CRM

CENTRE DE RECERCA MATEMÀTICA

Memòria d'Activitats
Report of Activities

2011

CENTRE DE RECERCA MATEMÀTICA

Centres de recerca de Catalunya

CENTRE DE RECERCA MATEMÀTICA

MEMÒRIA D'ACTIVITATS 2011

REPORT OF ACTIVITIES 2011

CENTRE DE RECERCA MATEMÀTICA

Centre de Recerca Matemàtica
Campus de Bellaterra, Edifici C
08193 Bellaterra (Barcelona)

Tel: +34 93 581 1081
Fax: +34 93 581 2202

crm@crm.cat
www.crm.cat

Graphic Design: Teresa Sabater
Printing:
Legal Deposit:

Presentació

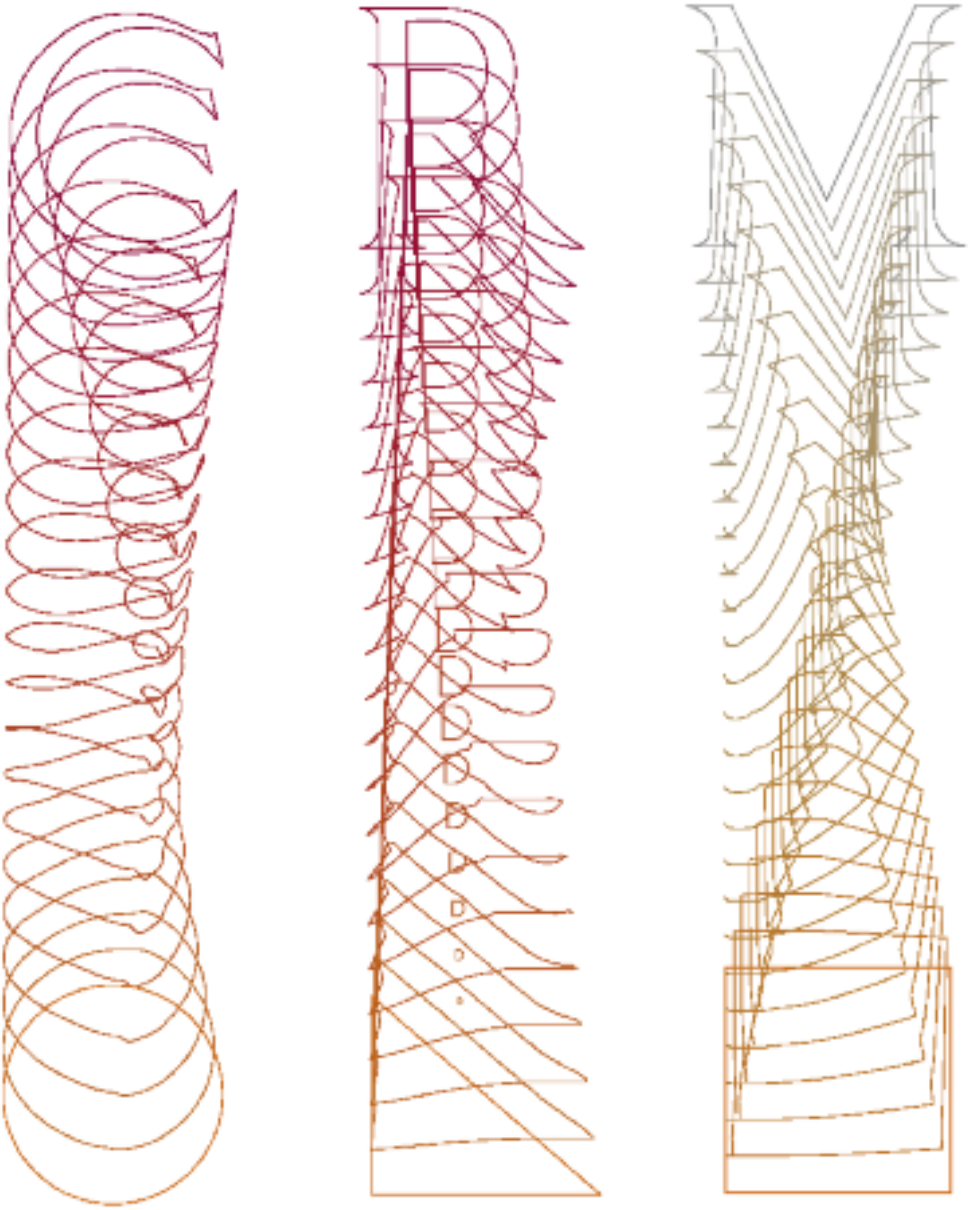
El 2011 ha estat un any especial, en algun aspecte difícil per al CRM. L'actual conjuntura econòmica, desfavorable des de fa uns anys, no és la millor per a fer realitat les previsions de lleuger creixement contemplades en el pla estratègic del Centre i en el contracte programa que el sustenta. Malgrat aquesta conjuntura desfavorable, l'activitat desplegada al Centre no ha estat menor que l'any anterior, i en alguns aspectes s'ha incrementat, tal i com podreu comprovar en aquesta memòria d'activitats.

Així, més d'un centenar d'investigadors locals i d'arreu del món han estat implicats en activitats organitzades al CRM durant el 2011. Entre aquestes vull destacar els programes de recerca del CRM, ben consolidats i amb creixent dimensió internacional, com ho fa palès el fet que la NSF n'incentiva la participació d'investigadors d'institucions americanes. El gruix d'aquests investigadors correspon als programes de recerca i la resta ho són en el marc dels altres programes tradicionals del CRM: el de visitants de mitja i llarga durada, el de *Research in Pairs* i el programa Lluís Santaló, adreçat a investigadors llatinoamericans. Els visitants postdoctorals tenen dues vies al CRM, ambdues competitives i en favor de la mobilitat europea, que són el programa Marie Curie i les beques de l'European Post-doctoral Institute (EPDI), en el qual cal assenyalar, però, el baixíssim nombre de candidats catalans que s'hi presenten.

Per a complir amb el seu objectiu fundacional, que en definitiva és millorar la recerca matemàtica a Catalunya, el CRM no només organitza activitats i acull visitants, sinó que també està incentivant recerca interdisciplinària amb els seus propis grups. En aquest aspecte, no hi ha hagut creixement durant el 2011, en part per complir amb les mesures de contenció de la despesa en el sector públic aprovades pel Govern. Si bé, doncs, en l'aspecte quantitatiu la plantilla de recerca del CRM s'ha mantingut estable, podreu comprovar que els grups en ells mateixos han desenvolupat una activitat creixent. Pel que fa a formació en recerca, el 2011 ha estat el primer any que becaris doctorals del CRM han llegit la seva tesi doctoral, tots ells amb directors de tesi de les universitats catalanes, fruit d'un programa que va començar el 2006. Finalment, durant el 2011 hem pogut consolidar l'extensió del CRM finançada amb fons FEDER i gaudir-ne plenament, en particular amb equipament multimèdia que en un termini breu permetrà posar a la xarxa, a disposició dels investigadors catalans, els seminaris especialment destacats que s'hi programin.

En aquesta memòria trobareu informació sobre tot plegat, informació que a la plana web del Centre (www.crm.cat) es troba més detallada en alguns aspectes.

Joaquim Bruna
Director



Presentation

The year 2011 has been a special one and particularly difficult in some aspects for the CRM. The current economic situation, unfavorable for several years, is not the best to allow the growth envisaged in the strategic plan of the Center and in the contract that supports it. Despite this unfavorable situation, the activity in the Center has not decreased from the previous year, and in some areas it has increased, as you can see from this report of activities.

Thus, over a hundred scientists, both local and worldwide, have been involved in CRM activities organised in 2011. Among these I single out the research programmes of CRM, well established and with growing international dimension, as shown by the fact that the NSF encourages participation of researchers from U.S. institutions. The bulk of these researchers corresponds to research programmes, and the rest are in the context of other traditional CRM programmes, such as the medium and long term visitors, the Research in Pairs programme and the Lluís Santaló programme, addressed to Latin American researchers. Visiting postdocs have two paths to CRM, both competitive and promoting European mobility, namely the Marie Curie programme and the European Post-doctoral Institute (EPDI) grants, in which it should be noted, however, the very low number of candidates from Catalan institutions.

To fulfill its mission statement, which ultimately is to improve mathematical research in Catalonia, the CRM not only organizes activities and hosts visitors but also encourages inter-disciplinary research with its own research groups. In this respect, there has been no growth in 2011, particularly to meet the cost containment measures in the public sector approved by the government. While thus quantitatively the research staff of the CRM has remained stable, you will appreciate that the groups themselves have developed a growing activity. As for research training, 2011 has been the first year when CRM doctoral fellows have read their doctoral theses, all with advisors from Catalan universities, this being the output of a programme that began in 2006. Finally, in 2011 we were able to consolidate the extension of CRM premises funded by FEDER and fully enjoy them, in particular with multimedia equipment that in a short time will make on line access to selected seminars available to researchers in Catalonia.

You will find information about all this in the present report; for more detailed information, see the CRM's website: www.crm.cat.

Joaquim Bruna
Director

Índex de continguts

Contents

Descripció institucional

Institutional Description

1

1.1. Missió i objectius

L'objectiu definit als estatuts del CRM és la recerca i la formació avançada en l'àmbit de les matemàtiques, mitjançant la col·laboració i les sinergies amb les universitats i les institucions de recerca de Catalunya, amb l'objectiu d'ésser un referent científic internacional en aquest àmbit.

El CRM és un centre amb implantació interuniversitària en el sentit que de la seva activitat se'n beneficia el conjunt de la recerca en matemàtiques del país. La política científica del CRM per a l'assoliment de la seva missió té dos eixos d'actuació, recollits en el seu pla estratègic i dins el marc del contracte-programa amb la Generalitat de Catalunya per al període 2008-2013:

☐ Donar suport als grups d'investigació catalans, organitzant tipus d'activitats que depassen la capacitat dels mateixos, amb projecció internacional i acollint visitants amb qui treballen conjuntament.

☐ Des d'un punt de vista més proactiu, dissenyar i executar polítiques estratègiques que incideixin en debilitats de la recerca matemàtica a Catalunya entesa globalment, incentivant el desenvolupament d'àrees estratègiques i creant-hi grups propis.

1.1. Mission and Objectives

As stated in its statutes, the CRM's aim is to foster research and advanced training in mathematics, by collaborating with the universities and research institutions in Catalonia, in order to become an international reference in this field.

The CRM is transversal in the sense that its activities benefit the whole community of mathematical researchers of our country. The scientific policy of the CRM towards fulfilling its mission is structured around two main axes, quoted in the strategic plan within the contract-programme with the Generalitat de Catalunya for the period 2008-2013:

☐ *To give support to research groups, by organising activities whose size or nature goes beyond the capabilities of the teams, achieving broad visibility and hosting visitors for joint work.*

☐ *To design and execute strategies aimed at repairing weaknesses of the mathematical research activity in Catalonia as a whole, encouraging emergent areas and creating its own research groups in these areas.*

1.2. Estructura jurídica

El CRM va ser creat l'any 1984 per l'Institut d'Estudis Catalans (IEC) com a centre de recerca propi. El mateix any, l'IEC signà un conveni de col·laboració amb la Universitat Autònoma de Barcelona (UAB), en virtut del qual el Centre quedà ubicat físicament en uns espais d'aquesta universitat. L'any 1993 s'adequaren uns espais propis per al CRM a la Facultat de Ciències de la UAB amb finançament de la CIRIT. Per aquest motiu, es reformulà el conveni entre l'IEC i la UAB i se sol·licità l'adscripció del CRM a la UAB com a institut universitari.

L'acord del Govern de la Generalitat de 9 de juliol de 2002 (DOGC núm. 3693, de 6 d'agost de 2002) aprovà la constitució del Consorci Centre de Recerca Matemàtica, integrat per la Generalitat de Catalunya i l'IEC. El Consorci és una entitat pública amb personalitat jurídica pròpia. El 2009 es va iniciar el procés, encara no completat, per incorporar la Universitat Autònoma al Consorci.

El CRM està regit pel Consell de Direcció i pel director, i compta amb un Consell Científic Assessor.

El CRM està integrat dins la Institució CERCA de centres de recerca participats majoritàriament per la Generalitat de Catalunya i forma part de l'Associació Catalana d'Entitats de Recerca (ACER). També forma part d'ERCOM, un comitè de la Societat Matemàtica Europea, i de la xarxa EPDI (European Post-Doctoral Institute).

1.2. *Legal Status*

The CRM was founded in 1984 by the Institut d'Estudis Catalans (IEC), the Catalan Academy. In the same year, an agreement was signed with the Universitat Autònoma de Barcelona (UAB), by virtue of which the CRM became established in the UAB Campus. In 1993 the CRM inaugurated its own premises at the UAB's Science Faculty, thanks to financial support from CIRIT. On that occasion, the CRM became associated with the UAB as one of its research institutes.

The Government of Catalonia approved on July 9, 2002 (DOGC No. 3693, August 6, 2002) the creation of the CRM Consortium, formed by the Generalitat de Catalunya and the IEC. The CRM Consortium is a public body with its own legal status. In 2009 the process started to incorporate Universitat Autònoma to the Consortium, which is still not completed.

The CRM is guided by its Governing Board and the Director, and has a Scientific Advisory Board.

The CRM is one of the centre in the CERCA Institution of research centre sponsored by the Generalitat de Catalunya, and of the Associació Catalana d'Entitats de Recerca (ACER). The CRM is also a member of ERCOM, a committee of the European Mathematical Society (EMS) and of the European Post-Doctoral Institute (EPDI).

1.3. Consell de Direcció

El Consell de Direcció, òrgan superior de decisió i d'administració del CRM, està format per:

☐ El president, que és el conseller d'Economia i Coneixement, o persona en qui delegui.

