 500	3 910 775		460 575		1 415 275	16	910 158	1 147 700	36 000	70 000	1 489 188	1 277 800
* Areas beyond offices, rent costs	17	-430 000	430 000	-520 000	520 000					17	430 000	520 000				
SUM Indirect Costs		-2 865 346	3 325 921	-3 015 500	4 430 775		460 575		1 415 275		1 340 158	1 667 700	36 000	70 000	1 489 188	1 277 800
Running costs																
Operational means, PhD+postdocs	18	-566 775	566 775	-536 400	911 225				374 825	18	60 500	77 550		15 000	506 275	443 850
Conferences	19		390 000		600 000		390 000		600 000	19						
Guests and trravelling	20		380 000		2 550 000		380 000		2 550 000	20						
Public Outreach, info	21		175 000		410 000		175 000		410 000	21						
Teaching services	22		35 000		200 000		35 000		200 000	22						
Various operational costs	23		95 000		400 000		95 000		400 000	23						
Rebuilding costs 2003	24	-4 000 000	4 000 000							24	4 000 000					
Extra grant from faculty	25	-500 000	500 000							25	500 000					
Oslo Graphics Laboratory	26	-250 000	250 000							26	250 000					
Sum Running costs		-5 316 775	6 391 775	-536 400	5 071 225		1 075 000		4 534 825		4 810 500	77 550		15 000	506 275	443 850
Equipment, investments	27	-425 000	1 075 000	-520 000	1 720 000		650 000		1 200 000	27	425 000	520 000				
Collaborative projects	28	-2 550 000	2 550 000	-3 122 000	3 122 000					28			250 000	222 000	2 300 000	2 900 000
TOTAL SUM		-34 121 873	30 111 401	-39 310 938	37 473 086	-9 032 000	5 021 528	-16 765 472	14 927 620		13 318 745	13 082 674	566 000	770 000	11 237 128	10 692 792
«Result»	29	-4 010 472		-1 837 852		-4 010 472		-1 837 852		29						

APPENDIX 3

Notes on accounting 2003 and budget 2004

1. Total revenues and expenditures. These expenditure figures are the foundation for table 1 in this report. The revenues, however, are here calculated regardless of the funding source (see note 3, 4, 5 and 6 for details on the different revenue items in table 1). All sums are obtained by adding the corresponding CMA Disposal figures with the contributions from UiO, SINTEF and Other.

2. The CMA disposals. These figures represent the CMA operating account – means that are provided to our credit, and which are resolved by the authorization of ours. The main incomes are the RCN-part and the UiO cash transfer, but there are also some minor items. The different expenses are commented upon in the notes 11-28.

3. UiO funding. CMA has exceeded the original estimates for the host funding. The main reasons are generally that more persons are involved, and for 2003 specifically, that the rebuilding operations were more expensive than estimated. We especially remark that the original budget contained three new positions promised by the host institution. These were:

- One scientific programmer.
- One full professorship (tenured)
- One 4-year postdoc position (2003-2006) (which was given as a reward when CMA was appointed Centre of Excellence).

All these promises are fulfilled, and the time schedules are met.

4. Contribution from active partner SINTEF. The 2003-figures are essentially as expected. The original figures were roughly estimated, if we originally had used the same accuracy and level of details as in the accounted figures now presented, the figures would probably have balanced. However, the increase in the 2004 budget is due to real new activities. SINTEF has been granted a «Strategic Institute Programme (SIP)», and intend to forward one PhD-student to CMA. This will constitute a significant percentage increase in the SINTEF contribution for the next three years.

5. Other funding. As stated in the Section «Outlooks on the associated projects», these figures outperform our estimates. See complete list of these projects in appendix 4. All individual projects have been averaged to standard rates. We have consequently used NOK 535.000 for PhD-grants, all costs included. The sum is then divided into NOK 407.000 for the salary expenses (note 11), NOK 95.000 to cover indirect costs (note 16), and NOK 33.000 provided for the fellow to cover operational costs (note 18). The corresponding figures for postdoc fellows are NOK 650.000 in total, of which 522.000 cover salaries (note 12), and the other expenses are equal (note 16 and 18). For fellows within collaborative projects, we have used the same figures.

The rest of the collaborative projects are more difficult to estimate with due accuracy. See note 28.

6. RCN funding. There are no changes in the plans for the RCN-funded financial income. The original schedule is maintained, also for 2004.

7. Cash funding from UiO. NOK 2.000.000 have generously been guaranteed by the University board each year from 2004-2007. In 2003 we also had a similar granted, but this was dedicated to the rebuilding operations. See note 24.

8. Minor cash revenues from affiliated projects. NOK 32.000 were invoiced the Department of Informatics (Ifi) due to the affiliated project «Mathematical Methods in Mesh-based Modeling». The project is run by Ifi, but CMA is housing three fellows (who are full CMA members, and salaries etc. are counted among the other funding). In 2004 we will invoice 130.000 for the house rent.

Finally CMA has been granted NOK 100.000 from an affiliated project «FORNY» in 2004.

9. Internationalization support from UiO. NOK 25.000 is granted from UiO regarding one long-term guest (Francesca Biagini, Aug 04 – Jan 05). We may expect more such contributions, but this one is the only one that is confirmed by now.

10. Resolution on the 2003 surplus. The 2003 surplus is transferred as a revenue item on the 2004 budget.

11. Salary costs for PhD students. This item is covering salaries and direct costs thereof for all our PhD-students in 2003, and those confirmed for 2004. The figures reflect the man year figures in table 3.

12. Salary costs for postdoc positions. As 11.

13. Salary costs for researcher positions. As 11. By «Researcher» we mean senior scientists (including the centre manager), and adjunct positions.

14. Salary costs for administrative and technical personell. As 11. Recall that a major part of the indirect costs (note 16) is dedicated to cover administrative and technical support for the centre as described in the section «Administrative support».

15. Estimated increase of wages. We have used 4% as earlier instructed by the RCN in the original budgets. However, political signals currently point towards inflation lower than 4%. We will adjust these figures in the revised budget. We have not estimated any increases to the affiliated projects. This is due to the fact that we have used standard rates for all positions (see note 5), and these rates are fixed through the whole employment period.

16. Indirect costs, per individual. This item covers offices and infrastructure provided for each individual. We have used prescribed rates at NOK 77.000 pr man-year except for PhD-students and Postdocs where we have used 95.000. For UiO funded personell, SINTEF personell and affiliates, these figures appear equally as revenues and expenditures, but we explicitly pay our host for all CMA employees, using the same rates.

17. Additional areas. NOK 500.000 (full year 2003) was annually specified to cover all areas beyond the offices counted in 16, meaning other offices, laboratories, seminar-rooms, meeting-rooms, lunch area, other areas. CMA has at its full disposal about 1400 square meters. In addition we have flexible solutions with our host if and when we need additional space. We maintain the original figures for this part both for the 2003 account as well as for the adjusted 2004 budget.

18. Operational means, PhDs and postdocs. For recruiting positions, common practice is to set aside some personal means for operational costs. In CMA we calculate NOK 33.000 pr year for this purpose. All affiliates have the same sum available, and we have used the same rate for the host-supported fellows.

19. Conferences. Workshops and conferences are main activities of the CMA activity. Appendix 5 contains a full list of the 2003 events.

20. Guests and travelling. This item reflects another main activity, Appendix 6 and 7f presents results of this extensive bilateral activity.

21. Public outreach. This item covers publicity efforts, posters, design elements for web and brochures, reports (like this) etc. We also plan to make efforts towards society in general, and children specifically. The support of www.matematikk.org is included in this item.

22. Teaching services. CMA members are not exemted 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.

23. Various operational costs. This item is meant for the daily needs and actions that are not covered by any other specific item.

24. Rebuilding costs. This is a 2003-specific item, which will be replaced by free means from 2004, see note 7. In 2003, the grant was raised to MNOK 3,4 and dedicated to cover the rebuilding costs for the new CMA-locations. However, the rebuilding operations turned out to become even more expensive than estimated, and the host institution carried this extra load.

25. Extra grant from the faculty. The Faculty of Mathematics and Natural Science covered significant expenses before and around the official centre start. (Furnishing, and various operational costs)

26. The Oslo Graphics Laboratory was granted for the geometry group in CMA. The laboratory consists of state-of-the-art computers with high-end graphics cards, and some additional equipment. The laboratory is in operational use in the CMA-locations.

