FOLLOW-UP WORKSHOP ON MATHEMATICS AND THE ENVIRONMENT

Scientific Report

The Follow-Up Workshop on Mathematics and the Environment took place in the CIM headquarters in Coimbra on January 27-28, 2006.

The meeting was intended as an informal gathering of some of the participants of the 2004 *CIM Thematic Term on Mathematics and the Environment* and other scientists with interest in this topic.

The two scientific sessions (on Oceanography and Atmospheric Sciences) were each organized under the following format: an invited talk, three short communications and an open discussion (see the complete program on www.aim.estt.ipt.pt/~jmmp/CIM/wme2006/program.htm). The main goal of the event has been to strengthen the connections and to plan future collaboration between mathematicians, geophysicists and engineers.

After the talks and the discussions it became clear that Oceanography and Atmospheric Sciences represent an immense land of opportunity for researchers and graduate students in Mathematics. Among the possible interactions we would like to highlight the following:

- modelling and derivation of systems of equations (asymptotic analysis);
- validation of boundary conditions;
- data analysis - model/observations (stochastic analysis);
- error propagation (numerical analysis);
- small scale phenomena;
- simulation of flows (computational mathematics).

These interactions may develop through the joint supervision of Master and PhD students and in the framework of national and international research projects.

The crucial role played by CIM was acknowledged and it was suggested that a web page gathering relevant and stimulating mathematical problems in the area of the environmental sciences would be kept in the CIM web site.

José Miguel Urbano (Universidade de Coimbra) and Juha Videman (Instituto Superior Técnico)

AVEIRO WORKSHOP ON GRAPH SPECTRA

Scientific Report

The theory of graph spectra is a strong field of research in mathematics and in several applied sciences (e.g. chemistry), combining different areas, like linear algebra, algebraic combinatorics and algebraic graph theory. The first explicit mathematical paper in the theory of graph spectra was published in 1957 by L. Collatz and U. Sinogowitz [1]. However, we may say that the theory of graph spectra began not after 1931,

when E. Hückel used graph spectra in an implicit way in quantum theoretical treatment of the chemistry of benzenoide hydrocarbons [3]. According to the list of publications referred in [4], between 1931 and 1957, a few papers dealing with graph spectra theory implicit technics applied to chemistry and molecular physics as well as some papers relating matrix theory and graphs, with applications in mathematical physics, economics

and geometry, were published. After 1957 an increasing number of papers on graph spectra has been published (at least 60 papers during the sixties, 158 during the seventies, 297 during the eighties, 425 during the nineties and, so far, more than 400 during the current decade).

The first comprehensive book on the topic, "*Spectra of Graphs - Theory and Applications*" by D. Cvetković, M. Doob and H. Sachs, appeared in 1979 [2], becoming a land mark and a priority reading for everyone interested in this field. In the last two decades several spectral techniques for treating graph theory problems have been developed: e.g. the use of graph eigenspaces, the star complement technique and many others. There are connections of the theory of graph spectra with other parts of combinatorics and also with algebra and geometry. It is very much used in theoretical chemistry but also has some relevance to other applied fields, e.g. physics, electrical engineering and computer science.

The Aveiro Workshop on Graph Spectra was the first international meeting organized as a forum for researchers on graph spectra and related topics. This three-day meeting took place in the Mathematics Department of University of Aveiro, between 10 and 12 of April 2006 (the web page is still active at ceoc.mat.ua.pt/conf/graph2006). This workshop deserved the attention of the Portuguese Mathematical Community, promoting the contact of some of his members (coming from several parts of the country) with the state of the art and with most of the recent advances in the topic. Indeed, 26 among the 60 participants, coming from Aveiro (10), Bragança (1), Coimbra (2), Covilhã (2), Lisbon (8), Porto (2), Setúbal (1), were in contact with international experts on graph spectra and their presentations. The foreign participants, including renowned specialist, came from Brazil (8), Canada (2), Germany (1), Italy (4), Malta (1), Poland (2), Serbia and Montenegro (3), Spain (4), The Netherlands (2), UK (4) and USA (3). The plenary presentations ranged through the following: *Spectral radius of tournaments and bipartite graphs* (Richard Brualdi, Univ. of Wisconsin - Madison, USA); *Graph spectra and graph isomorphism* (Chris Godsil, Univ. of Waterloo, Canada); *Star complement in finite graphs* (Peter Rowlinson, Univ. of Stirling, UK); *The Laplacian and Cheeger inequalities for direct graphs* (Fan Chung Graham, Univ. of California, San Diego, USA); *Old and new results on algebraic connectivity of graphs* (Nair Abreu, UFRJ, Rio de Janeiro, Brazil); *Constructing graphs with integral Laplacian spectra* (Steve Kirkland,