☐ El vicepresident, que és el president de l'IEC, o persona en qui delegui.

1.3. *Governing Board*

The Governing Board, the highest level of decision and management of CRM, consists of:

☐ *The president, who is the Minister of Economy and Knowledge, or his delegate.*

☐ *The vice president, who is president of the IEC, or his delegate.*

☐ Tres vocals en representació de la Generalitat de Catalunya.

☐ Tres vocals en representació de l'IEC.

☐ El director del CRM, que hi participa amb veu però sense vot.

A la reunió del Consell de Direcció del 24 de març de 2011 es comuniquen els canvis en la composició del Consell de Direcció produïts des de la reunió anterior. El Sr. Andreu Mas-Colell, en la seva condició de conseller d'Economia i Coneixement, assumí el càrrec de president del Consell de Direcció. D'acord amb la resolució de 23 de març de 2011, s'acordaren les següents designacions: el Sr. Antoni Castellà, en la seva condició de secretari d'Universitats i Recerca; el Sr. Josep M. Martorell, en la seva condició de director general de Recerca; el Sr. Lluís Rovira, en la seva condició de director d'i-CERCA (Centres de Recerca de Catalunya). Tots ells, presents a l'acte, manifestaren acceptar llurs càrrecs.

Per tant, durant l'any 2011, la Generalitat de Catalunya hi va estar representada pel conseller d'Economia i Coneixement, Andreu Mas-Colell, el secretari d'Universitats i Recerca, Antoni Castellà, que va presidir el Consell, el director general de Recerca, Josep M. Martorell i el director d'i-CERCA, Lluís Rovira. L'IEC hi va estar representat pel seu president, Salvador Giner, el vicepresident, Joandomènech Ros, i per Joan Girbau. Carles Jaime, vicerrector de Projectes Estratègics de la UAB, va assistir com a convidat a totes les sessions.

El Consell de Direcció es va reunir el 24 de març de 2011, el 23 de maig de 2011 i el 16 de desembre de 2011.

☐ *Three representatives of the Generalitat de Catalunya.*

☐ *Three representatives of the IEC.*

☐ *The Director of CRM, who participates with a voice but not a vote.*

In the meeting of the Governing Board on March 24, 2011, changes in the composition of the Governing Board produced from the previous meeting were communicated. Mr. Andreu Mas-Colell, in his capacity of Minister of Economy and Knowledge, assumed the position of Chairman of the Board. In accordance with the resolutions of March 23, 2011, the Board agreed the following designations: Mr. Antoni Castellà, as Secretary of Universities and Research; Mr. Josep M. Martorell, as General Director of Research; Mr. Lluís Rovira, as Director of the Institute of Research Centres of Catalonia (CERCA Institution). All of them, accepted their commitments.

So, during 2011, the Generalitat de Catalunya was represented by the Minister of Economy and Knowledge, Andreu Mas-Colell, the Secretary of Universities and Research, Antoni Castellà, who chaired the Board, the General Director of Research, Josep M. Martorell and the Director of i-CERCA, Lluís Rovira. The IEC was represented by its president, Salvador Giner, its vice president, Joandomènech Ros, and Joan Girbau. Carles Jaime, vice-rector of Strategic Projects at UAB, attended all meetings as a guest.

The Governing Board met on March 24, 2011, on May 23, 2011 and December 16, 2011.

Generalitat de Catalunya

Institvt d'Estvdis Catalans

1.4. Consell Científic Assessor

El Consell Científic Assessor (CCA) està integrat per personalitats de prestigi científic en l'àmbit d'actuació del Centre, nomenats pel Consell de Direcció a proposta del director.

El CCA va tenir la seva reunió anual presencial el 14 de gener de 2011. Al llarg de l'any es van fer diverses reunions no presencials. A continuació, llistem els membres del CCA que van assistir a aquesta reunió, i que acabaren el seu mandat el 26 de març de 2011 (tal com s'especifica a l'acta de la reunió del Consell de Direcció del dia 26 de març de 2007):

Jaume Aguadé, Universitat Autònoma de Barcelona
Alfredo Bermúdez de Castro, Universidade de Santiago de Compostela
Michel Boileau, Université de Toulouse
Aline Bonami, Université d'Orléans
Bodil Branner, Danmarks Tekniske Universitet, Lyngby
Luis Caffarelli, University of Texas at Austin
Eduard Casas-Alvero, Universitat de Barcelona
José Luis Fernández, Universidad Autónoma de Madrid
Oscar García Prada, Consejo Superior de Investigaciones Científicas, Madrid
Antonio Huerta, Universitat Politècnica de Catalunya, Barcelona
Dominique Picard, Université Paris VII
Kristian Seip, Norges Teknisk-Naturvitenskapelige Universitet, Trondheim
Maria Eulalia Vares, Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
Dominic Welsh, University of Oxford

A la reunió del Consell de Direcció del 23 de maig de 2011 s'aprovà la proposta de la nova composició del Consell Científic Assessor, així com el seu règim de funcionament i s'anomenen com a membres del nou CCA les persones següents:

Stephen O'Brien, University of Limerick
Helen Byrne, University of Oxford
Wolfgang Dahmen, RWTH Aachen
Charles Fefferman, Princeton University
Peter Imkeller, Humboldt-Universität zu Berlin
Mogens H. Jensen, University of Copenhaguen
Gábor Lugosi, Universitat Pompeu Fabra, Barcelona
Consuelo Martínez, Universidad de Oviedo
Jaroslav Nešetřil, Charles University, Prague
Joan Porti, Universitat Autònoma de Barcelona

1.4. Scientific Advisory Board

The Scientific Advisory Board (SAB) is composed of prestigious personalities in the scientific scope of the Centre, appointed by the Governing Board, after proposal by the Director.

The SAB held its annual meeting in person on January 14, 2011. Throughout the year, on-line meetings were held. The SAB members who attended this meeting, listed below, finished their commitment on March 26, 2011 (as specified in the minutes of the meeting of the Governing Board on March 26, 2007):

The Governing Board approved on May 23, 2011, the proposal of a new composition of the Scientific Advisory Board and its operating regime. The new SAB members are:

1.5. Contracte-programa

El primer contracte-programa del CRM amb la Generalitat de Catalunya es va signar el 18 de juny de 2003. Es va mantenir vigent fins a 2006 i es va prorrogar durant l'any 2007. El 14 de febrer de 2009 es va signar un segon contracte-programa que cobreix el període de 2008 a 2013. Aquest contracte-programa emana del pla estratègic del Centre, que va ser aprovat pel Consell de Direcció, i és la concreció dels eixos de desplegament continguts en el pla. L'objecte del contracte-programa és: establir un nou marc de relacions i mecanismes de coordinació entre la Generalitat de Catalunya i el CRM; dotar el CRM dels mitjans necessaris per seguir complint els seus objectius; determinar la participació de la Generalitat de Catalunya en la definició i la programació dels objectius i del finançament del CRM; i configurar-se com un instrument de planificació estratègica, de gestió de la recerca, la formació, la difusió del coneixement i la millora de la qualitat. El desenvolupament del contracte-programa s'analitza en una reunió anual d'una comissió mixta de seguiment.

1.5. Contract-programme

The first contract-programme of the CRM with the Catalan Government was signed on June 18, 2003. It remained into force until 2006 and was extended over 2007. On February 14, 2009, a new contract-programme was signed for the period 2008-2013. This contract-programme stems from the CRM's strategic plan, which was approved by the Governing Board, and specifies the main axes of the strategic plan. The goal of the contract-programme is the following: to set up a new framework for relations and coordination mechanisms with the Catalan Government; to provide the CRM with the necessary resources to achieve its foundational aims; to specify the participation of the Catalan Government in the definition of the CRM's goals and financing; and to become an instrument for strategic planning, management of research, training, knowledge dissemination, and quality improvement. The development of the contract-programme is analys and discussed in an annual meeting of a monitoring commission.

1.6. ERCOM

ERCOM és l'acrònim del comitè European Research Centres on Mathematics de la Societat Matemàtica Europea (EMS), format pels directors científics de diversos centres de recerca europeus. Els centres representats a ERCOM són aquells el nombre de visitants dels quals supera essencialment el nombre d'investigadors permanents o de llarga durada i que cobreixen un espectre ampli de les matemàtiques. El CRM és membre d'ERCOM des de la seva fundació l'any 1997.

El president d'ERCOM és nomenat per un període de quatre anys pel comitè executiu de l'EMS. Des de 2006 fins a 2009, ERCOM va ser presidit per Jan Karel Lenstra, director del Centrum voor Wiskunde en Informatica d'Amsterdam (Holanda). A finals de l'any 2009 va ser escollit

1.6. ERCOM

ERCOM is the acronym of the European Research Centres on Mathematics committee of the European Mathematical Society (EMS), consisting of the scientific directors of European research centres in the mathematical sciences. Only centres for which the number of visiting staff substantially exceeds the number of permanent and long-term staff, and which cover mathematical sciences broadly, are eligible for representation in ERCOM. The CRM has been a member of ERCOM since its foundation in 1997.

The president of ERCOM is appointed for a period of four years by the EMS Executive Committee. From 2006 to 2009, ERCOM has been chaired by Jan Karel Lenstra, director of the Centrum voor Wiskunde en Informatica, Amsterdam. In 2009, Gert-Martin Greuel, direc-

president Gert-Martin Greuel, director del Mathematisches Forschungsinstitut Oberwolfach.

La reunió anual d'ERCOM de 2011 tingué lloc el dia 9 d'abril al Mathematisches Forschungsinstitut Oberwolfach.

Per a més informació: www.ercom.org

tor of the Mathematisches Forschungsinstitut Oberwolfach, was elected new chair.

The annual meeting of ERCOM in 2011 was held on April 9 in the Mathematisches Forschungsinstitut Oberwolfach.

For more information: www.ercom.org

1.7. Ingenio Mathematica

El CRM és un dels promotors i un node d'un projecte anomenat Ingenio Mathematica, finançat pel Ministeri de Ciència i Innovació durant cinc anys dins del programa Consolider-Ingenio 2010. La data d'inici d'aquest projecte va ser el 3 d'octubre de 2006.

1.7. Ingenio Mathematica

The CRM is one of the promoters, and a node, of a project called Ingenio Mathematica, which has been funded by the Spanish Ministry of Science and Innovation for five years, starting October 3, 2006, within the Ministry's Consolider-Ingenio 2010 programme.

L'investigador coordinador del projecte és Marco Antonio López Cerdá, de la Universitat d'Alacant, i l'entitat gestora és la Universitat de Cantàbria. La direcció científica del projecte correspon a un consell de direcció format per investigadors de diverses institucions de l'estat espanyol. Els nodes del projecte són: CRM, CESGA (Centro de Supercomputación de Galicia), CIEM (Centro Internacional de Encuentros Matemáticos, Castro Urdiales), ICMAT (Instituto de Ciencias Matemáticas, Madrid) i IMUB (Institut de Matemàtica de la Universitat de Barcelona). Les activitats del projecte s'emmarquen en diverses plataformes, anomenades Future, Consulting, Computing, EDU, PMII, SARE, SAIRT i MIGS.

Moltes de les activitats del CRM desenvolupades durant l'any 2011 (programes de recerca, congressos, cursos avançats, etc.) varen ser finançades parcialment per Ingenio Mathematica.

The coordinator of the project is Marco Antonio López Cerdá, from Universitat d'Alacant, and the management center is located at Universidad de Cantabria. The scientific direction of the project lies under the responsibility of a Governing Board formed by researchers from several Spanish institutions. The nodes of the project are: CRM, CESGA (Centro de Supercomputación de Galicia), CIEM (Centro Internacional de Encuentros Matemáticos, Castro Urdiales), ICMAT (Instituto de Ciencias Matemáticas, Madrid), and IMUB (Institut de Matemàtica de la Universitat de Barcelona). Several platforms, named Future, Consulting, Computing, EDU, PMII, SARE, SAIRT, and MIGS, provide a framework for the actions of Ingenio Mathematica.

Many CRM activities, including research programmes, conferences, advanced courses, etc., were partially funded by Ingenio Mathematica in 2011.

1.8. Beques EPDI

Des de desembre de 2000, el CRM és membre de l'EPDI (European Post-Doctoral Institute for the Mathematical Sciences), que agrupa deu prestigiosos instituts d'investigació europeus: Institut des Hautes Études Scientifiques, Bures-sur-Yvette (el director del qual n'és el coordinador); Max-Planck-Institut für Mathematik, Bonn; Isaac Newton Institute for the Mathematical Sciences, Cambridge; Max-Planck-Institut für Mathematik in den Naturwissenschaften, Leipzig; Institute Mittag-Leffler, Djursholm; Banach Center, Varsòvia; Erwin Schrödinger Institut, Viena; Forschungsinstitut für Mathematik, Zuric; Mathematisches Forschungsinstitut Oberwolfach; Centre de Recerca Matemàtica, Bellaterra.

L'EPDI convoca anualment beques postdoctorals de dos anys de durada en l'àmbit de les matemàtiques i de la física matemàtica, ofertes a joves investigadors de països europeus.

1.8. EPDI Fellowships

Since December 2000, the CRM has been a member of the EPDI (European Post-Doctoral Institute for the Mathematical Sciences), which currently groups ten European research institutes: the Institut des Hautes Études Scientifiques (IHÉS) in Bures-sur-Yvette (the Director of which is the coordinator), Max-Planck-Institut für Mathematik in Bonn, Isaac Newton Institute for the Mathematical Sciences in Cambridge, Max-Planck-Institut für Mathematik in den Naturwissenschaften in Leipzig, Institute Mittag-Leffler in Djursholm, Banach Center in Warsaw, Erwin Schrödinger Institut in Vienna, Forschungsinstitut für Mathematik (FIM) in Zürich, the Mathematisches Forschungsinstitut Oberwolfach, and CRM.

