

ESF Mathematics Conference in partnership with EMS
and ERCOM/IML

MEGA 2011: Effective Methods in Algebraic Geometry

Stockholm University, SE
30 May-3 June 2011

Chaired by:

- **Sandra di Rocco**, KTH Stockholm, SE
- **Mikael Passare**, Stockholm University, SE

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Conference Highlights

Please provide a brief summary of the conference and its highlights in non-specialist terms (especially for highly technical subjects) for communication and publicity purposes. (ca. 400-500 words)

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I hereby authorize ESF – and the conference partners to use the information contained in the above section on ‘Conference Highlights’ in their communication on the scheme.

MEGA is the acronym for Effective Methods in Algebraic Geometry (and its equivalent in Italian, French, Spanish, German, Russian, etc.), a series of roughly biennial conferences on computational and application aspects of Algebraic Geometry and related topics with very high standards. Previous meetings were held in 1990 (Castiglioncello, Italy), 1992 (Nice, France), 1994 (Santander, Spain), 1996 (Eindhoven, Netherlands), 1998 (St. Malo, France) 2000 (Bath, United Kingdom), 2003 (Kaiserslautern, Germany), 2005 (Porto Conte, Italy), 2007 (Strobl, Austria) and 2009 (Barcelona, Spain). The 2013 meeting will take place in Berlin, Germany.

The conference aimed at presenting effective methods and practical complexity issues in Algebraic Geometry and neighboring fields. One example of topics chosen for this conference is "algebraic methods in Cryptography". Encoding information in a safe and efficient way is an important issue in our everyday life. Widening applications of efficient crypto-systems have given rise to the need of new types of systems, minimizing the need for secure key channels and supplying the equivalent of a written signature. It is a fundamental problem to design efficient systems ready to use quantum-computer power, as it expected that a quantum computer will be built in the near future. Algebraic methods have resulted extremely useful in this area of research.

The other topics were: Differential Algebra, Algorithmic resolution of singularities, Numerical Algebraic Geometry, Real Algebraic Geometry, Tropical Algebraic Geometry, Convex Algebraic Geometry, Applications to Algebraic Geometry to semidefinite programming, Applications of Algebraic Geometry to Mathematical Physics. The conference program

included two plenary talks a day and a number of invited talks related to one of the topics.

We were extremely pleased to have participants from all age-groups and from many different countries, including USA and Japan. This variety in experience and culture provided a stimulating atmosphere.

Besides plenary talks and invited presentations we selected poster presentations which were put out during the whole conference. This turned out to be a good source of meeting point and collaborations.

Besides the scientific part of the program, the participants greatly enjoyed the various social activities organized in Stockholm. We mention two events which were particularly well received. On Tuesday a social dinner was organized at a typical restaurant situated in one of the historical attractions of Stockholm, the outdoor museum of Skansen. On Wednesday The city of Stockholm offered a buffé dinner, just for the participants of the conference, at the city hall of Stockholm. The dinner was followed by a guided tour of the building.

Scientific Report

Executive Summary

The conference brought together some of the leading figures in fields related to applications of Algebra and Algebraic Geometry. Researchers from a wide spectrum of areas, ranging from Cryptography to Mathematical Physics, had the opportunity to present their latest achievements and exchange ideas with colleagues from different research areas.

The plenary talks were aimed at giving an up-to-date overview of the accomplishments and relevant open questions in the various fields. The invited talks were more specific in presenting recent results in the various areas.

It was one of the conference's goals to attract as many young researchers as possible and we feel we have succeeded in inviting a good number of junior researchers, from various countries in Europe, Japan, Argentina and USA.

Interaction between neighboring fields is essential for progress in research and applications. The format of this conference has proven, over the years, to give an essential contribution to new scientific collaborations. Research agencies, like ESF, should promote this activities on a larger scale.

(2 pages max)

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Scientific Content of the Conference

The conference spread over 5 days, Monday to Friday. Every day (besides Wednesday) the program included two plenary talks and a number of invited talks. On Wednesday the afternoon was free of talks in order to facilitate local excursions.

The participants were welcomed by Prof. Anders Björner, at that time director of the Institute Mittag-Leffler, and by the dean of the faculty of Science of Stockholm University (co-sponsor of the conference).

The plenary speakers and the invited speakers represented the following areas: Differential Algebra, Algorithmic resolution of singularity, Numerical Algebraic Geometry, Real Algebraic Geometry, Tropical Algebraic Geometry, Convex Algebraic Geometry, Applications of Algebraic Geometry to semidefinite programming, Applications of Algebraic Geometry to Mathematical Physics.

Slides from the talks can be found at: <http://www.math.kth.se/mega2011/MEGA/Megatalks.html>

During the whole week a poster session was installed on the upper floor of the Aula Magna (where the conference took place). The 15 posters selected ranged from theoretical subjects, as "Equivariant D-modules" to software presentations as "A Macaulay2 interface for PHCpack".

(1 page min.)

- *Summary of the conference sessions focusing on the scientific highlights*
- *Assessment of the results and their potential impact on future research or applications*

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Forward Look

Proceedings of the conference will be published as a special issue of the "Journal of symbolic computations". A selection of the papers is under review.

As for the conference topics here is a brief summary of the conference contribution:

- 1) Cryptography. The plenary speaker was Johannes Buchmann (Darmstadt) who gave a presentation of "Future signature".
- 2) Differential Algebra. The plenary talk was given by Guy Casale (Rennes) on "Liouvillian solutions of nonlinear differential equations".
- 3) Algorithmic Resolution of singularities. The plenary talk was given by Anne Frühbis-Krüger (Hannover) presenting an overview on the subject.
- 4) Numerical Algebraic Geometry. The plenary talk was given by Anton Leykin (Georgia Tech) on [Certification in Numerical Algebraic Geometry](#).
- 5) Real algebraic geometry. The plenary talk was given by Monique Laurent (Amsterdam) on [Semidefinite Programming Characterization and Computation of Real Radical Ideals](#)
- 6) Tropical algebraic geometry. The plenary talk was given by Diane Maclagan (Warwick) who gave an overview on the subject.
- 7) Convex algebraic geometry. The plenary talk was given by Pablo Parrilo (MIT) who gave a talk entitled "From Sparsity to Rank, and Beyond: algebra, geometry, and convexity".
- 8) Applications of algebraic geometry to semidefinite programming, optimization and statistics. The Plenary speaker was Kristian Ranestad (Oslo) who spoke on ["Symmetric tensor decompositions"](#).
- 9) Applications to mathematical physics. The plenary speaker was Duco van Straten (Mainz) who gave a presentation on "Algorithmic Aspects of Monodromy."

Several new techniques and important results were presented during the conference. We are confident that new collaborations were established during that week and that new ideas have circulated beyond the fields' boundaries.

(1 page min.)

- *Assessment of the results*
- *Contribution to the future direction of the field – identification of issues in the 5-10 years & timeframe*
- *Identification of emerging topics*

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- Is there a need for a foresight-type initiative?

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Atmosphere and Infrastructure

- *The reaction of the participants to the location and the organization, including networking, and any other relevant comments*

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X Sandra Di Rocco

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