27. Equipment. CMA itself mostly obtains computers and additional accessories. The centre members also make use of existing equipment, especially the astrophysisists. In the original budget we estimated this to an annual amount of NOK 500.000. The activity goes on as expected, and we see no reasons to adjust this contribution to the figures. However, the total figures for the equipment item should possibly be higher than stated. See note 28.

28. Collaborative projects. Appendix 4 provides a full overview of all affiliated projects. All individual grants are covered by note 11 and 12. So are all PhD-students and postdocs coming from larger, collaborative projects. Then we are left with the estimates on the rest of the project activities. See the argumentation and example in section «Statement on the accounting and budgetary principles». We repeat, though, that the estimates are quite carefully made. Scientifically spoken, these projects are of highly relevant to the CMA research plan, and contribute to fulfil the research goals of CMA. However, the content of this budgetary item, should be spread out on other items. It includes a major part of equipment, several guests, travelling, conferences etc. But we don´t have qualified measures to divide the figures. Hence we have found it most reasonable to state these activities in one sum.

29. The surplus. With regards to the 2003 figures, the accounts reveal that our significant surplus of 2003 is stemming from the core activity of CMA and its main RCN funding. This is due to a late start on March 1, and even more waiting until we moved into new locations on September 1. It has been an inevitable fact that we were totally dependent of our own locations in order to increase the speed of activities. In addition we were a totally new constellation, and it takes time to employ a number of persons! These are our main explanations as to why we have obtained a 2003 surplus of MNOK 4,010. The similar, accumulated surplus of 2004 reduces to MNOK 1,838.

APPENDIX 4 List of associated projects

INDIVIDUAL

Names	Pos.	Source	Proj. #	Project leader	Period
Hans Kristian Kamfjord Eriksen	PhD	RCN	157882/432	Per Lilje	01.07.2003 - 30.06.2006
Mari Anne Killie	PhD	RCN	153233/431	Øystein Lie-Svendsen	01.02.2003 - 31.01.2006
Eirik Endeve	PhD	RCN	145519/432	Egil Leer	... - 30.06.2004
Njål Foldnes	PhD	RCN	142971/432	Geir Dahl	... - 15.04.2004
Sure Mataramvura	PhD	Univ.of Zimbabwe		Bernt Øksendal	... - 30.06.2004
Thilo Meyer-Brandis	PhD	RCN	147234/432	Bernt Øksendal	... - 28.02.2005
Klara Hveberg	PhD	RCN	138388/432	Tom Lindstrøm	... - 31.10.2004
Martin Reimers	PhD	RCN	142150/320	Knut Mørken	... - 31.12.2003
Trond Brenna	PhD	RCN	131867/410	Tom Lyche	... - 31.01.2004
Truls Flatberg	PhD	RCN	134514/410	Geir Dahl	... - 31.03.2004
Alberto Lanconelli	PhD	Univ. Of Pavia		Bernt Øksendal	... - 31.10.2003
Arne Løkka	PhD	RCN		Fred Espen Benth	... - 15.09.2003
Elise Bergli	PhD	RCN		Morten Hjort-Jensen	... - 30.07.2005
Gaute Hagen	PhD	RCN		Morten Hjort-Jensen	... - 31.07.2004
Paul C. Kettler	PhD	own funded		Fred Espen Benth	01.08.2003 - 31.07.2006
An Thi Kieu	PhD	RCN		Bernt Øksendal	01.05.2004 - 30.04.2007
Håkon Dahle	postdoc	RCN	153218/431	Per Lilje	01.02.2003 - 31.01.2005
Steinar Børve	postdoc	RCN	147567/431	Jan Trulsen	... - 31.12.2003
Andrew McMurry	postdoc	Michigan State University		Mats Carlsson	... - 30.09.2003
Frank Proske	postdoc	EU / DFG		Frank Proske	... - 31.05.2004
Cloud Makasu	postdoc	RCN	155115/432	Bernt Øksendal	01.02.2003 - 31.01.2005
Jurate Saltyte-Benth	postdoc	RCN	155120/432	Jurate Saltyte-Benth	01.07.2003 - 30.06.2005
Runhild Aae Klausen	postdoc	CIPR / Bergen		Runhild Aae Klausen	15.10.2004 - 14.10.2005

COLLABORATIVE

Title /Acronym	Pos.	Source	Proj. #	Project leader	Period
ESMN		EU / RTN	HPRN-CT-2002-00313	Mats Carlsson	... - 31.10.2006
TOSTISP		EU / RTN	HPRN-CT-2001-00310	Viggo Hansteen	01.03.2003 - 28.02.2006
SHP		RCN / SUP	146467/420	Mats Carlsson	... - 31.12.2005
Norwegian Participation in the Planck LFI tinstrument and cosmology with NOT		RCN	153380/431	Per Lilje	01.01.2003 - 31.12.2004
GAIA II (UiO-del, se ogsĆ SINTEF)	1 PhD	EU / FET	IST-2001-35512	Tor Dokken	... - 30.06.2005
HYKE	Visitors	EU / RTN	HPRN-CT-2002-00282	Kenneth K. / Helge H.	... - 31.07.2005
OMATS	Visitors	EU / MC-EST	HPMT-CT-2000-00104	Geir E. / Ragni P.	2001 - 2004
MACSINET		EU / RTN	IST-1999-14077	Helge Holden	... - 13.04.2004
Robust Numerical Methods for Partial Differential Equations	1 postdoc	RCN / BeMatA	135420/431	Ragnar Winther	20.02.2002 - 19.02.2004
SUPREMA	Visitors	RCN / SUP	154077/420	Geir E. / Ragni P.	2003 - 2006
Mathematical Methods in Mesh-based Geometric Modelling	1 PhD+2post	RCN / BeMatA	154895/431	Mike Floater	01.01.2003 - 30.06.2006
Nonlinear partial differential equations of evolution type - theory and numerics		RCN / BeMatA	139144/431	Helge Holden	01.01.2000 - 31.12.2003
Winter Schools in Computational Mathematics		RCN / BeMatA	137461/431	Kenneth K. / Helge H.	2001 - 2004
Winter Schools in Computational Mathematics		RCN / BeMatA		Kenneth K. / Helge H.	2005 - 2006
FORNY		RCN		H Galdal	2004 forprosjekt
Analysis and numerics for Nonlinear Waves (NonWave). BeMatA		RCN / BeMatA		Helge Holden / K. Karlsen	2004 - 2006

THROUGH SINTEF

Title /Acronym	Pos.	Source	Proj. #	Project leader	Period
MINGLE		EU / RTN	HPRN-CT-1999-00117	Mike Floater	15.01.2000 - 14.01.2004
GAIA II (see also above)		EU/FET			01.07.2002 - 30.06.2005
AIM @ SHAPE		FP6 / NOE		Ewald Quak	2004 - 2008
Graphics hardware as a high-end computational resource		RCN / SIP		Tor Dokken	2004-2008

APPENDIX 5

A full list of research events, arranged or co-arranged by CMA

In 2003 CMA arranged the following conferences and workshop (see moe detailed descriptions in the Scentific Activity Report).