EPDI annually awards post-doctoral grants in mathematics (pure and applied) and mathematical physics, which are offered to young researchers in European countries.

1.9. Direcció i administració

1.9.1. Equip de Direcció

El director del CRM és nomenat pel Consell de Direcció, a proposta del president, per a un període de quatre anys. El director actual és Joaquim Bruna, que va ser nomenat per al període de 2007 a 2011.

A la reunió del Consell de Direcció del dia 10 de desembre de 2010 es decidí renovar l'acord de nomenament de Joaquim Bruna com a director del CRM per a un període addicional de quatre anys, amb efectes a partir de l'1 d'abril de 2011.

Atès que l'equip de direcció que es va nomenar a la reunió del Consell de Direcció del dia 26 de març de 2007 va haver de renunciar a les seves funcions per haver contret altres compromisos professionals, es proposà el nomenament d'Antoni Guillamon com a Adjunt de Direcció, aprovat per unanimitat pel Consell de Direcció.

El director, l'adjunt de direcció, el gerent i un representant del personal de recerca formen la Comissió Executiva del Centre, que es reuneix periòdicament per tractar afers de tràmit o urgents. El representant dels investigadors és Álvaro Corral.

Manuel Castellet, que va ser director del CRM des de la seva creació l'any 1984, va ser nomenat director honorari pel Consell de Direcció l'any 2007.

1.9.2. Gerent

El Sr. Oriol Fernández ocupa el càrrec de gerent des de l'any 2008.

ofernandez@crm.cat telèfon 93 586 8424

1.9. Direction and Administration

1.9.1. Team of Directors

The Governing Board elects a Director, proposed by the Chair, to serve for a period of four years. The current Director is Joaquim Bruna, who was elected for the period from 2007 to 2011.

At the meeting of the Governing Board on December 10, 2010, it was decided to renew the agreement for the appointment of Mr. Joaquim Bruna as the CRM Director for an additional period of four years, with effect from April 1, 2011.

Since the Team of Directors appointed at the meeting of the Governing Board on March 26, 2007, had to relinquish its duties for having contracted other professional commitments, the appointment of Mr. Antoni Guillamon as Associate Director was proposed and approved unanimously by the Governing Board.

The director, the associate director, the manager and one representative of the researchers form the Executive Commission of the CRM, which meets regularly to discuss routine or urgent affairs. The representative of the researchers is Álvaro Corral.

Manuel Castellet, who had been director of the CRM since its creation in 1984, was nominated Honorary Director by the Governing Board at its 2007 meeting.

1.9.2. Manager

The CRM's Manager is Mr. Oriol Fernández since 2008.

ofernandez@crm.cat phone 93 586 8424

1.9.3. Equip de secretaria

Les persones següents han format l'equip de secretaria del CRM durant el 2011.

1.9.3. Secretarial Team

The following people made up the administrative team in 2011.

Manuel Carvajal	mcarvajal@crm.cat	Tel: 93 586 8496
Ana García-Donas	agarcia@crm.cat	Tel: 93 581 2953
Núria Hernández	nhernandez@crm.cat	Tel: 93 586 8192
Raquel Hernández	rhernandez@crm.cat	Tel: 93 581 2953
Maria Àngels Huertos	mahuertos@crm.cat	Tel: 93 586 8496
Guillem Pérez	gperez@crm.cat	Tel: 93 586 8423
Neus Portet	nportet@crm.cat	Tel: 93 581 4086
Consol Roca	croca@crm.cat	Tel: 93 581 1081
Mari Paz Valero	mpvalero@crm.cat	Tel: 93 581 1081

1.10. Equipament

Els espais que actualment ocupa el CRM estan situats en una ala de l'edifici de la Facultat de Ciències de la UAB, amb una superfície total de 2.125 m^2, després de la darrera ampliació finalitzada l'octubre de 2010, amb el finançament de la Generalitat i del fons FEDER. Permeten la ubicació de la secretaria, la direcció, un màxim de 60 investigadors, tres sales de reunions, tres aules amb capacitat per a 40 persones i un auditori amb capacitat per a 100 persones.

Per a l'allotjament dels investigadors visitants, el CRM utilitza la oferta d'apartaments de la Vila Universitària de Bellaterra.

Durant l'any 2011 l'equipament informàtic del CRM constava d'una xarxa LAN Ethernet d'aproximadament unes vuitanta estacions de treball estructurades sota un domini Windows. Entre d'altres serveis, la xarxa constava d'un servidor de correu electrònic, un servidor d'impressió (que gestionava els treballs de cinc impressores), un servidor de fitxers i un *Firewall/Router* que la connectava a la infraestructura de la UAB mitjançant un enllaç d'1 Gb. El centre disposava també de connexió a internet sense cables i de set canons de projecció per a les aules i sales de reunions.

1.10. Equipment

The CRM has facilities in the UAB Faculty of Sciences with a total floor space of 2.125 m^2, after completion in October 2010 of the enlargement of CRM premises, made possible through Generalitat and FEDER funding. The facilities include secretarial offices, the Director's desk, up to 60 researcher places, three meeting rooms, three lecture rooms with capacity for 40 people and an auditorium with capacity for 100 people.

To host visiting researchers, the CRM uses the facilities provided by Vila Universitària at Bellaterra.

During 2011, the CRM computer equipment was based on a LAN Ethernet net of, approximately, eighty workstations structured under a Windows domain. Among other services, the net included an e-mail server, a printer server (managing the tasks of five printers), a file server and a Firewall/Router that linked it to the UAB infrastructure by means of a 1 Gb connection. Wi-Fi connection was also available. The lecture room and the meeting rooms were equipped with seven projectors.

1.11. Serveis externs

El CRM té contractats els serveis de l'empresa externa "Gestió laboral: 3F Consultors".

1.11. External Services

The company "Gestió laboral: 3F Consultors" has service contracts with the CRM.

La recerca al CRM

Research at CRM

2

2.1. Els grups de recerca del CRM

Tal i com s'ha dit a la secció 1.1, la política científica del CRM es concreta mitjançant dos eixos d'actuació, el segon dels quals contempla la creació de grups de recerca propis en àrees poc desenvolupades a Catalunya. Durant el 2011, s'han anat consolidant els següents grups de recerca del CRM:

2.1. CRM Research Groups

As mentioned in Section 1.1, the scientific policy of the CRM has two main axes, the second one aiming at building its own groups in less developed in Catalonia. During 2011 the following CRM research groups continued their consolidation:

- *Complex Systems*
- *Computational & Mathematical Biology*
- *Financial Mathematics and Risk Control*
- *Harmonic Analysis and Approximation Theory*
- *Industrial Mathematics*
- *Numerical Analysis and Scientific Computing*

Àmbit de recerca

Podem considerar com a sistemes complexos aquells formats per un nombre molt gran de components que interactuen intensament. Molts dels reptes actuals de la humanitat estan en comprendre el comportament de sistemes complexos, com ara el clima, l'economia, la societat, el cervell humà, la biologia del desenvolupament, etc. En oposició a aquest concepte, l'àtom d'hidrogen, el sistema solar o un gas ideal serien sistemes simples, malgrat que per descriure'ls necessitem conceptes profunds de la física i matemàtiques sofisticades. Tanmateix, si tot allò que és complex és un sistema complex, què aporta de nou el nou paradigma de la complexitat? Tots aquests sistemes d'àmbits tan diversos poden ser tractats des d'una única perspectiva? Una de les idees clau en els estudis de complexitat és que les estructures apareixen en aquest tipus de sistemes a tots els nivells, incloent nivells molt llunyans dels propis de la interacció entre els components i, a més, mostren regularitats estadístiques sorprenents.

En el grup de Sistemes Complexos del CRM ens concentrem en dues línies de recerca: la primera, desastres naturals i fenòmens meteorològics, resultat de l'activitat complexa de la Terra; i la segona, l'estructura de la informació en la comunicació entre humans, originada per l'activitat complexa de les zones cerebrals que les controlen i de les relacions socials entre els comunicadors. A la línia de desastres naturals investiguem els patrons d'ocurrència de terratrèmols, incendis forestals, huracans, pluja, etc., amb la idea que les seves propietats estadístiques amaguen claus per a la seva comprensió, modelització i previsió. En referència a la comunicació humana, ens fixem tant en el llenguatge humà com en la música. Novament, estudiem patrons d'ocurrència, aquest cop dels símbols que componen els textos o les composicions musicals, per tal d'entendre millor com funcionen aquestes característiques tan exclusives del gènere humà i, per què no?, si les màquines les podrien reproduir.

Research Field

We can consider complex systems to be the ones formed by a large number of heavily interacting elements. As a result, many of mankind's greatest challenges come from trying to unravel the behaviour of these systems, such as the climate, the economy, the society, the brain, biological development, etc. Contrary to this, the hydrogen atom, the solar system or an ideal gas would be simple systems, despite the fact that in order to study them we need to use in-depth physics concepts and sophisticated mathematics. However, if everything that is complex is a complex system, what does the new science of complexity bring to the table? Can such wide-ranging systems be tackled with a single perspective? One of the key ideas in complexity studies is that structures appear in these types of systems at all levels, including levels far in excess from those achieved by the interaction between components; in addition to this, the structures also show surprising statistical regularities.

At the CRM Complex Systems Group, we focus on two major lines of research: one, natural disasters and meteorological phenomena, resulting from the complex activity of the Earth's system, and the other, the structure of information in human communication, produced by the areas of the brain responsible for this and the relationship between the speakers. Regarding natural hazards, we study the occurrence patterns of earthquakes, forest fires, hurricanes, rainfall, etc., with the idea that the statistical properties of these phenomena contain key information for their understanding, modeling and forecasting. In relation to human communication, we concentrate both in natural language and in music. Again, we study occurrence patterns, this time of the symbols that constitute the texts or the musical compositions, in order to better understand how these unique characteristics of humans work, and also, why not, if machines could reproduce them.

Projectes vigents
Current Projects

- FIS2009-09508. *Complexity and Scaling Laws in Meteorological Phenomena, Natural Disasters and Human Language*, 2010-12. PI: Álvaro Corral.

Membres del grup
Research Team

• Álvaro Corral	(team leader)
• Anna Deluca	(PhD student)
• Francesc Font Clos	(PhD student, from Dec. 2011)

Activitats relacionades
Related Activities

- Beyond physics: Multidisciplinary challenges Seminar.
- Seminar of the network complexitat.cat

Col·laboradors
Collaborators

• Ole Peters	Imperial College London
• Josep Enric Llebot	Universitat Autònoma de Barcelona
• Gemma Boleda	Universitat Politècnica de Catalunya
• Albert Díaz-Guilera	Universitat de Barcelona
• Ramon Ferrer i Cancho	Universitat Politècnica de Catalunya
• Lucas Lacasa	Institute for Cross-Disciplinary Physics and Complex Systems, Madrid
• Lucilla de Arcangelis	Second University of Naples

Group Activity in 2011

Last year has been devoted to the development of diverse topics. One PhD student of the group, Anna Deluca, has performed intensive research on the statistics and modeling of rainfall. She has worked on statistical procedures to test universality in rain occurrence, has explored the perspective of rainfall as a spatio-temporal event, and has employed methods of time series analysis to the prediction of rain-event sequences. She has also attended several conferences and international schools, among them the prestigious one on Complex Systems at the Santa Fe Institute. She has also enjoyed a one-month visit to the Max Planck Institute for the Physics of Complex Systems, in Dresden, under the supervision of professor Holger Kantz.

In collaboration with Antonio Turiel, from the Institut de Ciències del Mar, we have studied the energy dissipation of hurricanes in the Atlantic, paying special attention to review the previous literature related to global warming. Together with Eugenio Lippiello and Lucilla de Arcangelis, from the Second University of Naples, we have investigated the factors that influence the probability distribution of the interevent times of earthquakes. We have also performed an analysis of the differences between the use of words or lemmata as the building blocks of texts and their influence on Zipf's law, jointly with Ramon Ferrer i Cancho and Gemma Boleda, from the Universitat Politècnica de Catalunya. An analogous of Zipf's law has been obtained for the timbral descriptors of music and speech, from work perfomed with Martín Haro, Joan Serrà, and Perfecto Herrera, from the Universitat Pompeu Fabra. We have also developed statistical tests to fit and evaluate the goodness-of-fit for discrete power-law distributions.

The group has also brought a number of speakers to contribute to CRM seminars, including Oriol Pont, from INRIA, France, Salvador Pueyo, from

the Institut Català de Ciències del Clima, and Joshua Garland, from the University of Colorado, and has had the visit of our long-term collaborator Lucas Lacasa, from the Universidad Politécnica de Madrid. We have also organised a first meeting of Spanish researchers working in complexity and nonlinear geoscience and have collaborated in the conferences organised by the network complexitat.cat.