Univ. of Regina, Canada); *Spectral characterization of distance-regular graphs* (Edwin van Dam, Tilburg Univ., The Netherlands); *Generalized adjacency matrices* (Willem Haemers, Tilburg Univ., The Netherlands); *Signless Laplacians of finite graphs* (Dragos Cvetković, Univ. of Belgrade, Serbia and Montenegro). The scientific program was complemented with 18 contributed talks with many recent results (part of them delivered by leader researchers on the theory of graph spectra) and with a problems session (coordinated by Dragan Stevanović from University of Nis, Serbia and Montenegro). Taking into account the high level of most of the presentations, their authors were invited to submit the papers to be referred for publication in a special issue of *Linear Algebra and Its Applications*, to be edited by Dragos Cvetković, Willem Haemers and Peter Rowlinson.

For the organization of this workshop was crucial the main support of the Chairman of Scientific Committee, Dragos Cvetković and the very important advice also received, during the preparation of the workshop, from the other colleagues of Scientific Committee: Nair Abreu, Richard Brualdi, Chris Godsil, Willem Hamers and Perter Rowlinson. Finally, I can not forget my colleagues from the Organizing and Local Committees: Raul Cordovil, Leal Duarte, Carlos Luz, Guedes de Oliveira, Agostinho Agra, Paula Carvalho, Rosa Amélia, Paula Rama and Cristina Requejo from whom, since the very beginning, all the commitment and requested collaboration was received.

References

[1] Collatz, L.; Sinogowitz, U. *Spektren endlicher Grafen.*Abhandlungen aus dem Mathematischen Seminar der Universität Hamburg 21 (1957): 63-77.

[2] Cvetković, D.; Doob, M.; Sachs, H. *Spectra of graphs.* Academic Press, New York, (1979).

[3] Hückel, E. *Quantentheoretische Beiträge zum Benzolproblem*, Z. Phys. 70 (1931): 2004-286.

[4] Spectral Graph Theory Home Page - SGTHP, www.sgt.pep.ufrj.br

Domingos Moreira Cardoso (Organizing Committee's Chairman)

CIM Scientific Council Meeting 2006

Scientific Report

The 2006 Meeting of the CIM Scientific Council took place in *Hotel Quinta das Lágrimas* in Coimbra on February 11, with the following timetable:

> 10:30-16:30 Meeting of the Scientific Council (including a work lunch).
>
> 17:00-18:00 Lecture by Mário Martinez (State Univ. of Campinas, Brazil):
> *Lower-sum order-value optimization.*
>
> 18:30-19:30 Lecture by Enrique Zuazua (Univ. Autónoma de Madrid, Spain):
> *Propagation, dispersion, control and numerical approximation of waves.*
>
> 20:00 Dinner.

The Scientific Council Meeting took place in a pleasant environment and was attended by thirteen of its fifteen Members. The CIM Activity Plan for 2007 was approved. Due to the outstanding scientific quality of its participants, the Scientific Council Meeting was the ideal opportunity for a broad discussion with the President about the strategies and future activities of the Centre.

The Seminars were attended by 50 participants, which is exactly the maximum number expected by CIM in their website announcement. This public session of the Scientific Council Meeting was highly participated and stimulating and many and interesting questions were put by the audience to the lecturers. A dinner was served to all the participants in this last event, which had the opportunity to socialize with the members of the scientific council. The Rector of the University of Coimbra also accepted the invitation of the Direction of CIM to participate in this dinner.

Joaquim João Júdice (President of the Executive Board of CIM)