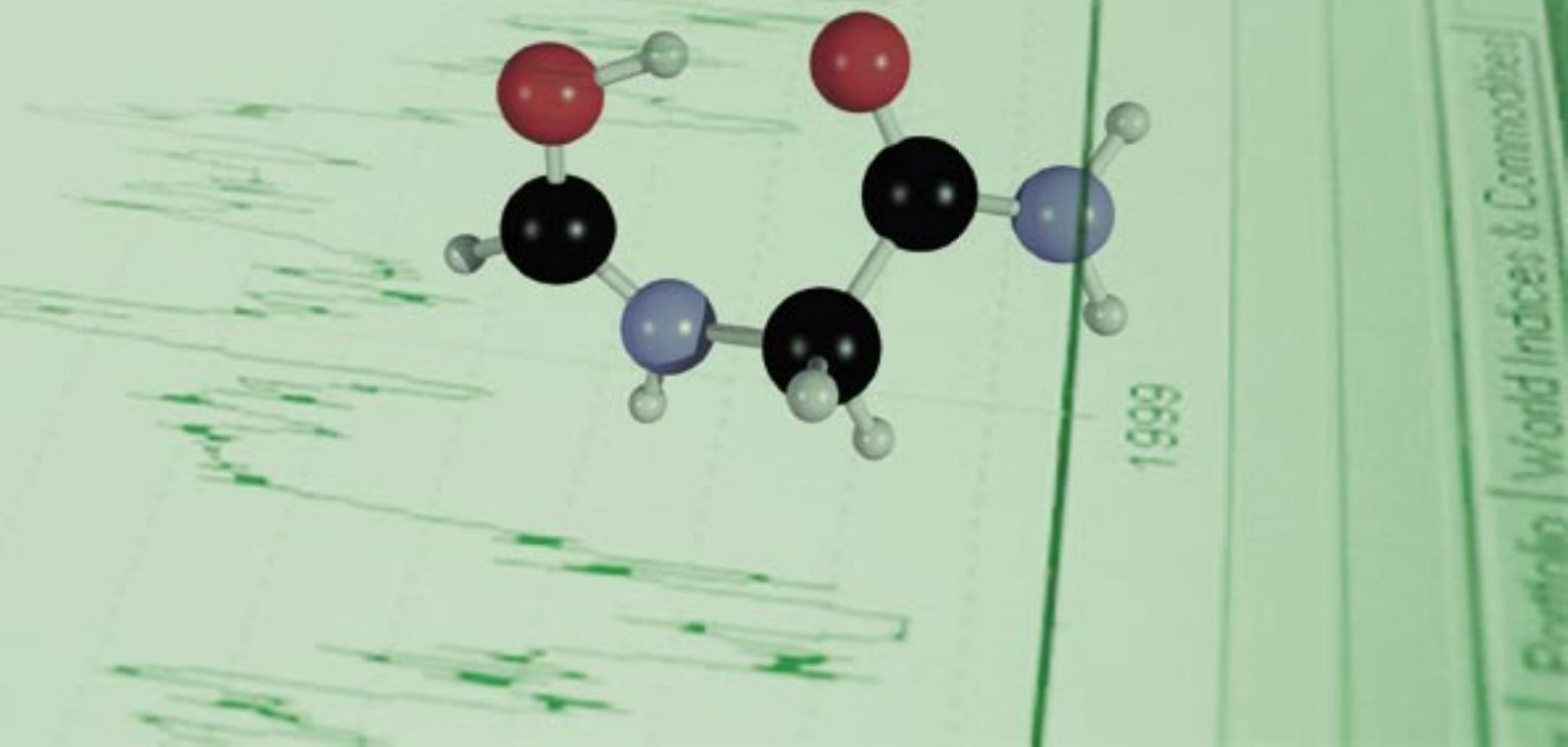
1. **The Arctic workshop on Stochastic Analysis and Matehematical finance**, Aug. 5-10. (44 participants, 33 talks)
2. **The official kick-off conference**, Sep. 1-2. (81 participants, 12 talks)
3. Workshop: **Level Set Methods**, Sep. 9-10. (19 participants, 10 talks)
4. Workshop: **Mathematics and economics day**, Oct 3. (28 participants, 6 talks)
5. Workshop: **Computational methods in astrophysical problems**, Nov. 4-5 (22 participants, 13 talks)
6. Workshop: **Computational methods for the time-dependent Schroedinger equation**, Nov. 17-18 (27 participants, 10 talks)

The following seminar series took place at CMA during 2003. These are also described more detailed in the Scientific Activity Report.

1. **The CMA Spring seminar** (12 talks)
2. **The CMA Fall seminar** (8 talks)
3. **The CMA Guest Lecture Series** (21 talks)
4. **The PDE seminar, spring** (8 talks)
5. **The Stochastic Analysis seminar**, fall (8 talks)
6. **The Informal seminar on geometry and PDEs** (7 talks)

Finally, CMA or members of CMA, co-organized the following list of international conferences and workshops. Links to all onferences are provided on our web-page here: http://www.cma.uio.no/conferences/2003/external2003.html

1. **Industry challenges in geometric modeling and CAD (WG 17).** Mar 31 - Apr 1. Organized by the Macsinet Working Group «Geometric Modeling, CAD, evolving interfaces and surfaces» at the Technical University Darmstadt, Germany, Organizer: Dr. Ewald Quak
2. **II International Workshop on Computer Graphics and Geometric Modeling CGGM'2003,** May 18-21. Montreal, Canada, Tor Dokken on the programme committee.
3. **15th International Conference on Domain Decomposition Methods.** July 21-25. Free University of Berlin, Germany, Xue-Cheng Tai organizer of one minisymposium.
4. **Multiresolution in geometric modelling.** September 9-11. Emanuelle College, Cambridge (England) Organizers: Michael Floater (CMA and SINTEF), Neil Dodgson, and Malcolm Sabin.
5. **Computational Methods for Algebraic Spline Surfaces (COMPASS).** Sep. 29 - Oct 3. Landesbildungszentrum Schloss Weinberg, Austria. Organizers: Tor Dokken (CMA and SINTEF Applied Mathematics, Norway) and Bert Jüttler (Johannes Kepler University of Linz, Austria)
6. **SOHO 13 `Waves, oscillations and small scale transient events in the solar atmosphere: A joint view of SOHO and TRACE'.** Sep. 29 - Oct 3. Palma de Mallorca, Balearic Islands, Spain. Member of scientific organizing committee: Mats Carlsson (CMA).
7. **The Eighth SIAM Conference on Geometric Design and Computing,** Nov. 9 - 13. Seattle, Washington, Member of scientific committee: Tor Dokken (CMA and SINTEF Applied Mathematics).
8. **Symposium on the Mathematics of Finance,** Dec. 8-12. Livingstone, Botswana. Bernt Øksendal on the organizing committee.



APPENDIX 6

Guests of CMA 2003

The following persons have been (invited) guests of CMA 2003:

Long term guests (> 3 months)

- Feb 1-Dec 31: Postdoc **Espen Jakobsen**, NTNU, Norway
- Feb 1-Oct 15: Postdoc **Mostafa Bendahmane,** Universite de Franche-Comte, Montbelliard, France

Short term guests (<3 months)

Norwegian visitors are not listed, but count more than 200. International visitors count 76 visits (73 unique persons), and are chronologically (by date of arrival) listed as follows:

- Dec 10-17 Dr. **Bruce Lites,** High Altitude Observatory, NCAR, USA
- Nov 15-20 (CMA Workshop): Postdoc fellow **Patrice Bertet,** TU Delft, Holland
- Nov 4-5 (CMA Workshop): Professor **Axel Brandenburg,** Nordita, Denmark
- Nov 4-5 (CMA Workshop): **Tobias Heinemann,** Nordita, Denmark
- Nov 4-5 (CMA Workshop): Associate professor **Åke Nordlund,** University of Copenhagen, Denmark
- Nov 2-4 (CMA Workshop): Professor **Dietmar Kröner,** University of Freiburg, Germany
- Nov 1-5 (CMA Workshop): Professor **Christian Klingenberg,** University of Wurzburg, Germany
- Oct 16 Dipl. Phys. **Peter Böhm,** Munich University of Technology, Germany
- Oct 13-31 Professor **Steven Kleiman,** MIT, USA
- Oct 3 (CMA Workshop): **Huyen Pham,** University of Paris VII, Paris, France
- Oct 3 (CMA Workshop): **Peter Bank,** Humboldt University, Berlin, Germany
- Sep 30 Professor **Peter Knabner,** Friedrich-Alexander University, Erlangen, Germany.
- Sep 23-Oct 16: Professor **Robert Stein,** Michigan State University, USA
- Sep 15-19 Professor **Richard F. Riesenfeld,** School of Computing, University of Utah, USA.
- Sep 8-11 (CMA Workshop): Professor **Richard Tsai,** Princeton University, USA
- Sep 1-3 (Kick-off Conference): Professor Carl de Boor, University of Wisconsin - Madison, USA
- Sep 1-2 (Kick-off Conference): Professor **David Dean,** Oak Ridge National Laboratory, USA
- Sep 1-2 (Kick-off Conference): Professor **Mark H.A. Davis,** Imperial College, London, England
- Sep 1-2 (Kick-off Conference): Professor **Weinan E,** Princeton University, USA
- Sep 1-2 (Kick-off Conference): **Achim Schroll,** Lund University, Sweden
- Sep 1-2 (Kick-off Conference): Professor **Rolf Stenberg,** Helsinki University of Technology, Finland
- Sep 1-2 (Kick-off Conference): Professor **Anders Szepessy,** KTH Stockholm, Sweden
- Aug 30-Sep 3 (Kick-off Conference): Professor **Helmut Pottmann,** Vienna University of Technology, Austria
- Aug 31-Sep 11 Dr. **Tom Bogdan,** High Altitude Observatory, NCAR, USA
- Aug 25 Professor **Loukas Vlahos,** University of Thessaloniki, Thessaloniki, Greece
- Aug 19-26 Professor Dr. dr.h.c. **Heiner Gonska,** Universität Duisburg-Essen, Germany.
- Aug 23-26 Professor **Alberto Bressan,** SISSA, Trieste, Italy
- Aug 23-26 Research associate **Wen Shen,** SISSA, Trieste, Italy
- Aug 17-Sep 6 Professor **Richard Falk,** Rutgers University, Washington DC, USA
- Aug 5-17 Professor **Anna Lisa Amadori,** Istituto per le Applicazioni del Calcolo «M. Picone», Consiglio Nazionale delle Ricerche, Rome, Italy
- Aug. 5-10 (Arctic Workshop): **Bruno Bassan,** University of Rome, Italy
- Aug. 5-10 (Arctic Workshop): **Dirk Becherer,** Imperial College, London, England
- Aug. 5-10 (Arctic Workshop): **Christian Bender,** University of Konstanz, Germany
- Aug. 5-10 (Arctic Workshop): **Francesca Biagini,** University of Bologna, Italy
- Aug. 5-10 (Arctic Workshop): **Dong Myung Chung,** Sogang University, Korea
- Aug. 5-10 (Arctic Workshop): **Myriam Cisneros-Molina,** University of Oxford, England
- Aug. 5-10 (Arctic Workshop): **Serena Fuschini,** University of Bologna, Italy
- Aug. 5-10 (Arctic Workshop): **Rusland Gomez-Nesterkin,** Central Bank of Mexico, Mexico
- Aug. 5-10 (Arctic Workshop): **Mika Hujo,** University of Jyvaskyla, Finland
- Aug. 5-10 (Arctic Workshop): **Martin Groth,** Univesity of Vaxsjø, Sweden
- Aug. 5-10 (Arctic Workshop): **Martin Jacobsen,** Unievrsity of Copenhagen, Denmark