2.1.2. Computational & Mathematical Biology

Àmbit de recerca

La majoria dels fenòmens estudiats per les Ciències Naturals, des de Ciència de Materials a Astrofísica, són processos d'escales múltiples, és a dir, fenòmens que impliquen l'acoblament de processos regits per escales espacials i temporals característiques molt diferents, de manera que el comportament global emergeix d'aquesta interacció. Mentre que en el camp de les Ciències Físiques s'ha fet un progrés considerable en el tractament d'aquest tipus de fenomen, els resultats obtinguts per a sistemes biològics són més modestos. Aquesta circumstància es deu a què la unitat fonamental en sistemes vius (la cèl·lula) és molt més complexa que les corresponents unitats en sistemes inerts. Per tant, es necessiten tant models com mètodes nous per analitzar els pro-

Research Field

Most phenomena studied by the Natural Sciences, from Material Sciences to Astrophysics, are multi-scale processes, i.e., they involve the coupling of multiple different processes characterised by widely-ranging time and length scales, with the macroscopic behaviour emerging from the complex interactions between them. Whilst considerable progress has been done in dealing with such problems in the Physical Sciences, the success achieved so far in the Biological Sciences is rather more limited. This is partly due to the fact that the individual components of biological systems (e.g., cells) are much more complex than their counterparts in physical systems and, therefore, new methods and models are needed to analyse multi-scale

cessos d'escales múltiples en Biologia. Aquest és el camp de recerca del grup de Biologia Computacional i Matemàtica al CRM: la formulació de nous models que siguin rellevants tant per a biòlegs experimentals com per a investigadors clínics, i el desenvolupament de les eines computacionals i analítiques necessàries per al seu estudi. Ens centrem en problemes de rellevància clínica, en particular els relacionats amb càncer.

processes in Biology. Such is the remit of the Computational & Mathematical Biology group at CRM: To propose new models relevant to experimental biologists and clinicians and develop the analytical and computational tools necessary for their analysis. We pay special attention to problems with clinical relevance, in particular those related to cancer.

L'activitat del nostre grup s'articula al voltant de les línies de recerca següents:

The research activity of our group is developed along the following lines:

- ☐ Modelització d'escales múltiples de creixement tumoral i angiogènesi.
- ☐ *Multiscale modelling of tumour growth and tumour-induced angiogenesis.*
- ☐ Dinàmica evolutiva de poblacions amb estructura complexa, en particular, de poblacions de cèl·lules amb estructura jeràrquica i mapa entre genotip i fenotip.
- ☐ *Evolutionary dynamics of populations with complex structure, in particular populations of cells with hierarchical structure and genotype-phenotype map.*
- ☐ Modelització del cicle cel·lular.
- ☐ *Mathematical modelling of the cell-cycle.*
- ☐ Modelització estocàstica de receptors tirosinaquinasa.
- ☐ *Stochastic modelling of receptor tyrosine kynase.*
- ☐ Tumors latents.
- ☐ *Tumour dormancy.*

Projectes vigents
Current Projects

- MTM2010-18318-E. *Mathematical models of population dynamics with complex structure*, 2011. PI: Tomás Alarcón.

Membres del grup
Research Team

• Tomás Alarcón	(team leader)
• Pilar Guerrero	(post-doctoral researcher)
• Esther Ibáñez	(PhD student)
• Daniel Sánchez	(PhD student)

Activitats relacionades
Related Activities

- Computational & Mathematical Biology Seminar

Col·laboradors
Collaborators

• Helen M. Byrne	University of Nottingham
• Aurora Hernández-Machado	Universitat de Barcelona
• Henrik J. Jensen	Imperial College London
• Philip K. Maini	Centre for Mathematical Biology, Oxford
• Markus R. Owen	Centre for Mathematical Medicine, Nottingham
• Pablo Padilla	Universidad Nacional Autònoma de México
• Karen M. Page	University College London
• Juan Soler	Universidad de Granada
• Rui Travasso	Universidade de Coimbra

Group Activity in 2011

During 2011, the research activity of the group has been developed along three pivotal activities. We have been working on the development of stochastic multiscale modelling of cell populations leading to the formulation of age-structured stochastic populations models with applications to tumour growth. A second research theme is the stability of stochastic structured (multi-type and hierarchical populations) which has led to the formulation of a new mechanism for extinction in hierarchically organised populations where delays induce extinction. The third research line concerns evolutionary dynamics of populations with phenotype-genotype map where we are exploring, using elements from graph theory and complex network theory, the topological properties of a new description of this map based on a bipartite graph.

During 2011, one of the students of the group, Daniel Sánchez-Taltavull, has successfully presented his Master's thesis directed by Tomás Alarcón in fulfilment of the requirements to complete his Master in Advanced and Professional Mathematics awarded by the Universitat de Barcelona.

The members of the group have attended several national and international conferences, workshops and summer schools, including an invited talk at the European Conference for Mathematical and Theoretical Biology held in Krakow, Poland. The Computational & Mathematical Biology group has played host to two academic visitor during 2011: Professor Henrik Jeldtoft Jensen, Department of Mathematics, Imperial College London, and Àlvaro Kohn-Luque, Universidad Complutense de Madrid.

During 2011, our group has published 2 papers in peer-reviewed journals in the top quartile of their respective categories and further publication as a chapter in an edited volume published by Springer-Verlag. We have three other papers accepted for publication which will appear in 2012 as well as another chapter in an edited volume. Also, our group organised in collaboration with researchers form the Vall d'Hebron Hospital Research Institute a joint workshop on mathematical and computational modelling in biomedicine with the aim of bringing together the clinical and modelling communities.

Finally, our group attracted a grant ("acción complementaria") awarded by the Ministerio de Ciencia e Innovación. The CRM also secured a small grant from the i-MATH project to fund the joint meeting with Vall d'Hebron Hospital Research Institute.

2.1.3. Financial Mathematics and Risk Control

Àmbit de recerca

El principal objectiu d'aquesta línia de recerca és estudiar problemes de caire tant teòric com aplicat que apareixen en Finances Quantitatives. Aquest Àmbit de recerca ha experimentat un creixement exponencial en els darrers anys, i es basa en utillatge matemàtic tan divers com l'Anàlisi Estocàstica, Equacions en Derivades Parcials, Anàlisi Numèrica, Estadística, etc.

Alguns dels problemes que estudiem són:

☐ Computació numèrica d'opcions exòtiques "Greeks" en models financers basats en processos de Lévy.

☐ Simulació numèrica d'equacions diferencials estocàstiques governades per processos de Lévy.

☐ Inversió de processos estocàstics.

☐ Mètodes Monte Carlo de reducció de variància usant variables antitètiques en alta dimensió.

Research Field.

The main goal of this line of research is to study certain problems, both theoretical and applied, appearing in the field of Quantitative Finance. This area of research has experienced an exponential growth in recent years and the mathematical tools used are as diverse as: Stochastic Analysis, Partial Differential Equations, Numerical Analysis, Statistics, etc.

Some of the problems we are studying are:

☐ *Numerical computation of exotic options "Greeks" in Lévy driven financial models.*

☐ *Numerical simulation of stochastic differential equations driven by Lévy processes.*

☐ *Inversion of the spot processes.*

☐ *Monte Carlo variance reduction by means of antithetic variates in higher dimensions.*

Projectes vigents / ***Current Projects***

- MTM2009-06647-E. *Explora: Matemática de la Ingeniería Financiera.*
- Contrato Future I-MATH: *Matemática Financiera*

Membres del grup / ***Research Team***

• Salvador Ortiz	(team leader, on leave)
• Albert Ferreiro	(PhD student, until May 31, 2011)
• Maite Naranjo	(PhD student)
• Luis Ortiz	(PhD student)

Activitats relacionades / ***Related Activities***

- Seminari de Finances Quantitatives, Xarxa temàtica del CRM.
- Financial Engineering Summer School, June 2011, Bolsa de Madrid.

Col·laboradors / ***Collaborators***

• Sebastián del Baño	Citybank, London
• Arturo Kohatsu-Higa	Ritsumeikan University and Japan Science and Technology Agency
• Peter Tankov	Université Paris-Diderot (Paris 7)

Group Activity in 2011

During 2011, the activity of the group has been focused on the study of models of financial markets with privileged information, the development of numerical schemes to approximate stochastical differential equations driven by Lévy processes, the development of numerical tools to solve the problem of stochastical filtering, and the measure of credit risk in portfolios. During this year, A. Ferreiro completed his PhD under the supervision of Frederic Utzet, at UAB, while L. Ortiz completed his PhD under the supervision of Josep J. Masdemont, at UPC.

2.1.4. Harmonic Analysis and Approximation Theory

Àmbit de recerca

L'anàlisi harmònica estudia la representació de funcions o senyals com a superposició d'ones elementals. Avui és un dels camps amb més aplicacions en matemàtiques, entre les quals hi ha el processament del senyal, la transmissió d'imatges, diversos camps en enginyeria, electrònica, probabilitat, física i molts altres camps de les matemàtiques.

La teoria de l'aproximació considera el problema d'aproximar de la forma més senzilla i acurada possible senyals complicats per d'altres més senzills i més manipulables. El significat de "senzill", "acurada" i "manipulable" depèn de l'aplicació que es consideri. La teoria d'aproximació és una àrea establerta de les matemàtiques en fase de creixement per la varietat de les seves aplicacions, no solament en matemàtiques (anàlisi numèrica, anàlisi en ondetes) sinó també en ciències de la computació, tractament del senyal, òptica biomèdica, geomàtica, etc. Els avenços recents de naturalesa teòrica en aproximació no lineal han permès incrementar la capacitat de manipular i extreure informació de grans conjunts de dades.

Research Field

Harmonic analysis studies the representation of functions or signals as the superposition of basic waves. Nowadays it is one of the most applicable fields of modern mathematics. Among its many applications are signal processing/image transmission, various electrical and computer engineering applications, probability theory, physics, and many fields of pure and applied mathematics.

Approximation theory considers the problems of best approximating general and possibly complicated functions by simpler and more easily calculated ones. The concepts "best", "simpler" and "easily calculated" depend on the applications. Although approximation theory is a well-established area of mathematics, it is currently experiencing a significant rise due to its wide applications both in mathematics (e.g., numerical, wavelet analysis) and in computer science, signal processing, biomedical optics and geographic information systems. Recent developments in nonlinear approximation theory are aimed at carrying out fundamental mathematical (compress, denoise...) and algorithmic study to increase our ability to process large data sets.

Projectes vigents
Current Projects

- MTM2011-27637. *Análisis Armónico, Teoría de Aproximación y Problemas Extremales*, 2011-2013. PI: S. Tikhonov
- ESF-3964. *Boas conjecture and summability properties of integral transforms of Fourier type*, Apr. 2011. PI: S. Tikhonov

Membres del grup
Research Team

• Sergey Tikhonov	(team leader)
• AndriiBondarenko	(post-doctoral researcher)
• Polina Glazyrina	(post-doctoral researcher)
• Nir Lev	(post-doctoral researcher)
• Ainur Jumabayeva	(PhD student)

Activitats relacionades
Related Activities

- Barcelona Analysis Seminar (every Monday, CRM or UB).
- Research Programme Seminar (every Monday or Tuesday; from September 2011)
- CRM Research Programme "Approximation Theory and Fourier Analysis" (September 2011 to February 2012, CRM)

Col·laboradors
Collaborators

• Feng Dai	University of Alberta
• Hrushikesh Mhaskar	California State University
• Michael Ruzhansky	Imperial College, London

• Edward B. Saf	Vanderbilt University, Nashville
• Vladimir D. Stepanov	Peoples' Friendship University of Russia
• Walter Trebels	Technische Universit¨at Darmstadt

Group Activity in 2011

During 2011 the members of the group studied the following topics: Fourier series, function spaces, embedding theorems, sampling and interpolation, Riesz bases, discrepancy theory, optimal configurations on the sphere, weighted norm for integral transforms, polynomial inequalities, spherical designs, optimal codes, best packing, energy minimization.

In particular, N. Lev together with A. Olevskii studied N. Wiener's conjecture on cyclic vectors with results published in the Annals of Mathematics. A. Bondarenko proved the well-known conjecture of Korevaar and Meyers on existence of spherical designs with small cardinalities (available in arXiv). P. Glazyrina investigated Landau's inequalities for algebraic polynomials and Bernstein's inequality. A. Jumabaeva has continued working on her PhD dissertation focusing on optimal inequalities between certain constructive and structural characteristics of the generalized Liouville derivatives. S. Tikhonov studied sharp Remez and Nikol'skii inequalities and weighted norm inequalities for Fourier-type transforms.

The group organised the six-month research programme "Approximation Theory and Fourier Analysis" in the CRM and several conferences including Conference on Function Spaces, Advanced Course on Approximation Theory, ICREA Conference on Approximation Theory and Fourier Analysis, and the session "Approximation theory and Fourier analysis" at the 8th ISAAC congress in Moscow.

2.1.5. Industrial Mathematics

Àmbit de recerca

Matemàtica industrial és un terme poc precís que cobreix bàsicament qualsevol aplicació de les matemàtiques en un context industrial. El nostre grup de recerca centra el seu treball en quatre àrees:

☐ Nanomatemàtica. La Nanotecnologia és un Àmbit de recerca en expansió en el qual apareixen constantment nous reptes. La recerca en aquest camp està dominada per l'experimentació i la computació. El grup està actualment treballant en impulsar l'aplicació de models matemàtics en nanociència. La recerca en marxa tracta la modelització del canvi de fase a la nanoescala, el flux de nanofluids i el flux en nanotubs de carbó.

☐ Canvi de fase. Les transicions de fase ocorren en un gran nombre de situacions naturals i

Research Field

Industrial mathematics is a rather loose term, basically covering any application of mathematics in an industrial context. Our research group has four main focus areas:

☐ *Nanomathematics. Nanotechnology is a rapidly growing and exciting research area that is constantly issuing new challenges. Research in this field is dominated by experiment and computation. The IM group is working to advance the application of mathematics to nano problems. Current projects deal with the mathematical modelling of phase change at the nanoscale, the flow of nanofluids and flow in carbon nanotubes.*

☐ *Phase change. Phase transitions occur in a multitude of natural and industrial situations such as in ice formation, metal formation from the molten state, computer disk manufacture,*

industrials, com ara la formació del gel, la formació del metall a partir de l'estat fos, la fabricació de discos informàtics, les cobertures de xocolata i molts més. El modelatge de les transicions de fase requereix l'estudi del flux calorífic en les diferents fases, que es defineixen en un domini desconegut i en moviment.

