

MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

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Computational Electromagnetism and Acoustics

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ABSTRACT. It is a moot point to stress the significance of accurate and fast numerical methods for the simulation of electromagnetic fields and sound propagation for modern technology. This has triggered a surge of research in mathematical modeling and numerical analysis aimed to devise and improve methods for computational electromagnetism and acoustics.

Numerical techniques for solving the initial boundary value problems underlying both computational electromagnetics and acoustics comprise a wide array of different approaches ranging from integral equation methods to finite differences. Their development faces a few typical challenges: highly oscillatory solutions, control of numerical dispersion, infinite computational domains, ill-conditioned discrete operators, lack of strong ellipticity, hysteresis phenomena, to name only a few. Profound mathematical analysis is indispensable for tackling these issues.

Many outstanding contributions at this Oberwolfach conference on Computational Electromagnetism and Acoustics strikingly confirmed the immense recent progress made in the field. To name only a few highlights: there have been breakthroughs in the application and understanding of phase modulation and extraction approaches for the discretization of boundary integral equations at high frequencies. Much has been achieved in the development and analysis of discontinuous Galerkin methods. New insight have been gained into the construction and relationships of absorbing boundary conditions also for periodic media. Considerable progress has been made in the design of stable and space-time adaptive discretization techniques for wave propagation. New ideas have emerged for the fast and robust iterative solution for discrete quasi-static electromagnetic boundary value problems.

Mathematics Subject Classification (2000): 65Mxx, 65Nxx, 65Rxx, 78-04.

Introduction by the Organisers

The Oberwolfach Conference on Computational Electromagnetism and Acoustics, held Feb 5-9, 2007, at the Mathematisches Forschungsinstitut Oberwolfach, was already the second in series, following the 2004 Oberwolfach Conference on Computational Electromagnetism. This time the scope was slightly broader, because there has been substantial progress in numerical techniques for high-frequency wave propagation. In this regime, the mathematical and numerical challenges in acoustics are very similar to those arising in the simulation of electromagnetic fields. Usually new ideas and methods are first explored for acoustics and then adapted to electromagnetics. Moreover, many researchers are active in both fields. So it is natural to cover them in the context of a single event.

Like the previous meeting, the 2007 conference brought together more than fifty researchers active in the field, hailing from more than 10 countries. Among them were a large number of leading experts, but also quite a few students and postdoctoral fellows. At this point the organizers acknowledge the generous support of the European Union and NSF that covered expenses for young European and overseas participants. The majority of the participants were applied mathematicians, but a sizable number of people with a background in engineering also attended, as appropriate for a field with close ties to engineering and the sciences.

A total of 28 presentations was given at the conference, eight of which were meant to give a survey of particular numerical techniques. They covered the following topics:

- *High order integral equation methods* by O. Bruno, page ??,
- *Robust integral equation methods for high-frequency scattering* by I. Graham, page ??,
- *Plane wave basis functions* by P. Monk, page ??
- *Getting even with the Maxwell stress tensor* by A. Bossavit, page ??
- *Discontinuous Galerkin methods for the Maxwell eigenvalue problem* by A. Buffa, page ??.

We must not forget to mention that Annalisa Buffa was awarded the first Oberwolfach Todd Fellowship during the workshop. She received the prize from the director M. Greuel for her many fundamental contributions to the numerical analysis of partial differential equations.

- *Discontinuous Galerkin for time-domain electromagnetics: Pros and cons* by T. Warburton, page ??
- *Non-spurious spectral-like elements for Maxwell's equations* by G. Cohen, page ??
- *Multiscale methods for plasma modeling* by P. Degond, page ??

As is typical of an event that is focused on an area of applications rather than a specific mathematical technique, talks varied a lot in style and scope, ranging from discussions of specific theoretical issues to general discussion of a computational method. Nevertheless, all of them managed to convey exciting new insights and developments. Thus the conference made it possible to catch a glimpse of the

future of computational electromagnetism and acoustics. The following extended abstracts will also enable the reader to keep abreast of many crucial trends in the field.