- Aug. 5-10 (Arctic Workshop): **Marina Kozlova,** Åbo Academy University, Finland
- Aug. 5-10 (Arctic Workshop): **Jeong Hyun Lee,** Sogang University, Korea
- Aug. 5-10 (Arctic Workshop): **Xu-Mei Li,** The Nottingham Trent University, England
- Aug. 5-10 (Arctic Workshop): **Eva Lutkebohmert,** University of Bonn, Germany
- Aug. 5-10 (Arctic Workshop): **Siu-Ah Ng,** University of Natal-Pietermaritzburg, South Africa
- Aug. 5-10 (Arctic Workshop): **Goran Peskir,** University of Aarhus, Denmark
- Aug. 5-10 (Arctic Workshop): **Huyen Pham,** Universite Paris VII, France
- Aug. 5-10 (Arctic Workshop): **Maurizio Pratelli,** University of Pisa, Italy
- Aug. 5-10 (Arctic Workshop): **Joon H. Rhee,** University of Hallym, Korea
- Aug. 5-10 (Arctic Workshop): **Wolfgang Runggaldier,** University of Padova, Italy
- Aug. 5-10 (Arctic Workshop): **Paavo Salminen,** Åbo Academy University, Finland
- Aug. 5-10 (Arctic Workshop): **Marta Sanz-Sole,** University of Barcelona, Spain
- Aug. 5-10 (Arctic Workshop): **Nadia Uys,** University of the Witwatersrand, South Africa
- Aug. 5-10 (Arctic Workshop): **Tusheng Zhang,** University of Manchester, England
- Aug. 5-10 (Arctic Workshop): **Huaizhong Zhao,** Loughborough University, England
- Jul 30-Aug 5: Professor **Raimund Bürger,** Universität Stuttgart, Germany
- Jun 25: Professor **Tom Russell,** University of Colorado, Denver, USA
- Jun 23-27: Dr. **Bart de Pontieu,** Lockheed Martin Solar & Astrophysics Lab, Palo Alto, CA, USA
- Jun 15-22: Dr. **Hardi Peter,** Kiepenheuer-Institut für Sonnenphysik, Germany
- Jun 9-14: Dr. Rony Keppens, Institute for plasma physics Rijnhuizen, Netherlands
- Jun 5-12: Dr. **Jorge Sanchez Almeida,** Instituto de Astrofisica de Canarias, Spain
- Jun 2: Professor **Denis Serre,** Ecole Normale Supérieure de Lyon, France
- Jun 2: Professor **Rolf Jeltsch,** ETH Zurich, Switzerland
- Jun 1 - 24: PhD student **Daniel Muller,** Kiepenheuer-Institut für Sonnenphysik, Germany
- Jun 1-14: Professor **Robert J. Rutten,** Sterrekundig Instituut Utrecht, Netherlands
- May 22: Professor **J. M. Greenberg,** U.S. Office of Naval Research, London, and Carnegie Mellon University, Pittsburgh, USA
- May 21-22: Professor **Hermann Thorisson,** Science Institute, University of Iceland, Iceland
- May 21: Dr. **Giuseppe Coclite,** S.I.S.S.A, Trieste, Italy
- May 7: Dr. **Gianni Garbarino,** University of Barcelona, Spain
- Apr 2: Dr. **Rickard Bergström,** Chalmers University of Technology, Sweden
- Mar 5-14: Professor **Robert J. Rutten,** Sterrekundig Instituut Utrecht, Netherlands
- Feb 28-Mar 6: Professor **Richard F. Riesenfeld,** School of Computing, University of Utah, USA
- Feb 27-Mar 2: Professor **Eitan Tadmor,** University of Maryland, USA
- Feb 24-Mar 6: Professor **Francesca Biagini,** University of Bologna, Italy
- Feb. 7: Associate Professor **Fabio Paronetto,** University of Lecce, Italy.