☐ Fluxos de pel·lícula fina. Aquesta mena de fluxos pot incloure el moviment de lubrificants, pintures, l'aigua que baixa per una finestra, l'aire que suporta un disc dur de rotació ràpida o el moviment de la lava o d'una glacera. El modelatge matemàtic dels fluxos de pel·lícula fina pot donar lloc a una gran varietat de comportaments i, òbviament, té moltes aplicacions.

☐ Fluxos de fluids no newtonians. Un fluid newtonià té una viscositat constant però pràcticament la majoria dels fluids interessants presenten una viscositat variable. Les pintures i els olis, per exemple, esdevenen menys viscosos quan se'ls aplica una força tallant. Alguns fluids com la pasta de dents o el quètxup es comporten com un sòlid fins que s'aplica la força suficient. La majoria de productes alimentaris líquids i fluids biològics són no newtonians. Per tant, hi ha un gran interès en el modelatge dels fluids no newtonians i en l'aplicació pràctica dels models d'aquest tipus de fluids.

chocolate coating and many more. To model phase transitions requires studying heat flow in the different phases, which are defined over an unknown, moving domain.

☐ *Thin film flows. Thin film flows can cover the motion of lubricants, paints, water running down a window, the air supporting a rapidly rotating computer hard drive or the motion of lava or a glacier. Mathematical modeling of thin film flows can lead to a rich variety of behaviour and obviously has many practical applications.*

☐ *Non-Newtonian fluid flows. A Newtonian fluid has a constant viscosity. However, most practically interesting fluids have a variable viscosity and are termed non-Newtonian. For example, paints and oils become less viscous when a shear force is applied. Fluids such as toothpaste or ketchup behave as a solid until sufficient force is applied. Most liquid food products and biological fluids are non-Newtonian. There is therefore great interest in the modeling of non-Newtonian fluids as well as the application of non-Newtonian fluid models to practical situations.*

Projectes vigents
Current Projects

- PIRG06-GA-2009-256417. *Industrial applications of moving boundary problems*, 2010–2014. PI: Tim Myers
- MTM2010-17162. *Problemas de frontera móvil en presencia de capas líquidas*, 2011. PI: Tim Myers

Membres del grup
Research Team

• Tim Myers	(team leader)
• Jonathan Low	(post-doctoral researcher)
• Michelle MacDevette	(PhD student)
• Francesc Font	(PhD student)

Activitats relacionades
Related Activities

- Workshop on Mathematical modelling of blood flow and baroreflex system, December 2011
- Industrial Mathematics Thematic Network Seminar

Col·laboradors
Collaborators

• Jon Chapman	University of Oxford
• Jean Charpin	University of Limerick
• Linda Cummings	New Jersey Institute of Technology
• James Hill	University of Adelaide
• Sarah Mitchell	University of Limerick

• Ebrahim Momoniat	University of the Witwatersrand, Johannesburg
• Brian Wetton	University of British Columbia

Group Activity in 2011

In 2011 the members of the Industrial Mathematics research group were active in a number of fronts:

In line with the group's new major focus in applying mathematics to nanotechnology Font and MacDevette fixed on specific topics for their theses. Font investigated the melting of nanoparticles, showing that existing mathematical models cannot fully capture this interesting phenomena. MacDevette started work on nanofluid flow for which there exists very little mathematical analysis. Myers developed a theory that explains why fluid flow in carbon nanotubes is much faster than expected through classical theory. This work agrees well with experiments and molecular dynamics simulations and was cited even before appearing in print.

Two master's students joined the group in November, both from the local company Sabirmedical. They are working on methods for modelling and understanding blood pressure variation, with application to the automatic interpretation of the signal from a pulse oximeter.

Group members attended meetings and gave talks around the world, including an industrial mathematics workshop in South Africa, the international conference on industrial and applied maths in Canada and the RSME conference on transfer and industrial maths in Santiago de Compostela.

Regarding dissemination, 4 papers were published in international journals, a further 3 publications resulted from talks given at the RSME meeting and T. Myers contributed a chapter to the book European Success Stories in Indus-trial Mathematics. To maintain the current level of activity another 4 papers were submitted. Obviously much of the group's work was presented at the conferences but members also gave talks within the CRM series and at European universities, as well as two popular science talks at the sessions del Ateneo del CPS in Zaragoza and at the Institut d'Estudis Catalans.

The group hosted a number of international collaborators: Prof. Wetton from the University of British Columbia in particular was an excellent addition during his two month stay, providing expert numerical advice, giving talks at CRM, UPC and Bilbao and giving a short course on fuel cell modelling which was well attended by both students and experimental scientists. Dr. Mitchell from the University of Limerick visited on more than one occasion, providing numerical and analytical advice in the field of phase change.

In December we held a conference at the CRM on nanofluids, which has led to a collaboration with an experimental/numerical group in the UK and formed a starting point for a more comprehensive meeting, Nanomath, to be held in the CRM in 2012.

2.1.6. Numerical Analysis and Scientific Computing

Àmbit de recerca

Els nostres interessos científics es concentren en l'àmbit dels mètodes numèrics per a equacions en derivades parcials. En particular, ens centrem en els mètodes d'elements finits de diferents tipus. Un dels principals interessos de la nostra recerca és el disseny i anàlisi dels mètodes de solució eficient dels sistemes algebraics discrets resultants. Les aplicacions de les tècniques que estudiem apareixen en diversos models matemàtics en Mecànica de Fluids, Mecànica dels Medis Continus i, més recentment, en les equacions cinètiques en Física de Plasma. En particular, treballem o hem treballat en els següents temes:

☐ Mètodes d'elements finits (conforme, disconforme i mixt).

☐ Mètodes de Galerkin discontinus.

☐ Domini dels mètodes de descomposició.

☐ Solucionadors iteratius multinivell i multigrau.

☐ Aproximació numèrica d'equacions cinètiques.

☐ Tècniques d'estabilització en problemes d'advecció-difusió.

☐ Post-processament de tècniques per a les equacions de Navier-Stokes en mecànica de fluids.

Research Field

Our primary scientific interests are concentrated in the field of Numerical Methods for Partial Differential Equations. In particular, our work is focused on Finite Element Methods of different types and the study of their basic properties. One of our main research interests is the design and analysis of efficient solution methods for the resulting discrete algebraic systems. The applications of the techniques that we study arise in various mathematical models in fluid mechanics, continuum mechanics and, more recently, kinetic equations in plasma physics. In particular, we work (or have worked) in the following topics:

☐ *Finite Element Methods (conforming, nonconforming and mixed).*

☐ *Discontinuous Galerkin Methods.*

☐ *Domain ecomposition Methods.*

☐ *Multilevel and Multigrid Iterative Solvers.*

☐ *Numerical Approximation of Kinetic Equations.*

☐ *Stabilization techniques for steady/unsteady advection-diffusion problems.*

☐ *Post-processing techniques for Navier-Stokes equations.*

Projectes vigents
Current Projects

- HI2008-0173. (Acción integrada España-Italia) Spanish PI: Blanca Ayuso. Italian PI: L. D. Marini.

Membres del grup
Research team

- Blanca Ayuso (Ramón y Cajal fellow)

Col·laboradors
Collaborators

• L. Donatella Marini	Università degli Studi di Pavia
• Franco Brezzi	IMATI–CNR & IUSS, Pavia
• Ludmil T. Zikatanov	Penn State University
• Paola F. Antonietti	MOX & Politecnico di Milano
• Chi-Wang Shu	Brown University
• José Antonio Carrillo	ICREA & Universitat Autònoma de Barcelona
• Yunrong Zhu	University of California at San Diego
• Michael Holst	University of California at San Diego
• Johannes Kraus	RICAM, Linz

2.2. Personal investigador del CRM

En correspondència amb els dos eixos d'actuació del CRM, en el Centre hi conviuen dos tipus de personal investigador: els investigadors vinculats contractualment al CRM, que llistem en aquesta secció, i els investigadors visitants (secció 2.3).

Accordingly with the two activity axes of CRM, two types of researchers can be found: the ones employed by CRM, quoted in this section, and visiting researchers (Section 2.3).

2.2.1. Senior Researchers

Report by
Tomás Alarcón

I have been working on the development of stochastic multiscale modelling of cell populations; this leads to age-structured stochastic population models with applications to tumour growth. A second research line has been the stability of stochastic structured populations, including the formulation of a new mechanism for extinction in hierarchically organised populations where delays induce extinction. A third research line concerns evolutionary dynamics of populations with phenotype-genotype map.

Besides, I have been promoting several activities, among which a collaboration of my group with Vall d'Hebron Hospital Research Institute, and tutoring the postdoc researcher and my two PhD students, one of whom submitted successfully his master's thesis.

☐ *Publications*

Articles

- T. Alarcón and H.J. Jensen, *Quiescence: a mechanism for escaping the effects of drug on cell populations,* J. R. Soc. Interface 8, 99–106 (2011).
- H. Perfahl, H.M. Byrne, T. Chen, V. Estrella, T. Alarcón, A. Lapin, R.A. Gatenby, R.J. Gillies, M.C. Lloyd, P.K. Maini, M. Reuss and M.R. Owen, *Multiscale modelling of vascular tumour growth in 3D: The roles of domain size and boundary conditions,* PLoS One 6 (4), e14790 (2011).

Preprints

- T. Alarcón and H.J. Hensen, *Invasion in multi-type populations: The role of robustness and fluctuations,* IMA J. Math. Med. Biol. (2011).
- Y. Nakata, Ph. Getto, A. Marciniak-Czochra, T. Alarcón, *Stability analysis of multi-compartment models for cell production systems,* J. Biol. Dyn. (2011).
- T. Alarcón, Ph. Getto, A. Marciniak-Czochra, MdM. Vivanco., *A model for stem cell population dynamics with maturation-regulated delay,* Disc. Cont. Dyn. Sys. B. (2011).

Books or book chapters

- T. Alarcón and K.M. Page, *Mathematical modelling of the VEGF receptor,* in Modeling Tumor Vasculature: Molecular, Cellular, and Tissue Level Aspects and Implications (2011).

☐ *Research projects*

- *Mathematical models of population dynamics with complex structure*, MTM2010-18318-E. From 2011 to 2011. Principal investigator: Tomás Alarcón.
- *Mathematical modelling and analysis of discrete and continuous structured population dynamics*, Ministry of Science and Innovation (MICINN), Spanish government, MTM2010-18318. From 01.01.2011 to 31.12.2013. Principal investigator: Tomás Alarcón (PI when awarded, no longer a mem-

ber of the project); Philipp Getto, BCAM (current PI).

• *Vascular tissue modelling environment*, European Union under the Virtual Physiological Human programme (7th framework). From 01-01-2011 to. Principal investigator: Markus R. Owen, University of Nottingham, UK.

• *Angiogenesis in Diabetic Retinopathy: Integrating Experiment into Modelling Dynamics*, Portuguese government, PTDC/SAU-ENB/110354/2009. From 2010 to 2012. Principal investigator: Rui Travasso, University of Coimbra, Portugal.

• *Modelización y análisis matemático de fenómenos no-lineales en teoría cinética de EDPs con origen en bio-medicina (dinámica tumoral y vías de señalización) y astrofísica*, Spanish Government. Ministerio de Ciencia Innovación (MICINN), MTM2008-05271. From 01.01.2009 to 31.12.2011. Principal investigator: Juan Soler Vizcaíno, Universidad de Granada.

• *Grup de Recerca Consolidat en Equacions en Derivades Parcials i Aplicacions de la UAB-UPC-UdG*, within the IV Pla de Recerca de Catalunya (2009-2013), 2009SGR345. From 2009 to 2013. Principal investigator: José Antonio Carrillo de la Plata, Universitat Autonòma de Barcelona.

☐ *Activity in research training*

• Daniel Sánchez-Taltavull, PhD student.(CRM). Master's thesis: Stability of stochastic models of hierarchical cell populations, July 2011.

• Esther Ibáñez, PhD student (CRM).

☐ *Teaching activity*

Lectures and short courses

• *Stochastic modelling and Master Equations.* Two-hour lecture delivered at the Master of Science in Applied Mathematics and Mathematical Engineering, Universitat Politècnica de Catalunya, Barcelona. November 2011.

☐ *Scientific activities*

Scientific activities organised

• Member of the organising committee of Biomat 2011 – *Perspectives in Mathematics and Life Sciences*, Universidad de Granada, June 2011.

• Co-organiser (with Fátima Núñez and Álex Sánchez, Vall d'Hebrón Hospital Research Institute) of the workshop on *Mathematical modelling for the health sciences,* Hospital Vall d'Hebrón, Barcelona, April 2011.

• Member of the scientific committee of the workshop on *Mathways into cancer*, Almagro, Spain, June 2012.

• Member of the scientific committee of the *School on emerging infectious diseases and mathematical modelling*, Centre de Recerca Matemàtica, Bellaterra, Barcelona, July 2011.

Participation in scientific activities

Invited lectures in conferences

• T. Alarcón. *Stochastic multi-scale modelling of small metastasis*. Invited talk at the Meeting on PDEs and Applications. Universitat de Girona, June 2011.

• T. Alarcón. *Mathematical modelling of VEGF receptors*. Invited mini-symposium talk at the European Conference of Theoretical & Mathematical Biology, Krakow, July 2011.

• T. Alarcón. *Stochastic multi-scale modelling of small metastasis*. Invited talk at the Feza Gürsey Institute - Imperial College Summer school and workshop

on Complexity. Istanbul, September 2011.

• T. Alarcón. *Robustness and evolvability of gene regulatory networks*. Invited talk at the 2nd Meeting of the Catalan Mathematical Society. Barcelona, October 2011.

