
Preface to the Series

The Niels Henrik Abel Memorial Fund was established by the Norwegian government on January 1, 2002. The main objective is to honor the great Norwegian mathematician Niels Henrik Abel by awarding an international prize for outstanding scientific work in the field of mathematics. The prize shall contribute towards raising the status of mathematics in society and stimulate the interest for science among school children and students. In keeping with this objective the board of the Abel fund has decided to finance one or two Abel Symposia each year. The topic may be selected broadly in the area of pure and applied mathematics. The Symposia should be at the highest international level, and serve to build bridges between the national and international research communities. The Norwegian Mathematical Society is responsible for the events. It has also been decided that the contributions from these Symposia should be presented in a series of proceedings, and Springer Verlag has enthusiastically agreed to publish the series. The board of the Niels Henrik Abel Memorial Fund is confident that the series will be a valuable contribution to the mathematical literature.

Ragnar Winther
Chairman of the board of the Niels Henrik Abel Memorial Fund

Preface

The Abel Symposium 2006 focused on the intersection between computer science, computational science and mathematics. Ever since the early years of computers, applied mathematics has depended heavily upon computational methods. However, in recent years, computation has also been affecting pure mathematics in fundamental ways. Conversely, ideas and methods of pure mathematics are becoming increasingly important in computational and applied mathematics. At the core of computer science is the study of computability and complexity for discrete mathematical structures. Studying the foundations of computational mathematics raises similar questions concerning continuous mathematical structures.

There are several reasons for these developments. The exponential growth of computing power is bringing computational methods into ever new application areas. Equally important is the advance of software and programming languages, which to an increasing degree allows the representation of abstract mathematical structures in program code. Symbolic computing is putting algorithms from mathematical analysis in the hands of pure and applied mathematicians, and the combination of symbolic and numerical techniques is becoming increasingly important both in computational science and in areas of pure mathematics.

We are witnessing a development where a focus on computability, computing and algorithms is contributing towards a unification of areas of computer science, applied and pure mathematics. The basis for this conference was a belief that these developments will prevail in the twenty-first century. The Symposium brought together some of the leading international researchers working in these areas, presented a snapshot of current state of the art, and raised questions about future research directions.

The symposium took place in Ålesund, from May 25–27, 2006 and was organized by

- Ron DeVore, University of South Carolina
- Arieh Iserles, University of Cambridge

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- Hans Munthe-Kaas, University of Bergen
- Peter Olver, University of Minnesota
- Brynjulf Owren, NTNU
- Nick Trefethen, University of Oxford

The scientific committee made a deliberate choice to compose a group of international invitees consisting of senior leading researchers and also brilliant young people. The participants were encouraged to be open (and perhaps even provocative) on future developments within computational science. This resulted in a meeting with open and very stimulating discussions.

Talks presented

- Doug Arnold: *Finite element exterior calculus and its applications*
- David Bindel: *Modeling resonant microsystems: toward cell phones on a chip?*
- Folkmar Bornemann: *The whence and whither of using PDEs in computer vision*
- Franco Brezzi: *Recent developments in Mimetic Finite Differences*
- Albert Cohen: *Some remarks on Compressed Sensing*
- Wolfgang Dahmen: *Adaptive multiscale methods*
- Ioana Dumitriu: *Toward accurate polynomial evaluation in rounded arithmetic: foundations for the future*
- Alan Edelman: *New Applications of Random Matrix Theory or Stochastic Eigen-analysis*
- Björn Engquist : *Heterogeneous Multi-scale Methods*
- Anna Gilbert: *Putting the “Computational” in “Computational Harmonic Analysis”*
- Leslie Greengard: *Modern algorithms and the future of mathematical software*
- Tom Hou: *The Interplay between Local Geometric Properties and the Global Regularity for the 3D Incompressible Euler Equations*
- Peter D. Lax: *The numerical solution of hyperbolic systems of conservation laws*
- Christian Lubich: *Variational approximations in quantum dynamics*
- Nilima Nigam: *The good, the bad, and the not-so-ugly: algorithms for computational scattering*
- Guillermo Sapiro: *Mathematics and computation in image processing and other high dimensional signals*
- Stephen Smale: *The mathematics of learning, from machine to human*
- Rob Stevenson: *Optimal adaptive finite element methods*
- Eitan Tadmor: *Theory and computation of entropy stability in quasilinear PDEs*
- Mike Todd: *The role of ellipsoids in optimization theory*
- Anna-Karin Tornberg: *Fluid-structure interactions: the collective dynamics of suspensions*

- Paul Tupper: *A difficult open conjecture in the analysis of molecular dynamics*
- Divakar Viswanath: *Strange attractors from Lorenz to turbulence*
- Shing-Tung Yau: *Minimization with the affine normal direction*

International participants who did not give talks:

- Ingrid Daubechies, Princeton
- Richard Falk, Rutgers
- Ernst Hairer, Geneva
- Reinout Quispel, LaTrobe

Participants from Norwegian universities and research labs:

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| • Petter Bjørstad, Bergen | • Tom Lyche, Oslo |
| • Elena Celledoni, Trondheim | • Syvert P. Nørsett, Trondheim |
| • Snorre Christiansen, Oslo | • Einar Rønquist, Trondheim |
| • Michael Floater, Oslo | • Trond Steihaug, Bergen |
| • Helge Holden, Trondheim | • Tor Sørevik, Bergen |
| • Kenneth H.-Karlsen, Oslo | • Xue-Cheng Tai, Bergen |
| • Trond Kvamsdal, Sintef | • Warwick Tucker, Bergen |
| • Anne Kværnø, Trondheim | • Ragnar Winther, Oslo |
| • Hans P. Langtangen, Oslo | • Antonella Zanna, Bergen |

More information about the symposium may be found at this web-page:
<http://abelsymposium.no/2006>

May 23, 2008
Hans Munthe-Kaas

Bergen and Trondheim,
Brynjulf Owren

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