APPENDIX 7a

Scientific articles in refereed journals

1. **Benth, Fred Espen:** *On arbitrage-free pricing of weather derivatives based on fractional Brownian motion.* Applied Mathematical Finance 2003;10(4):303-324
2. **Benth, Fred Espen;** Dahl, Lars and **Karlsen, Kenneth Hvistendahl.** *Quasi Monte Carlo evaluation of sensitivities of options in commodity and energy markets.* Int. J. Theor. Appl. Finance 2003; 6(8):865-884
3. **Benth, Fred Espen; Karlsen, Kenneth Hvistendahl** and Reikvam, Kristin. *Merton's portfolio optimization problem in a Black & Scholes market with non-Gaussian stochastic volatility of Ornstein-Uhlenbeck type.* Mathematical Finance, 2003; 13(2):215-244
4. **Benth, Fred Espen; Karlsen, Kenneth Hvistendahl** and Reikvam, Kristin. A semilinear Black and Scholes partial differential equation for valuing American options. Finance and Stochastics 2003; 7(3):277-298
5. **Benth, Fred Espen;** Ekeland, Lars; Hauge, Ragnar; Nielsen, Bjørn Fredrik. *A note on arbitrage-free pricing of forward contracts in energy markets.* Applied Mathematical Finance 2003;10(4):325-336
6. **Benth, Fred Espen;** Theting, Thomas Gorm. *Some regularity results for the stochastic pressure equation of Wick-type.* Stochastic Analysis and Applications 2003;20(6):1191-1223
7. Guio, Patrick; **Børve, Steinar,** et al: *Phase space vortices in collisionless plasmas.* Nonlinear Processes in Geophysics 2003;10:75-86
8. Omang, Marianne; **Børve, Steinar;** Trulsen, Jan. *Numerical simulation of shock-vortex interactions using regularized smoothed particle hydrodynamics.* International Journal of Computational Fluid Dynamics 2003;12(2):258-265
9. Asensio ramos, A; Trujillo bueno, Javier; **Carlsson, Mats;** Chernicharo, J. *Nonequilibrium CO Chemistry in the Solar Atmosphere.* Astrophysical Journal Letters 2003; 588:61-64
10. Asplund, M; **Carlsson, Mats;** Botnen, Andreas Valeur. *Multi-level 3D non-LTE computations of lithium lines in the metal-poor halo stars HD 140283 and HD 84937.* Astronomy and Astrophysics 2003;399:L31-L34
11. Bogdan, T.J.; **Carlsson, Mats; Hansteen, Viggo; Mcmurry, Andrew** et al: *Waves in the Magnetized Solar Atmosphere. II. Waves from Localized Sources in Magnetic Flux Concentrations.* Astrophysical Journal 2003; 599: 626-660
12. Judge, P.G.; **Carlsson, Mats;** Stein, R.F.. *On the Origin of the Basal Emission from Stellar Atmospheres: Analysis of Solar C II Lines.* Astrophysical Journal 2003;597:1158-1177
13. Buffa, Annalisa; **Christiansen, Snorre H.** *The Electric Field Integral Equation on Lipschitz screens: definitions and numerical approximation.* Numerische Mathematik 2003;94(2):229-267
14. **Christiansen, Snorre H.** *Uniformly stable preconditioned mixed boundary element method for low-frequency electromagnetic scattering.* Comptes Rendus Mathematique 2003;336(8):677-680.
15. Brualdi, R.A.; **Dahl, Geir.** *Majorization-Constrained Doubly Stochastic Matrices.* Linear Algebra and its Applications 2003;361:75-97
16. **Dahl, Geir.** *A note on linear discrepancy.* The Electronic Journal of Linear Algebra 2003;10
17. **Dahl, Geir;** et al.. *Matrices of zeros and ones with given line sums and a zero block.* Linear Algebra and its Applications 2003;371 191-207
18. **Dahl, Geir.** *The doubly graded matrix cone and Ferrers matrices.* Linear Algebra and its Applications 2003; 368: 171-190
19. **Dahl, Geir; Flatberg, Truls.** *Reconstructing hv-convex (0,1)-matrices by optimization methods,* Electronic Notes in Discrete Mathematics
20. **Dahl, Geir; Foldnes, Njål.** *Complete description of a class of knapsack polytopes.* Operations Research Letters 2003;31:335-340
21. **Dahle, Håkon;** Hannestad, Steen; Sommer-Larsen, Jesper. *The Density Profile of Cluster-Scale Dark Matter Halos.* Astrophysical Journal Letters 2003;588:L73-L76
22. **Dahle, Håkon;** Pedersen, Kristian; **Lilje, Per Barth** et al: *Weak gravitational lensing by a sample of X-ray luminous clusters of galaxies - III. Serendipitious weak lensing detections of dark and luminous mass concentrations.* Astrophysical Journal 2003;591:662-676
23. Holland, S.; **Dahle, Håkon;** et al.: *Optical Photometry of GRB 021004: The First Month.* Astronomical Journal 2003;125:2291-2298
24. **Di Nunno, Giulia:** *Holder equality for conditional expectations with application to linear monotone operators.* Theory of Probability and its Applications 2003;48(1):194-198
25. **Endeve, Eirik; Leer, Egil;** Holzer, T.E.: *Two-dimensional Magnetohydrodynamic Models of the Solar Corona: Mass Loss from the Streamer Belt.* Astrophysical Journal 2003;589:1040-1053
26. **Floater, Michael S.:** *Analysis of curve reconstruction by meshless parameterization.* Numerical Algorithms 2003;32:87-98
27. **Floater, Michael S.:** *Error formulas for divided difference expansions and numerical differentiation.* Journal of Approximation Theory 2003;122:1-9
28. **Floater, Michael S.:** Mean value coordinates. Computer Aided Geometric Design 2003;20:19-27
29. **Floater, Michael S.:** *One-to-one piecewise linear mappings over triangulations.* Mathematics of Computation 2003;72:685-696
30. Lie-Svendsen, Øystein; **Hansteen, Viggo; Leer, Egil.** *Helium Abundance in the Corona and Solar Wind: Gyrotropic Modeling from the Chromosphere to 1 AU.* Astrophysical Journal 2003;596(1):621-645
31. Müller, Daniel; **Hansteen, Viggo;** Peter, Hardi: *Dynamics of solar coronal loops. I. Condensation in cool loops and its effect on transition region lines.* Astronomy and Astrophysics 2003;411:605-613

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34. Dean, David J.; **Hjorth-Jensen, Morten.** *Toward coupled-cluster implementations in nuclear structure.* AIP Conference Proceedings 2003;656:197-204

35. Dillmann, I; Kratz, K.-L.; Wöhr, A; Arndt, O; Brown, B.A.; Hoff, Per; **Hjorth-Jensen, Morten** et al: . *N=82 shell-quenching of the classical r-process "waiting-point" 130-Cd.* Physical Review Letters 2003;91(162503)

36. Guttormsen, Magne; Chankova, Rositsa; **Hjorth-Jensen, Morten** et al.: *Free energy and criticality in the nucleon pair breaking process.* Physical Review C 2003;68(034311)

37. Schiller, Andreas; Algin, Emel; Bernstein, Lee; Garrett, P.E.; Guttormsen, Magne; **Hjorth-Jensen, Morten** et al: *Level Densities in FE-56,57 and MO-96,97,* Physical Review C 2003;68(054326)

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39. **Holden, Helge; Karlsen, Kenneth Hvistendahl and Risebro, Nils Henrik:** *On uniqueness and existence of entropy solutions of weakly coupled systems of nonlinear degenerate parabolic equations.* Electron. J.Differential Equations, 2003; 2003(46):1-31

40. **Karlsen, Kenneth Hvistendahl; Risebro, Nils Henrik** and Towers, John: *L^1 stability for entropy solutions of nonlinear degenerate parabolic convection-diffusion equations with discontinuous coefficients.* Skr. K. Nor. Vidensk. Selsk. 2003; 3:1-49

41. Burger, Raimund and **Karlsen, Kenneth Hvistendahl:** *On a diffusively corrected kinematic-wave traffic model with changing road surface conditions.* Math. Models Methods Appl. Sci. (M3AS) 2003; 13:1767-1799

42. Burger, Raimund; Frid, Hermano and **Karlsen, Kenneth Hvistendahl:** *On a free boundary problem for a strongly degenerate quasilinear parabolic equation with an application to a model of pressure filtration.* SIAM J. Math. Anal. 2003; 34(3):611-635

43. Berres, Stefan; Burger, Raimund; **Karlsen, Kenneth Hvistendahl** and Tory, Elmer. *Strongly degenerate parabolic-hyperbolic systems modeling polydisperse sedimentation with compression.* SIAM J. Appl. Math. 2003; 64(1):41-80

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47. **K. H. Karlsen,** C. Klingenberg, and **N. H. Risebro.** *Relaxation schemes for conservation laws with discontinuous coefficients.* In T.Y. Hou and E. Tadmor (eds.), Hyperbolic Problems: Theory, Numerics, Applications. Proceedings of the Ninth International Conference on Hyperbolic Problems held in CalTech, Pasadena, March 25-29, 2002. Springer-Verlag, Berlin, 611-620 (2003).

48. R. Bürger and **K. H. Karlsen.** *Recent advances in conservation laws with discontinuous flux and clarifier thickener models.* In W. Wendland and M. Efendiev (eds.), Analysis and Simulation of Multifield Problems, Springer-Verlag, Berlin, 137-142 (2003).

49. **Klausen, Runhild Aae;** et al.: *Well Index in Reservoir Simulation for Slanted and Slightly Curved Wells in 3D Grids.* SPE Journal 2003(March):41-47

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55. **Risebro, Nils Henrik;** et al.: *When are HJB-equations for control problems with stochastic delay equations finite dimensional? .* Stochastic Analysis and Applications 2003;21(3):643-671

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57. **Surazhsky, V.** and Gotsman, C: *Intrinsic Morphing of Compatible Triangulations,* International Journal of Shape Modeling 9, 2003, 191--201.