Seminars

• T. Alarcón. *Integrative mathematical modelling of biological systems*. Colloquium talk at the Mathematics Applications Consortium for Science & Industry (MACSI), University of Limerick, January 2011.

• T. Alarcón. *Multiscale modelling of tumour-induced angiogenesis*. Seminar at the Mathematics Applications Consortium for Science & Industry (MACSI), University of Limerick, January 2011.

• T. Alarcón. *Competition dynamics in populations with complex structure*. Seminar at the Department of Mathematics (PDE discussion group), Universitat Autònoma de Barcelona, February 2011.

• T. Alarcón. *Mathematical modelling of population dynamics in biomedical problems*. Seminar at the Department of Mathematics, Politecnico di Torino, November 2011.

• *T. Alarcón. Tackling biomedical problems using mathematical models of cell population dynamics*. Joint seminar of the Department of Physics and the Institute for Biomedical Research in Light & Image (IBILI), School of Medicine, University of Coimbra, December 2011.

Report by
Blanca Ayuso

My research has focused on two main lines; design and analysis of Discontinuous Galerkin (DG) methods, and the development and analysis of efficient solvers.

In relation with the first line, in collaboration with the group in Pavia, I have studied in the issue of L^2-optimality/non-optimality of the Non-symmetric Interior Penalty methods (NIPG and IIPG) for elliptic problems. We have provided a rigorous L^2-error analysis for the IIPG-0, without mesh restrictions and with sharp hypothesis on the required regularity of the problem. I have also continued the research on the development and analysis of DG methods for kinetic equations, focusing on the Vlasov-Poisson system. I have advised a Mathmods master's student, Soheil Hajian, at the UAB. In his master's thesis, the implementation and theoretical validation of the proposed DG schemes is carried out. It also contains relevant numerical simulations of many benchmark problems in plasma physics.

Regarding the design and analysis of solvers, I have worked on different topics. On the one hand, in collaboration with the group of Penn-State Univ., we have continued our study of the design of solvers via space decompositions of the Discontinuous Finite element spaces. We have proposed and analyzed multilevel preconditioners for IP approximations of elliptic problems with jump coefficients. We have also proposed (and analyzed) subspace correction methods for the efficient solution of linear elasticity problems. We have also considered the application of the developed techniques to

design a two level solver for convection dominated problems. On the other hand, in collaboration with the group of MOX-Milan, we have proposed (and analyzed) a domain decomposition method for a preconditioned WOPSIP approximation of elliptic problems.

During 2011, I have participated and delivered 5 invited talks (1 plenary) at international conferences and workshops. I have also given 2 seminars (Spain and China) and 1 colloquium (USA).

I have co-organised a workshop on DG methods at the Archimedes Center for Modeling, Analysis & Computation (ACMA) in Crete. I have also organised several minisymposia at the DD20 international conference (held in USA) and one minisymposia at the international conference Numerical Methods for Hyperbolic problems: Theory and Applications, held in Spain. Of this last conference, I was also part of the Scientific Committee.

☐ *Publications*

Articles

- B. Ayuso, J.A. Carrillo and C.W. Shu, *Discontinuous Galerkin Methods for the one-dimensional Vlasov-Poisson system*, Kinetic and Related Models 4,4, 955–989 (2011).
- B. Ayuso de Dios, F. Brezzi, O. Havle and L.D. Marini, *L^2-error analysis of the IIPG-0 method*, Numerical Methods for Partial Differential Equations June (on line), (2011).

Preprints

- B. Ayuso de Dios, M.Holst, Y. Zhu and L.T. Zikatanov, Multilevel *Preconditioners for Discontinuous Galerkin discretizations of jump-coefficient problems*, Technical report: arXiv:1012.1287v1; submitted (January 14th, 2011).
- B. Ayuso de Dios, I. Georgiev, J. Kraus and L.T. Zikatanov, *A Subspace Correction Method for Discontinuous Galerkin discretizations of Linear Elasticity equations*, Technical report: arXiv:1110.5743v2; submitted (October 2011).
- P.F. Antonietti, B. Ayuso de Dios, S.C. Brenner and Li-yeng Sung, *Schwarz methods for a preconditioned WOPSIP method for elliptic problems*, submitted (November 2011).
- B. Ayuso de Dios, A. Lombardi, P. Pietra and L.T. Zikatanov, *A block solver for the exponentially fitted IIPG-0 method*, Technical report arXiv:1107.2831v1; submitted (2011).
- B. Ayuso de Dios, M. Holst, Y. Zhu and L.T. Zikatanov, *Multigrid Preconditioner for Nonconforming Discretization of Elliptic Problems with Jump Coefficients*, Technical report: arXiv:1107.2160v1 (2011).

Books or book chapters

- B. Ayuso, I. Georgiev, J. Kraus and L.T. Zikatanov, *A Simple Preconditioner for the SIPG Discretization of Linear Elasticity Equation*, in *Numerical Methods and Applications, Lecture Notes in Computer Science*, Vol. 6046 (2011).
- B. Ayuso and L.T. Zikatanov, *A Simple Uniformly Convergent Iterative Method for the Non-Symmetric Incomplete Interior Penalty Discontinuous Galerkin discretization*, in *Domain Decomposition Methods in Science and Engineering XIX, Series: Lecture Notes in Computational Science and Engineering, Vol. 78* (2011).

☐ Research projects

• *Acción integrada España-Italia*, HI2008-0173, 2011. Principal investigator: Blanca Ayuso (Spain), L.D. Marini (Italy).
• *Ecuaciones en Derivadas Parciales: Análisis, Control, Numérico y Aplicaciones*, MTM 2008-03541. Financial Entity: Spanish Ministry of Science and Education (MEC), Jan 2009–Dec 2011. Principal investigator: E. Zuazua.

☐ Activity in research training

• Soheil Hajian, Mathmods Master's Student. *An Energy preserving Discontinuous Galerkin Method for the Vlasov-Poisson system*. Master's Thesis defended at Universitat Autònoma de Barcelona, September 2011.
• Dr. Andrew Barker (postdoc Advising, 1 month in May–June 2011), visitor at CRM. Research topic: preconditioning for non-symmetric systems.

☐ Teaching activity

• February 2011–Jun 2011: Master's Course in Advanced Mathematics: *Introduction to Fluid Mechanics*, Universitat Autònoma de Barcelona.

☐ Scientific activities

Scientific activities organised

• Member of Scientific and Organizing Committee of the Workshop: *Discontinuous Galerkin Methods for Partial Differential Equations*, Archimedes Center for Modeling, Analysis & Computation (ACMAC), Heraklion, September 2011.
• Member of Scientific Committee of the International Conference: *Numerical Methods for Hyperbolic Equations: Theory and Applications*, Santiago de Compostela, July 4–8, 2011.
• Organiser of the session *Finite volume and discontinous Galerkin schemes for stiff source term problems*, Numerical Methods for Hyperbolic Equations: Theory and Applications, Santiago de Compostela, 2011 (10 speakers).
• *Theory and Application of Adaptive and Multilevel Methods* at DD20, USA, 2011 (16 speakers). Co-organizers: B. Ayuso, Long Chen, Jun Hu, Ludmil Zikatanov.
• *Domain Decomposition for Discontinuous Galerkin Methods*, at DD20, USA, 2011 (4 speakers). Co-organizer: B. Ayuso, S.C. Brenner.

Participation in scientific activities

Plenary Lectures

• *Solvers for Interior Penalty Discontinuous Galerkin Methods*, Workshop on Algebraic Multigrid Methods (ChinaMG2011), Kunming, August 1st-10th, 2011.

Invited Lectures

• *Subspace Correction Methods for Interior Penalty discretizations of Linear Elasticity*, invited talk in Minisymposia: Discontinuous Galerkin methods for Partial Differential equations at ICIAM 2011, Vancouver, July 18th-22nd, 2011.
• *Schwarz methods for a WOPSIP method*, invited talk in Minisymposia: Fast Solvers for Discontinuous Galerkin methods at ICIAM 2011, Vancouver, July 18th-22nd, 2011.
• *Discontinuous Galerkin Methods for the Vlasov-Poisson system*, invited talk in ICIAM-Satellite Meeting-Workshop: Applied Mathematics Perspectives: Numerical Methods for Incompressible Flow, University of British Columbia, Vancouver, July 14th-16th, 2011.

• *Multilevel Methods for Discontinuous Gakerkin discretizations of problems with jump coefficients*, Invited talk in Minisymposia: Robust multigrid, multilevel and multiscale, deterministic and stochastic methods for modeling highly heterogeneous media, International Conference on Large Scale Scientific Computing, LSSC 11, Sozopol, June 6th-10th, 2011.
• *Multilevel Methods for Discontinuous Gakerkin discretizations of problems with jump coefficients*, Invited talk in Minisymposia: Domain Decomposition methods for discontinuous Galerkin discretizations at the 20th International Conference on Domain Decomposition Methods DD20, San Diego, February 7th-11st, 2011.

Communications in conferences

• On the L^2-*optimality for non-symmetric IP DG methods for elliptic problems*, Finite Element Fair-Finite Element Circus-Finite Element Rodeo, University of Chicago, Paris, June 2011.

Seminars

• *Fast Solvers for Discontinuous Galerkin Methods*, Scientific Computing Seminar, University of Science and Technology of China, Hefei, August 18th, 2011.
• *Preconditioning Interior Penalty Discontinuous Galerkin methods*, Scientific Computing Seminar, Universitat Politècnica de Catalunya, Barcelona, February 25th, 2011.

Research stays

• September–October 2011: Invited Researcher at Archimedes Center for Modeling, Analysis & Computation (ACMAC), Heraklion, Crete, (3 weeks).
• August 2011: Visiting Research Scholar at University of Science and Technology of China, Hefei, (10 days).
• May 2011: Invited Researcher at Instituto de Matematica Applicata e Tecnologie Informatiche del C.N.R., IMATI-CNR, Pavia (2.5 weeks).

Report by Álvaro Corral

I have been working in several topics. In collaboration with Antonio Turiel, from the Institut de Ciències del Mar, we have studied the laws of energy dissipation of hurricanes in the Atlantic; as a previous step, we have reviewed the previous literature related to global warming. Together with Eugenio Lippiello and Lucilla de Arcangelis, from the Second University of Naples, I have been looking at the factors that influence the probability distribution of the interevent times of earthquakes.

In a completely different topic, I have analyzed the differences between the use of words or lemmata as the building blocks of texts and their influence on Zipf's law, jointly with Ramon Ferrer i Cancho and Gemma Boleda, from the Universitat Politècnica de Catalunya. Still in a different but related area, an analogy to Zipf's law has been obtained for the timbral descriptors of music and speech, from work performed with Martín Haro, Joan Serrà, and Perfecto Herrera, from the Universitat Pompeu Fabra. We have also developed statistical tests to fit and evaluate the goodness-of-fit for discrete power-law distributions.

I have also co-organised at IEC the first meeting of Spanish researchers working in complexity and nonlinear geoscience and I have been involved in the network complexitat.cat.

☐ Publications

Articles

• A. Corral, F. Font and J. Camacho, *Non-characteristic Half-lives in Radioactive Decay*, Phys. Rev. E 83, 066103 (2011).

Preprints

• A. Corral and A. Turiel, *Variability of North Atlantic Hurricanes: Seasonal versus Individual-event Features*, submitted (2011).
• M. Haro, J. Serrà, P. Herrera and A. Corral, *Zipf's Law in Short-time Timbral Codings of Speech, Music, and Environmental Sound Signals*, submitted (2011).
• *M. Haro, J. Serrà, A. Corral and P. Herrera, Power-Law Distribution in Encoded MFCC Frames of Speech, Music, and Environmental Sound Signals*, submitted (2011).

Others

• A. Corral, *Hurricanes as Weatherquakes and their Response to Climate Change*, Notices of the American Mathematical Society 58 (6), 767 (2011).

☐ Research projects

• *Complexity and Scaling Laws in Meteorological Phenomena, Natural Disasters and Human Language*, FIS2009-09508. From 2010 to 2012. Principal investigator: Álvaro Corral.
• *Consolidated Research Group on Statistical Physics*, 2009SGR-164. From 2009 to 2012. Principal investigator: David Jou i Mirabent.

☐ Activity in research training

Supervision of research students

• Anna Deluca Silberberg, PhD student (CRM).
• Francesc Font Clos, PhD student (CRM).

☐ Diffusion activity

• Appearance in the blog *Planet 3.0*, by Michael Tobis, presentation at AGU meeting designed as "best presentation I saw in person at AGU". Video available at http://vimeo.com/33327335.

☐ Teaching activity

• Estadística (teoria), Llicenciatura de Química, UAB, Febrer–Juny 2011.

☐ Scientific activities

Scientific activities organised

• Organizer and member of the Scientific Committee of the *Jornada Complejidad y nolinealidad en geociencia*, October 2011.
• Member of the Scientific Committee of the Catalan Network on Complex Systems, complexitat.cat.
• Member of the Scientific Committee of the International Course of Mathematical Models in Seismology, SeismMath. L'Aquila, June 2011.

Participation in scientific activities

Invited lectures in conferences

• A. Corral, A. Ossó and J.E. Llebot, *Power Law and Scaling in the Energy of Tropical Cyclones*, European Geosciences Union General Assembly, Vienna, April, 2011.
• A. Corral, *Complex Statistical Features of Earthquakes and Other Natural Hazards,* Math & Earth, Zaragoza, June, 2011.

• A. Corral, *Criticality and Self-organization in Atmospheric Processes*, American Geophysical Union Fall Meeting, San Francisco, December, 2011.

Communications in conferences

• A. Deluca, O. Peters, A. Corral, J.D. Neelin and C.E. Holloway, *Universality of Rain Event Size Distributions*, European Geosciences Union General Assembly, Vienna, April 2011.
• A. Corral, A. Ossó and J.E. Llebot, *Leyes de potencia y leyes de escala en la distribución de energía de los huracanes*, XVII Congreso de Física Estadística, FisEs 2011, Barcelona, June 2011.
• A. Deluca, O. Peters, A. Corral, J.D. Neelin and C.E. Holloway, *Universality of Rain Event Size Distributions*, XVII Congreso de Física Estaddística, FisEs 2011, Barcelona, June 2011.
• A. Corral, A. Ossó and J.E. Llebot, *Survival and Energy Dissipated by Tropical Cyclones*, Fourth International Symposium Bifurcations and Instabilities in Fluid Dynamics, Barcelona, June 2011.
• A. Deluca, O. Peters, J.D. Neelin, C.E. Holloway and A. Corral, *Universality of rain event size distributions*, International Summer School and Research Workshop on Complexity, Istambul, September 2011.
• A. Corral, *Convección atmosférica: criticidad o caos?*, Complejidad y nolinealidad en geociencia, Barcelona, October 2011.
• A. Deluca, A. Corral and N. Moloney, *Analysis of the Predictability of Local Rain Records from Different Climates*, American Geophysical Union Fall Meeting, San Francisco, December, 2011.

Seminars

• A. Corral, Energy *Dissipation of Hurricanes: Influence of Ocean Warming and Criticality*, Institut Català de Ciències del Clima, Barcelona, July 2011.

☐ ***Other***

• 2011 Lorenz Lecturer, AGU Fall Meeting, San Francisco, December 2011.

Report by Tim Myers

This year the major focus of the group has shifted towards applying mathematics to nanotechnology. In particular I have worked on a new theory to explain why fluid flow in carbon nanotubes is much faster than expected through classical theory. In December I organised a conference at the CRM on nanofluids, leading to collaboration with an experimental/numerical group in the UK that will be continued by a more comprehensive meeting, Nanomath, to be held in CRM in 2012. Together with Francesc Font we have investigated the melting of nanoparticles: our work indicates that existing mathematical models do not fully capture the observed physical behavior.

In a completely different area, I carried out a careful study of the motion of an inflight soccer ball for a South African premiership team. I also worked on approximate solution methods for phase change and heat flow and contributed to the book "European Success Stories in Industrial Mathematics".

☐ *Publications*

Articles

- T.G. Myers, *Why are slip lengths so large in carbon nanotubes?*, Microfluidics and Nanofluidics 10 (5), 1141–1145 (2011).
- T.G. Myers and J. Low, *An approximate mathematical model for solidification of a flowing liquid in a microchannel*, Microfluidics and Nanofluidics 11 (4), 417–428 (2011).
- T.G. Myers and S.L. Mitchell, *Application of the Combined Integral Method to Stefan problems*, Appl. Math. Modelling 35 (9), 4281–4294 (2011).

Preprints

- T.G. Myers and S.L. Mitchell, *A mathematical analysis of the three-dimensional motion of an inflight soccer ball*, submitted to Sports Engineering (2011).
- M.M. MacDevette and T.G. Myers, *Contact melting of a three-dimensional phase change material on a flat substrate*, submitted to Int. J. Heat Mass Trans. (2011).
- L.J. Cummings, J. Low and T.G. Myers, *Extensional flow of nematic liquid crystal under electric field gradient*, submitted to Euro. J. Appl. Math. (2011).
- S.L. Mitchell and T.G. Myers, *Improving the accuracy of heat balance integral methods applied to thermal problems*, preprint (2011).
- T.G. Myers, *An approximate solution method for boundary layer flow of a power law fluid over a flat plate*, preprint (2011).
- T.G. Myers and S.L. Mitchell, *Application of the combined integral method to Stefan problems*, preprint (2011).

Books or book chapters

- T.G. Myers, *Aircraft icing, in European Success Stories in Industrial Mathematics* (ISBN 978-3-642-23847-5).

Conference proceedings

- T.G. Myers, M.M. MacDevette and F. Font and J. Low, *Modelling solidification and melting with a flowing liquid layer*, Transfer and Industrial Mathematics: proceedings of the RSME Conference on Transfer and Industrial Mathematics, Universidade de Santiago de Compostela (2011).
- M.M. MacDevette and T.G. Myers, *Contact melting of a three-dimensional phase change material on a flat substrate*, Transfer and Industrial Mathematics: proceedings of the RSME Conference on Transfer and Industrial Mathematics, Universidade de Santiago de Compostela (2011).
- F. Font, T.G. Myers and J. Low, *Microfluidic phase change valves*, Transfer and Industrial Mathematics: proceedings of the RSME Conference on Transfer and Industrial Mathematics, Universidade de Santiago de Compostela (2011).

☐ *Research projects*

- *Industrial applications of moving boundary problems*, PIRG06-GA-2009-256417. From 2010 to 2013. Principal investigator: Tim G. Myers.
- *Problemas de frontera móvil en presencia de capas líquidas*, MTM2010-17162. 2011. Principal investigator: Tim G. Myers.
- *Grup de Recerca Consolidat en Equacions en Derivades Parcials i Aplicacions de la UAB-UPC-UdG*, within the Pla de Recerca de Catalunya (2009-2013), 2009SGR345. From 2009 to 2013. Principal investigator:

José Antonio Carrillo de la Plata, UAB.

☐ ***Activity in research training***

• Master's projects (registered at U. Politècnica de Catalunya): 1. Michelle MacDevette (finished Feb. 2011) *Methods for solving 1D Stefan problems with application to contact melting*. 2. Vicent Ribas Ripoll (started Nov. 2011) *Assessment of Blood Pressure by means of the Baroreflex Model and Machine Learning Techniques*. 3. Anna Sáez de Tejada (started Nov. 2011) *A mathematical model of blood pressure*.
• PhD projects (registered at Universitat Politècnica de Catalunya): 1. Michelle MacDevette, *Mathematical modelling of the convective transport and thermal properties of nanofluids*, started Feb 2011. 2. Francesc Font Martinez, *Beyond the classical Stefan problem*, started Sept. 2010.
• Post-doc: Jonathan Low. March 2010 – Feb 2012.

☐ ***Diffusion activity***

• Tim Myers, *Un campeón matemático: Puedo resolver problemas mientras acuno a mi hijo*. Back page El Periódico, 8th June 2011.

☐ ***Teaching activity***

• T.G. Myers and J. Solà-Morales, Mathematical Modelling with Partial Differential Equations, Course in the Master of Science in applied Mathematics and Mathematical Engyneery, Universitat Politècnica de Catalunya, Sept-Dec, 2011, as Professor Associat, see course's page at https://www.fme.upc.edu/.

☐ ***Scientific activities***

Scientific activities organised

• Main organiser Grups D'Estudi Matemàtica i Tecnologia, Workshop on Nanofluids, CRM Dec 2011.
• Main organiser Industrial Mathematics Thematic Network seminar series
• Founder of CRM Industrial maths seminar series; then Industrial and Biological maths and now CRM Applied Maths and Physics seminars.

Participation in scientific activities

Invited lectures in conferences

• T.G. Myers, *Modelling solidification and melting with a flowing liquid layer*, RSME Conference on Transfer and Industrial Mathematics, Universidade de Santiago de Compostela, July 2011.
• T.G. Myers, 8th South African Mathematics in Industry Study Group, Univ. of Witwatersrand, January 2011.

Communications in conferences

• T.G. Myers, *Modelling solidification and melting with a flowing liquid layer*, International Conference on Industrial and Applied Mathematics, Vancouver, July 2011.
• F. Font, T.G. Myers and J. Low, *Microfluidic phase change valves*, International Conference on Industrial and Applied Mathematics, Vancouver, July 2011.
• M. MacDevette and T.G. Myers, *3D Contact melting*, International Conference on Industrial and Applied Mathematics, Vancouver, July 2011.
• T.G. Myers, *Enhanced flow in carbon nanotubes*, International Conference on Industrial and Applied Mathematics, Vancouver, July 2011.
• T.G. Myers, *How to choose your ball*, International Conference on Industrial and Applied Mathematics, Vancouver, July 2011.

Seminars

• T.G. Myers, *Mathematics in Everyday Life: from Footballs to Nanotubes*, sessions del Ateneo del CPS, Zaragoza, April 2011.
• T.G. Myers, *Does the football really matter?*, Institut d'Estudis Catalans, Barcelona, April 2011.
• T.G. Myers, From football to carbon nanotubes: *Practical applied mathematics*, Dept. of Civil Engineering, University of Leeds, October 2011.
• T.G. Myers, *Industrial mathematics research at the CRM and mathematical modelling of flow and phase change in micro and nano channels*, Dept. of Physics, Universitat Autònoma de Barcelona, March 2011.
• T.G. Myers, *Which of my balls should I play with?*, CRM Applied Maths and Physics, Centre de Recerca Matemàtica, March 2011.

☐ ***Other***

• Council member (stand-in for J. Carrillo), European Consortium for Mathematics in Industry.
• Member of Scientific Committee for European Consortium for Mathematics in Industry conference, Lund 2012.
• External examiner, University of Limerick applied mathematics undergraduate courses, 2011-2013.
• PhD examiner: Dept. of Mathematics, University of Limerick, Nov. 2011. LACAN, Universitat Politècnica de Catalunya, Feb 2011.
• Successfully applied for Acreditació de recerca avançada with the Agència per a la Qualitat del Sistema Universitari de Catalunya. This translates to a classification as Full Research Professor within the Catalan system.

Report by
Sergey Tikhonov

In 2011, I continued my research in Harmonic Analysis and Approximation Theory. More specifically, I have been studying the following four topics:

1. Weighted inequalities for the integral transforms (Fourier, Hankel, Mehler-Fock, Fourier-type, Hilbert). Here I have obtained two-sided weighted Fourier inequalities for the Muckenhoupt weights. Also, we found a characterization of the two power-weight $(L^p(\mathrm{u}), L^q(\mathrm{v}))$ *norm inequalities for the Hilbert transform on the cones of monotone functions in the case* $0 < p \le q < \infty$.

2. Approximation inequalities (Bernstein, Remez, Landau). I studied the sharp Remez and Nikol'skii inequalities, and weighted Landau and Bernstein's inequalities.

3. Sharp inequalities for moduli of smoothness (mostly, inequalities in different metrics). I continued the investigation of sharp interrelations between moduli of smoothness. In particular, we proved (p, q)*-inequalities of Ulyanov type for moduli of smoothness of fractional order in the* $L^p(T)$ *and the* $L^p(R^n)$ *setting,* $p \ge 1$. *We obtained estimates for the modulus of smoothness of a generalized Liouville derivative of a function via the modulus of smoothness of the function itself.*

4. Moduli of smoothness and growth properties of Fourier transforms (two-sided estimates). Here we obtained two-sided inequalities between the integral moduli of smoothness of a function on R^d/T^d *and the weighted tail-type integrals of its Fourier transform/series. Sharpness of obtained results in particular is given by the equivalence results for functions satisfying certain regular conditions. Applications include a quantitative form of the Riemann-Lebesgue lemma as well as several other questions in approximation theory and the theory of function spaces.*

☐ *Publications*

Articles

- D. Gorbachev, E. Liflyand, S. Tikhonov, *Weighted Fourier Inequalities: Boas conjecture in* $\mathbb{R}^n$, J. d'Analyse Math. 114, 99–120 (2011).
- E. Liflyand, S. Tikhonov, *A concept of general monotonicity and applications*, Math. Nachr. 284, 1083–1098 (2011).
- E. Liflyand, S. Tikhonov, M. Zeltser, *Convolution inequalities in Lorentz spaces*, Jour. Math. Anal. Appl. 377, 194–206 (2011).
- E. Nursultanov, S. Tikhonov, *Net spaces and boundedness of integral operators*, J. of Geometric Analysis 21, 950–981 (2011).
- E. Nursultanov, S. Tikhonov, *Convolution Inequalities in Lorentz Spaces*, J. Fourier Anal. Appl. 17, 486–505 (2011).
- V. Stepanov, S. Tikhonov, *Two power-weight inequalities for the Hilbert transform on the cones of monotone functions*, Complex Variables and Elliptic Equations 56, 1039–1047 (2011).
- V. Stepanov, S. Tikhonov, *Two-weight inequalities for the Hilbert transform of monotone functions*, Doklady Mathematics 437, 606–608 (2011).
- S. Tikhonov, W. Trebels, *Ulyanov inequalities and generalized Liouville derivatives*, Proc. Roy. Soc. Edinburgh Sect. A 141, 205–224 (2011).

Preprints

- E. Liflyand, S. Tikhonov, *Two-sided weighted Fourier inequalities*, to appear in Annali della Scuola Normale Superiore. Classe di Scienze. (2011).
- H. Mhaskar, S. Tikhonov, *Wiener type theorems for Jacobi series with non-negative coefficients*, to appear in Proc. Amer. Math. Soc. (2011).
- E. Nursultanov, S. Tikhonov, *A sharp Remez inequality for trigonometric polynomials*, CRM Preprint 1045 (2011).

☐ *Research projects*

- *Análisis Armónico, Teoría de Aproximación y Problemas Extremales*, MTM 2011-27637. From 2011 to 2013. Principal investigator: Sergey Tikhonov.
- *Boas conjecture and summability properties of integral transforms of Fourier type*, ESF-3964. 2011. Principal investigator: Sergey Tikhonov.
- *Grup de Teoria de Funcions de la UB/UAB*, Generalitat de Catalunya, Support to research groups of quality, type B, 2009SGR-1303. From Sept. 1, 2009 to Sept. 1, 2013. Principal investigator: C. Cascante.
- *UAB Analysis group*; Diversos Aspectos de la Teoría de Funciones y Aplicaciones, Ministerio de Ciencia e Innovación Grant, Spain, MTM2008-05561-C02-02. From Jan. 1, 2009 to Jan. 31, 2011. Principal investigator: J. Carmona.