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59. Chan, Tony F.; **Tai, Xue-Cheng.** *Identification of Discontinuous Coefficients from Elliptic Problems Using Total Variation Regularization.* SIAM Journal on Scientific Computing 2003;25(3):881-904

60. Chan, Tony F.; **Tai, Xue-Cheng.** *Level Set And Total Variation Regularization For Elliptic Inverse Problems With Discontinuous Coefficients.* Journal of Computational Physics 2003;193:40-66

61. Lysaker, Marius; Lundervold, A; **Tai, Xue-Cheng.** *Noise Removal Using Fourth-Order Partial Differential Equations with Applications to Medical Magnetic Resonance Images in Space and Time.* IEEE transactions on image processing 2003;12(12):1579-1590

62. **Winther, Ragnar;** et al.: *Mixed finite elements for elasticity in the stress-displacement formulation.* Contemporary Mathematics 2003;329:33-42

63. **Winther, Ragnar;** et al.. *Nonconforming mixed methods for elasticity.* Mathematical Models and Methods in Applied Sciences 2003;13:295-307

64. **Øksendal, Bernt; Di Nunno, Giulia; Benth, Fred Espen; Løkka, Arne; Proske, Frank.** *Explicit representation of the minimal variance portfolio in markets driven by Lévy processes.* Mathematical Finance 2003;13:55-72

65. Hu, Yaozhong; **Øksendal, Bernt.** *Fractional white noise calculus and applications to finance.* Infinite dimensional analysis quantum probability and related topics 2003;6:1-32

66. **Øksendal, Bernt;** Biagini, Francesca. *Minimal variance hedging for fractional Brownian motion.* Methods and Applications of Analysis 2003;10:1-16

67. **Øksendal, Bernt;** Hu, Yaozhong; Sulem, Agnès. *Optimal consumption and portfolio in a Black-Scholes market driven by fractional Brownian motion.* Infinite dimensional analysis quantum probability and related topics 2003;6:519-536

APPENDIX 7b

Books

1. **Lindstrøm, Tom Louis;** Lorentzen, Lisa; Hole, Arne. *Kalkulus - med én og flere variable:* Universitetsforlaget 2003. ISBN 82-00-42433-2. 716 pages.

2. **Lyche, Tom ;** Mazure, Marie-Laurence; Schumaker, Larry: *Curve and Surface Design.* Brentwood, TN: Nashboro Press 2003. 425 pages.

3. **Saltyte-Benth, Jurate;** Ducinskas, Kestutis: *Erdvine Statistika (Spatial Statistics).* Klaipeda, Litauen: Klaipeda University 2003. ISBN 9955-585-09-9. 116 pages.

4. **Øksendal, Bernt.** *Stochastic Differential Equations,* 6th edition. Berlin Heidelberg New York: Springer-Verlag 2003. ISBN 3-540-047581. 360 pages.

APPENDIX 7c

Texts for Public Outreach

1. Einevoll, Gaute T.; **Lilje, Per Barth;** Lutken, Carsten A. *Fysikkens fremtid?.* Fra Fysikkens Verden (Norwegian) 2003;2/3:70-80

2. Einevoll, Gaute T.; **Lilje, Per Barth;** Lutken, Carsten A. *Fysikkens fremtid?.* Kvant: tidsskrift for fysik og astronomi (Danish) 2003;3:19-27

3. Engvold, Oddbjørn; **Lilje, Per Barth.** *Eberhart Jensen 1922 -* 2003. Astronomy & Geophysics 2003;44

4. **Quak, E.:** *Nettverk gir styrke,* Intervjubidrag til Forskningsrådets mobilitetsbrosjyre "Grenseløse forskere, grenseløs kunnskap, 2003.

5. **Ellingsrud, Geir.** *Mersenneprimtall* [Talk (Norwegian) oct. 23]. Institutt for lærerutdanning og skoleforskning, Oslo, Norway

6. **Ellingsrud, Geir.** *Om primtall* [Talk (Norwegian) Nov. 8-9]. Nasjonalt senter for matematikk i opplæringen, Trondheim, Norway

APPENDIX 7d

Contributions, Proceedings, Reports etc.

1. **Carlsson, Mats;** Stein, R.F.: *Towards 3D NLTE Radiation Magneto-Hydrodynamics* International conference on Stellar Atmosphere Modeling (April 2002) Published inASP Conference Series,Volum 288, 2003.
2. **Dahl, Geir;** Brualdi, R.A.. *Matrices of zeros and ones and a zero block* 18th International Symposium on Mathematical Programming. Published in: Linear Algebra and Its Appl.
3. **Dokken Tor, Thomassen, Jan Brede.** *Overview of approximate implicitization.* In book: Topics in Algebraic Geometry and Geometric Modeling. Providence: American Mathematical Society 2003. ISBN 0-8218-3420-7. s. 81-102
4. **Flatberg, Truls; Dahl, Geir.** *Optimization and reconstruction of hv-convex (0,1)-matrices.* Electronic Notes in Discrete Mathematics 2003;12
5. Dean, David J.; **Hjorth-Jensen, Morten.** *Coupled Cluster approach to nuclear physics.* Los Alamos National Lab, USA: nucl-th/0308088, http://xxx.lanl.gov 2003. 15 pages.
6. Guttormsen, Magne; **Hjorth-Jensen, Morten** et al: *Measurements of nuclear level densities and gamma-ray strength functions and their interpretations.* Proceedings from 10th International Seminar on Interaction of Neutrons with Nuclei (ISINN-10): Neutron Spectroscopy, Nuclear Structure, Related Topics, Dubna, Russia, (JINR E3-2003-10). p. 134
7. **Hagen, Gaute; Hjorth-Jensen, Morten;** Vaagen, Jan Sigurd: *Two-body resonance and scattering approaches by contour deformation in momentum space.* Los Alamos National Lab, USA: nucl-th/0303039 2003. 18 pages.
8. Kowalski, Karol; Dean, David J.; **Hjorth-Jensen, Morten** et al.: *Coupled cluster calculations of ground and excited states of nuclei.* Los Alamos National Lab: nucl-th/0310082, http://xxx.lanl.gov 2003. 4 pages.
9. Schiller, Andreas; Guttormsen, Magne; **Hjorth-Jensen, Morten** et al: Caloric curves of atomic nuclei and other small systems. Los Alamos preprint archive 2003;nucl-th/(0306082)
10. **Hjorth-Jensen, Morten.** *Challenges for shell-model studies and emergent phenomena in nuclei,* APS april meeting, Philadelphia, Abstract published in Bulletin of the American Physical Society, 2003
11. **Hjorth-Jensen, Morten.** *Effective interactions for weakly bound systems,* DNP fall meeting, Tucson Arizona, Abstract published in Bulletin of the American Physical Society, 2003
12. **Hjorth-Jensen, Morten.** *Pairing correlations in nuclear systems,* Talk at Sorbonne, Paris. Published in Nuclear Physics A.
13. **Surazhsky, T.** et al.: A comparison of Gaussian and mean curvatures estimation methods on triangular meshes, Proceedings of International Conference on Robotics and Automation (ICRA 2003), Taipei, Taiwan, 1021--1026.
14. **Surazhsky, V.,** Alliez, P., Gotsman, C.: *Isotropic Remeshing of Surfaces:* a Local Parameterization Approach, Proceedings of 12th International Meshing Roundtable, Santa Fe, USA, 2003, 215--224.
15. **Surazhsky, V.,** Gotsman, C.: *Explicit Surface Remeshing,* Proceedings of Eurographics Symposium on Geometry Processing, Aachen, Germany, 2003, 17--28.
16. Chung, Eric T.; Chan, Tony F.; **Tai, Xue-Cheng.** *Electrical Impedance Tomography Using Level Set Representation and Total Variational Regularization.* UCLA Applied Mathematics CAM Report 2003(03-64)
17. Lie, Johan; Lysaker, Marius; **Tai, Xue-Cheng.** *A Variant of the Level Set Method and Applications to Image Segmentation.* UCLA Applied Mathematics CAM Report 2003(03-50)
18. Majava, K; **Tai, Xue-Cheng.** *A Level Set Method for Solving Free Boundary Problems Associated with Obstacles.* UCLA Applied Mathematics CAM Report 2003(03-69)
19. **Tai, Xue-Cheng;** Chan, Tony F.. *Multiple Level Set Methods and Some Applications for Identifying Piecewise Constant Functions.* UCLA Applied Mathematics CAM Report 2003(03-68)
20. **Winther, Ragnar;** Østby, Ivar. *Stability of a model of human granulopoiesis using continuous maturation:* Institutt for Informatikk, UiO 2003. 40 pages.
21. Bravina, L., **Zabrodin, E.** et al: *Microscopic description of anisotropic flow in relativistic heavy ion collisions,* Progress in Particle and Nuclear Physics, September 2003.
22. **Zabrodin, E.** et al: *Vacuum particle creation in a non-stationary Casimir bag,* Vestnik of Moscow State University, September 2003

APPENDIX 7e

2003 CMA Preprint series

Access to full texts of all papers is provided on our web-site. The list is reverse chronologically ordered (December comes first)

1. **A. Lanconelli and F. Proske:** Explicit strong solutions of stochastic differential equations on Hilbert spaces
2. **G. Di Nunno, T. Meyer-Brandis, Bernt Øksendal, F. Proske:** Optimal Portfolio for an Insider in a Market Driven by Lévy Processes.
3. **Klausen R. A.** and Russell T.F.: Relationships among some locally conservative discretization methods which handle discontinuous coefficients
4. **Klausen R. A.:** Convergence of Multi-Point Flux Approximations on Quadrilateral Grids
5. Eigestad G.T. and **Klausen R. A.:** A note on the Convergence of the Multi-Point Flux Approximation O-method; Numerical Experiments
6. **Mari Anne Killie,** Åse Marit Janse, Øystein Lie-Svendsen, and Egil Leer: Improved Transport Equations for Fully Ionized Gases
7. **H. K. Eriksen, P. B. Lilje,** A. J. Banday and K. M. Gorski: Estimating N-point correlation functions from pixelized sky maps
8. **T. Meyer-Brandis and F. Proske:** Explicit Solution of a Non-linear Filtering Problem for Lévy Processes with Application to Finance.
9. **T. Lyche** and M-L Mazure: On the existence of piecewise exponential B-splines
10. **B. Øksendal,** A. Sulem: Partial observation control in an anticipating environment.
11. Costantini, P., **T. Lyche,** and C. Manni: On a class of weak Tchebycheff systems
12. **S. Christiansen:** Div-Curl lemma for Edge Elements.
13. **F. E. Benth, J. Saltyte-Benth:** The normal inverse Gaussian distribution and spot price modeling in energy markets.
14. **A. Lanconelli, F. Proske:** On explicit strong solution of Itô-SDE's and the Donsker delta function of a diffusion.
15. **B. Øksendal:** Fractional Brownian motion in finance.
16. **S. Christiansen:** A characterization of second order differential operators on finite element spaces.
17. **H. K. Eriksen,** F. K. Hansen, A. J. Banday, K. M. Gorski, **P. B. Lilje:** Asymmetries in the CMB anisotropy field
18. R. Bürger and **K. H. Karlsen:** On a diffusively corrected kinematic-wave traffic model with changing road surface conditions.
19. M. Bendahmane and **K. H. Karlsen:** Renormalized entropy solutions for quasilinear anisotropic degenerate parabolic equations.
20. **F. Proske:** The Stochastic Transport Equation Driven by Space-Time Lévy White Noise.
21. **G. Di Nunno, B. Øksendal, F. Proske:** Malliavin Calculus for Lévy Processes.
22. S. Albeverio, **G. Di Nunno,** Yu. A. Rozanov: Price Operators Analysis in Lp-spaces.
23. E. R. Jakobsen and **K. H. Karlsen:** A "maximum principle for semicontinuous functions" applicable to integro-partial differential equations.
24. Y. Hu, **B. Øksendal:** Optimal Smooth Portfolio Selection for An Insider.
25. M. Bendahmane and **K. H. Karlsen:** Nonlinear anisotropic elliptic and parabolic equations in $\R^N$ with advection and lower order terms and locally integrable data.
26. **B. Øksendal, F. Proske,** M. Signahl: The Cauchy problem for the wave equation with Lévy noise initial data.
27. **S. Mataramvura, B. Øksendal, F. Proske:** The Donsker Delta function of a Lévy Process with Application to Chaos Expansion of Local Time.
28. **F.E. Benth, K.H. Karlsen:** A PDE representation of the density of the minimal entropy martingale measure in stochastic volatility markets.
29. Gui-Qiang Chen, **K.H. Karlsen:** L1-framework for continuous dependence and error estimates for quasilinear anisotropic degenerate parabolic equations.
30. R. Bürger, **K.H. Karlsen, N.H. Risebro,** J.D. Towers: Well-posedness in BV_t and convergence of a difference scheme for continuous sedimentation in ideal clarifier-thickener units.
31. **K.H. Karlsen, N.H. Risebro,** J.D. Towers: L1 stability for entropy solutions of nonlinear degenerate parabolic convection-diffusion equations with discontinuous coefficients.
32. **K.H. Karlsen, N.H. Risebro,** J.D. Towers: Front tracking for scalar balance equations.
33. I. Berre, **K. H. Karlsen,** K.-A. Lie, J. Natvig: Fast computation of arrival times in heterogeneous media.
34. **J. Saltyte-Benth,** K. Ducinskas: Linear discriminant analysis of multivariate spatial-temporal regressions.

APPENDIX 7f

(Invited) talks by CMA members 2003:

We here list a reverse chronologically ordered presentation of (invited) talks given by CMA members outside CMA. Details on time, events and abstracts are provided on our web-site.

1. **Fred Espen Benth:** Choosing and evaluating stochastic processes for pricing in electricity markets, Stockholm, Sweden.
2. **Kenneth Karlsen:** Quasilinear anisotropic degenerate parabolic equations, Shanghai, China.
3. **Kenneth Karlsen:** Conservation laws and degenerate parabolic equations with discontinuous coefficients, Shanghai, China.
4. **Giulia Di Nunno:** *On equivalent martingale measure with bounded densities,* Livingstone, Zambia
5. **Håkon Dahle:** *Lectures on Gravitational Lensing,* Copenhagen, Denmark.
6. **Tom Lyche, Knut Mørken** et al.: *Faber Decomposition with Vanishing Moments,* Grenoble, France
7. **Kenneth Karlsen:** *Weak Convergence Methods and Recent Mathematical Theory for the Compressible Navier-Stokes Equations,* Trondheim, Norway
8. **Øksendal, Bernt.** *What is the optimal portfolio for an honest trader in a market influenced by insiders?* Livingstone, Zambia
9. **Ellingsrud, Geir.** *Fra makro til mikro,* Oslo, Norway
10. **Viggo Hansteen.** *The Solar Wind: Why so hot? Why so cold?* Oslo, Norway
11. **Giulia Di Nunno:** *Optimal portfolio for an Insider in a Market driven by Levy Processes,* Copenhagen, Denmark.
12. **Mats Carlsson:** *Chromospheric Heating and Dynamics,* Tokyo, Japan.
13. **Trond Brenna:** *A 3D Tensor Spline Method for Fitting Functions on the Solid Sphere,* Seattle, USA.
14. **Håkon Dahle:** *På jakt etter den mørke materien,* Oslo, Norway
15. **Tor Dokken** et al: *Approximate Algebraic Methods,* Seattle, USA.
16. **Michael Floater:** *Barycentric coordinates over convex polygons,* Seattle, USA.
17. **Hjorth-Jensen, Morten.** *Neutron stars and challenges for RIA physics,* Tucson, USA
18. **Thomassen, Jan Brede.** *Approximate Inversion,* Seattle, USA
19. **Øksendal, Bernt.** *Optimal portfolio for an insider in a market driven by Lévy processes,* Munich, Germany
20. **Øksendal, Bernt.** *Optimal portfolio for an insider in a market driven by (i) Brownian motion (ii) Lévy processes (Two talks),* Trondheim, Norway
21. **Pål Hermunn Johansen:** *Monoid curves and surfaces,* Nice, France
22. **Pål Hermunn Johansen** *Sylvester's theorem and the classification of real cubic surfaces,* Nice, France
23. **Giulia Di Nunno:** *On a direct formula for the Malliavin derivative with respect to Gaussian-Poisson stochastic measure,* Hammamet, Tunisia.
24. **Steinar Børve,** Marianne Omang, Jan Trulsen: *New Techniques for Treating Reflective Boundaries and Free Surfaces with (R)SPH,* Badajoz, Spain.
25. **Håkon Dahle:** *Gravitational Lensing as a Cosmological Probe,* Oslo, Norway
26. **Hjorth-Jensen, Morten.** *Effective interactions for weakly bound systems,* Tucson, USA
27. **Lilje, Per Barth.** *Med Planck til universets begynnelse,* Oslo, Norway
28. **Øksendal, Bernt.** *Optimal portfolio for an insider in a market driven by Lévy processes,* Tunis, Tunisia
29. **Dahl, Geir; Foldnes, Njål.** *A randomized algorithm for the multiple knapsack problem with assignment restrictions,* HVOR
30. **Giulia Di Nunno:** *On a direct formula for the Malliavin derivative with respect to Gaussian-Poisson stochastic measure,* Bologna, Italy.
31. **Giulia Di Nunno:** *Malliavin Calculus for Levy processes,* Rome, Italy.
32. Larissa Bravina, **Evgeny Zabrodin** et al: *Microscopic description of anisotropic flow in relativistic heavy ion collisions,* Sicilia, Italy.
33. **Evgeny Zabrodin** et al: *Vacuum particle creation in a non-stationary Casimir bag,* Moscow, Russia.
34. **Fred E. Benth:** *Matematisk finans,* Oslo, Norway
35. **Børve, Steinar;** Omang, Marianne; Trulsen, Jan. *Linear Stability Analysis of MHD waves using (R)SPH,* Bonn, Germany.
36. Astrid Fossum, **Mats Carlsson:** *Detectability of high frequency waves with TRACE,* Mallorca, Spain
37. **Håkon Dahle:** *Med Planck til universets begynnelse,* Vindfjelltun, Norway.
38. **Tor Dokken:** *Weak Approximate implicitization,* Kefermarkt, Austria.
39. **Michael Floater:** *Recent advances in surface parameterization,* Cambridge, England
40. **Michael Floater:** *Surface parameterization,* Erbach, Germany
41. **Tom Lyche, Knut Mørken,** Francesca Pelosi: *Stable linear spline wavelets on nonuniform knots with vanishing moments,* Cambridge, England
42. **Piene, Ragni.** *On the classification of real algebraic curves and surfaces,* Kefermarkt, Austria.
43. **Thomassen, Jan Brede.** *Self-intersection problems and approximate implicitization,* Kefermarkt, Austria.

44. **Øksendal, Bernt.** *Optimal portfolio for an insider ina market driven by Lévy processes,* Lisbon, Portugal
45. **Pål Hermunn Johansen:** *What algebraic geometry can do for you: the case of the tangent developable,* Kefermarkt, Austria.
46. **Quak, Ewald,** *Polynomial and spline multiresolution analysis and the lifting scheme,* Multiresolution in geometric modelling, Cambridge, England
47. **Snorre Christiansen:** *Preconditioning the Electric Field Integral Equation at low frequencies,* Prague, Czech Republic.
48. **Giulia Di Nunno:** *Martingale Measures and Extension Theorems for Operators,* Madeira, Portugal.
49. **Håkon Dahle:** *Kartlegging av mørk materie i universet,* Sundvolden, Norway.
50. **Hjorth-Jensen, Morten.** *Pairing correlations in nuclear systems,* Tennessee, USA.
51. **Øksendal, Bernt.** *Optimal control with partial observation in an anticipating environment,* Madeira, Portugal
52. **Dahl, Geir;** Brualdi, R.A.: *Matrices of zeros and ones and a zero block,* Copenhagen, Denmark
53. **Dahl, Geir; Flatberg, Truls.** *Reconstructing (0,1)-matrices using Lagrangian decomposition,* Copenhagen, Denmark
54. **Dahl, Geir; Foldnes, Njål;** *et al.. On hop-constrained walk polytopes,* Copenhagen, Denmark
55. **Snorre Christiansen:** *Preconditioning the Electric Field Integral Equation at Low Frequencies,* Sydney, Australia.
56. **Xue-Cheng Tai:** *Nonlinear Positive Intepolation Operators for Analysis with Multilevel Grids,* Berlin, Germany
57. **Steinar Børve,** et. al.: *New Developments in Regularized Smoothed Particle Hydrodynamics,* Sydney, Australia.
58. **Kenneth Karlsen:** *Quasilinear anisotropic degenerate parabolic equations: continuous dependence estimates and renormalized entropy solutions,* Evanston, Illinois, USA
59. **Giuila Di Nunno:** *On Monotone Extension of Linear Operators with Applications to Finance,* Moscow, Russia
60. **Kenneth Karlsen:** Quasilinear anisotropic degenerate parabolic equations: continuous dependence estimates and renormalized entropy solutions, Maryland, USA
61. **Vitaly Surazhsky:** *Explicit Surface Remeshing,* Aachen, Germany
62. **Håkon Dahle:** *The Density Profile of Massive Clusters from Weak Lensing,* Munchen, Germany.
63. **Hjorth-Jensen, Morten.** *Effective interactions from Greens functions,* recent advances in the nuclear shell model, Trento, Italy
64. **Hjorth-Jensen, Morten.** *Pairing correlations in nuclear systems,* Paris, France
65. **Øksendal, Bernt.** *Optimal control with partial observation in an anticipating environment,* L´Aquila, Italy.
66. **Øksendal, Bernt.** *Optimal control with partial observation in an anticipating environment,* Moscow, Russia
67. **Giulia Di Nunno:** *Some Versions of the Hahn-Banach Extension Theorem for Operators with Application to Mathematical Finance,* Bonn, Germany.
68. **Ragni Piene:** *On the use of classical algebraic geometry in computer aided design,* Trieste, Italy.
69. **Snorre Christiansen:** *On discretisations of Yang-Mills equations,* Oslo, Norway.
70. **Ragnar Winther:** *Mixed elements and discrete differential complexes,* Oslo, Norway.
71. **Helge Holden:** *Operator splitting for evolutionary nonlinear partial differential equations: theory and applications,* Oslo, Norway.
72. **Tom Lyche:** *Mixed norm condition number for the univariate Bernstein basis,* Nashville, USA.
73. **Viggo Hansteen:** *Waves in the chromsophere and transition region,* Freiburg, Germany
74. **Fred E. Benth:** *Options, portfolios and risk evaluation in energy markets,* Kristiansand, Norway.
75. **Truls Flatberg** and **Geir Dahl:** *Optimization and reconstruction of hv-convex (0,1)-matrices,* Italy.
76. Bagheri, Assadollah; Chankova, Rositsa; Guttormsen, Magne; **Hjorth-Jensen, Morten** et al: *Electromagnetic and thermodynamic proprties of rare earth nuclei,* Oslo, Norway
77. **Hjorth-Jensen, Morten.** *Bruk av numeriske verktøy i undervisningen,* Oslo, Norway
78. **Hjorth-Jensen, Morten.** *Many-body methods and the nuclear shell-mode,* Oslo, Norway
79. Schiller, Andreas; Becker, J.A.; Bernstein, Lee; Voinov, Alexander; Guttormsen, Magne; **Hjorth-Jensen, Morten** et al: *Thermal aspects of the nuclear pairing process,* Oslo, Norway.
80. **Øksendal, Bernt.** *White noise analysis and Malliavin calculus for fractional Brownian motion,* Warwick, England
81. **Dahl, Geir; Flatberg, Truls.** *Reconstructing hv-convex (0,1)-matrices by optimization methods,* Palermo, Italy.
82. **Tor Dokken:** *Do we need a holistic approach to product design?,* Darmstadt, Germany.
83. **Mats Carlsson:** *Solens ytre atmosfære - observasjoner og modellering,* Tromsø, Norway
84. **Viggo Hansteen,** *Norwegian participation in Solar B,* Tromsø, Norway
85. **Mats Carlsson:** *How to compare theory with observations?,* Stockholm, Sweden
86. **Hjorth-Jensen, Morten.** *Challenges for shell-model studies and emergent phenomena in nuclei,* Philadelphia, USA
87. **Hjorth-Jensen, Morten.** *Effective interactions for weakly bound systems,* Tennessee, USA
88. **Ellingsrud, Geir.** *Sur le Schema de Hilbert d'une surface,* Paris, France
89. **Mats Carlsson:** *Wave processes in the solar upper atmosphere,* Palo Alto, USA
90. **Viggo Hansteen:** *Morphology of the magnetic transition region, and wave transport and mode mixing through the TR,* Palo Alto, USA
91. **Runhild Aae Klausen:** *The Connection from Expanded MFEM to MPFA, and Convergence Results,* Austin, USA
92. **Martin Reimers:** *Geodesic Distance Functions on triangulations,* Oslo, Norway
93. **Helge Holden:** *Operator Splitting, Fast Methods, and Application.* Austin, USA.

94. **Bernt Øksendal:** *Optimal control of stochastic delay equations and applications (Three talks),* Berlin, Germany.
95. **Kenneth Karlsen:** *Some uniqueness results for degenerate parabolic and hyperbolic PDEs with discontinuous coefficients,* Stuttgart, Germany.
96. **Mats Carlsson:** *Wave processes in the solar upper atmosphere,* Tokyo, Japan
97. **Tor Dokken:** *Approximate Implicitization,* Nice, France.
98. **Tor Dokken:** *Approximate Implicitization,* Oslo, Norway.



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