☐ *Activity in research training*

- PhD: Ainur Jumabayeva (doctorate student at the UAB, partially supported by CRM)
- Research Fellow: Petr Chunaev (doctorate student, scientific training at the CRM).
- Post-Doc: Andrii Bondarenko (Beatriu de Pinós, post-doc supported by the Catalan Goverment).
- Post-Doc: Polina Glazyrina (CRM Post-Doc, supported by the CRM).
- Main organizer of the Research programme "Approximation Theory and

☐ *Scientific activities*

Scientific activities organised

Fourier Analysis" in the Centre de Recerca Matemàtica, September 2011-February 2012.

• Main organizer of the ICREA Conference on Approximation Theory and Fourier Analysis, December 12–16, 2011.

• Main organizer of the Advanced Course on Approximation Theory, November 7–11, 2011.

• Main organizer of the International Conference on Function Spaces, Weights and Variable Exponent Analysis, September 26–30, 2011.

• Organizer of the Session "Approximation Theory and Fourier Analysis" at the 8th International ISAAC congress (International Society for Analysis, Applications and Computations), Moscow, August 22–27, 2011.

Participation in scientific activities

Courses delivered

• Advanced Course on Constructive Approximation and Harmonic Analysis, Advanced Courses. CRM, March, 2011.

Communications in conferences

• S. Tikhonov, *Moduli of smoothness and growth properties of Fourier transforms*, ISAAC congress, Moscow, August 22-27, 2011.

• S. Tikhonov, *Fourier transforms and smoothness*, International Conference on Function Spaces, Weights and Variable Exponent Analysis, CRM, September 26-30, 2011.

Seminars

• S. Tikhonov, *Weighted Fourier inequalities*, Besov/Nikolskii Seminar, Steklov Mathematical Institute, Moscow.

• S. Tikhonov, *Fourier transforms and general monotonicity*, Analysis Seminar, Steklov Mathematical Institute, Moscow.

Research stays

• Department of Mathematics, Bar-Ilan University, Ramat-Gan, Israel. April 15–April 26, 2011.

☐ *Other*

• Selected as Number 1 in the area of Mathematics in the Ramón y Cajal programme of MCyT.

• Member of Editorial board, Bulletin of Mathematical Analysis and Applications.

• Member of International Society for Analysis, its Applications, and Computation.

Report by
Laurent Meersseman

My research activity shapes up around three themes: complex geometry, toric topology, and theory of deformations. The objects I consider are compact complex manifolds and their generalizations, such as holomorphic foliations, foliations by complex leaves and CR-structures. My main actual goal is to construct local moduli spaces for some of these geometric structures, keeping in mind the Kuranishi's space of a compact complex manifold as a prototype. Theories involved to attain this objective are classical deformation theory of Kodaira-Spencer and Kuranishi, Donaldson's construction of moduli spaces in differential geometry as well as basics of foliation theory and several complex variables.

☐ *Publications*

Articles

• L. Meersseman, *Foliated Structure of The Kuranishi Space and Isomorphism of Deformation Families of Compact Complex Manifolds*, Ann. Sci. de l'École Norm. Sup. 44, fasc. 3, 495–525 (2011).

☐ *Research projects*

• *COMPLEXE*, ANR-08-JCJC-0130-01. From 2008 to 2011. Principal investigator: Laurent Meersseman.

☐ *Scientific activities*

Scientific activities organised

• Co-organizer of the Congress "Complex Geometry and Uniformization" (with F. Bosio, S. Dumitrescu and A. Glutsyuk) held at CIRM (Luminy), October 17–21, 2011.

• Co-organizer of the Workshop "Géométrie et Dynamique Complexe" (with S. Dumitrescu) held at Nice, November 30–December 2, 2011. (math.u-bourgogne.fr/IMB/dubouloz/ANR-Cplx/Nice/).

Report by
Andrii Bondarenko

My research mainly focuses on the investigation of optimal configurations on the sphere applying methods of Approximation Theory, Harmonic Analysis and Discrete Mathematics. This includes spherical designs, optimal codes, best packing, energy minimization and other topics related to them. I work on both asymptotic and exact problems. Recently, we have proved the well-known conjecture of Korevaar and Meyers on existence of spherical designs with small cardinalities. I am also interested in different questions in Approximation Theory, Harmonic Analysis, and Graph Theory.

☐ Publications

Preprints

- A. Bondarenko, D. Hardin, and E. Saff, *Minimal N-Point Diameters and f-Best-Packing Constants in $\mathbb{R}^d$*, to appear in *Proceedings American Mathematical Society* (2011).
- A. Bondarenko, D. Leviatan, and A. Prymak, *Pointwise Estimates for 3-monotone Approximation*, to appear in *Journal of Approximation Theory* (2011).
- A. Bondarenko, D. Gorbachov, *Minimal weighted 4-designs on the sphere S2*, to appear in *Mathematical Notes* (2011).
- A. Bondarenko, D. Radchenko, and M. Viazovska, *On optimal asymptotic bounds for spherical designs, submitted to Annals of Math.* (Mar 10, 2011).

☐ Research projects

- Ministerio de Ciencia e Innovación grant MTM2011-2763 (for more detailed information see the report of S. Tikhonov).

☐ Scientific activities

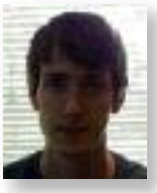
Participation in Scientific activities

Communications in conferences

- A. Bondarenko, *Proof of the Korevaar-Meyers conjecture for spherical designs*, II Jaén Conference on Approximation Theory, Jaén, June 26–July 1, 2011.
- A. Bondarenko, *Proof of the Korevaar-Meyers conjecture for spherical designs*, 8th International ISAAC Congress, Moscow, August 22–27, 2011.
- A. Bondarenko, *Proof of the Korevaar-Meyers conjecture for spherical designs*, ICREA Conference on Approximation Theory and Fourier Analysis, CRM, Barcelona, December 12–16, 2011.

Research stays

Department of Mathematical Analysis, National Taras Shevchenko University, Kyiv, Jan 1–11, Apr 5–13, Jul 15–31, Dec 20–31, 2011.
Max-Planck Institute for Mathematics, Bonn, Feb 17–21, 2011.
Department of Mathematics, Vanderbilt University, Nashville, Oct 9–Nov 6, 2011.



Report by
Sébastien Bubeck

From January 2011 to May 2011 I have been focusing on a new hypothesis problem, inspired by a recent line of work on multiple hypothesis testing. The setting is the following: given n data points, can you tell if k of them are correlated? A more precise formulation can be proposed in the Gaussian case. This work has been done with Ery Arias-Castro and Gabor Lugosi. It resulted in a submission of a journal paper at the Annals of Statistics. From May 2011 to September 2011 I worked with Nicolo Cesa-Bianchi and Gabor Lugosi on a multi-armed bandits survey for the journal Foundations and Trends in Machine Learning. This project raised a number of new questions. We solved one of them and the corresponding paper is in preparation. In addition to these projects I also worked on three other topics:

1. A combinatorial point of view on the popular L1 regularization technique in Statistics (known as LASSO). Joint work with Gabor Lugosi.

2. A new algorithm which combines the best known strategies for adversarial and stochastic multi-armed bandits. Joint work with Aleksanders Slivkins.

3. A new multi-armed bandit setting, called Good-Turing Bandits. Joint work with A. Garivier.

☐ *Publications*

Preprints

- S. Bubeck and A. Slivkins, *The best of both worlds: an adaptive strategy for stochastic and adversarial multi-armed bandits*, preprint (2011).
- S. Bubeck and A. Garivier, *Good-Turing Bandits*, preprint (2011).
- E. Arias-Castro, S. Bubeck and G. Lugosi, *Detection of correlation*, preprint (2011).

Conference proceedings

- J.Y. Audibert, S. Bubeck and G. Lugosi, *Minimax policies for combinatorial prediction games*, Proceedings of COLT 2011, Microtome Publishing (2011).

☐ *Scientific activities*

Participation in Scientific activities

Communications in conferences

- S. Bubeck, *New (and old) estimators for the mean*, Dagstuhl Workshop, Wadern, July 19, 2011.
- J.Y. Audibert, S. Bubeck and G. Lugosi, *Minimax Policies for Combinatorial Prediction Games*, COLT (Conference on Learning Theory), Budapest, July 11, 2011.
- S. Bubeck, *Exposés des prix de thèse SPECIF*, Congrès SPECIF (French conference on computer science), Grénoble, February 3, 2011.

Report by
Pilar Guerrero

I joined on January 1, 2011, the Computational and Mathematical Biology Group at the Centre de Recerca Matemàtica as a post-doctoral fellow under the supervision of Tomás Alarcón.

This year we worked on the formulation, analysis and stochastic simulation models focused on multiscale tumor growth. More specifically we have made a study of population dynamics involving issues such as competition between normal and malignant cells in cancer for space and resources, the interaction between immune cells and infected cells in viral infections and the development of drug resistance. The aim of this work is to illustrate how the concepts and techniques of mathematical population dynamics can be used to treat and further on a number of important issues in biomedical contexts.

In order to formulate the stochastic model of the intracellular level, in particular, the coupling between oxygen levels and extra-cellular progression through the cell cycle, we have reformulated our model as a Markov process in terms of a master equation. The resulting model, a continuity equation for multidimensional, probability density will be analyzed using the WKB asymptotic methods, i.e., large population. An alternative approach is to treat the progression through the cell cycle and other intracellular processes as the problems' first step.

This (sub) model will provide the rate of cell proliferation as a function of extracellular oxygen. This information will be used within the cellular level as a parameter (i.e., the birth rate of oxygen-dependent) in the master equation describing the dynamics of the cellular phase.

A mathematical model of a population of different types of individuals will track the evolution in time and space, the number or density of each species according to a set of parameters: (birth and death rates metabolic, mutation rates, ...).

During this year I have collaborated in organizing the seminar "The CRM Applied Mathematical and Physics (CAMP) Seminars" held at the CRM. I participated with a poster at the conference named "The Mathematical Frontiers in Life Sciences", University of Limerick. I presented a talk at the conference "Biomat 2011: Perspectives in Mathematics and Life Sciences" held at the University of Granada. I have also presented a talk on "Joves Investigadors Day" at the Institute of Catalan Studies. I also attended "Trobada d'EDPS i aplicacions: Girona 2011" and "Exploratory Workshop on Emerging Infectious Diseases and Mathematical Modelling" held at the CRM. I also stayed from December 19 to 23 at the Universidad de Granada invited by María J. Cáceres Granados.

This year CRM has allowed me to delve into the biological concepts and learn how to handle with ease specific techniques in the field of stochastic modeling and simulation. With this new knowledge I have gained and the good relationship with both my peers and my supervisor, I can face new professional challenges with confidence and investigations which I hope to contribute now.

☐ ***Research projects***

- Modelización y Análisis Matemático de Fenómenos No Lineales En Teoria Cinética de EDP's Con Origen En Biomedicina (Dinámica Tumoral y Vías De Señalización) y Astrofísica, P08-FQM-04267. From 2009 to 2012. Principal investigator: Juan Soler-Vizcaíno.
- Proyecto de excelencia, Junta de Andalucía. Biomat: Modelos Matemáticos En Vías De Señalización Originados En Dinámica Tumoral, Sistemas Complejos Multicelulares, Neurociencia Y Coagulación

Sanguínea, MTM2008-05271. From 2009 to 2011. Principal investigator: Juan Soler-Vizcaíno.

☐ *Scientific activities*

Scientific activities organised

• Co-organizer of The CRM Applied Mathematical and Physics (CAMP) seminars.

Participation in scientific activities

Communications in conferences

• P. Guerrero, *A nonlinear flux limited reaction-diffusion equation with applications in biology: analysis of travelling waves*, Biomat 2011: Perspectives in mathematics and Life Sciences, Granada, June 9, 2011.
• P. Guerrero, *A nonlinear flux limited reaction diffusion equation with applications in biology: analysis of travelling waves*, Mathematical Frontiers in the life Sciences, Limerick, July 3–5, 2011.
• P. Guerrero, *Stochastic multi-scale models of cell populations*, Jornada Joves Investigadors, Institut d'Estudis Catalans, Barcelona, October 14, 2011.

Research stays

Department of Mathematics, Granada University, Granada, Spain. December 19th–23rd, 2011.

Report by
José Manuel Higes

I study the broad area of Geometric Group Theory. The idea of Geometric Group Theory is to view groups as metric spaces in order to obtain properties invariant under the action of the group.

I study the relationship between the dimensions of a metric space and properties of some groups. There are many different types of dimensions and I have studied some of them this year.

At the beginning of the year I finished some results about Assouad-Nagata dimension. It is a linear type of dimension. In particular I finished completely the study of Assouad-Nagata dimension for general Lie groups and for free products of groups. This solved several open questions on Assouad-Nagata dimension.

Lately I focus my attention in spaces with infinite dimension. I studied the transfinite asymptotic dimension and the infinite coarse dimension. There is not much known about the transfinite asymptotic dimension. It is an infinite version of the asymptotic dimension that is a very important invariant in Geometric Group Theory. I proved a product theorem for transfinite asymptotic dimension. This result solved an open problem in the literature.

For the coarse dimension I proved that for countable groups the mayor coarse dimension is equal to the asymptotic dimension. It is a previous step to prove that the minor coarse dimension is equal to the asymptotic dimension that is a very important problem in Geometric Group Theory.

☐ ***Publications***

Preprints

• J. Higes and I. Peng, Assouad-Nagata dimension of connected Lie groups, to appear in Math. Zeitschrift (2011).
• N. Brodskyi and J. Higes, Assouad-Nagata dimension of tree-graded spaces, preprint (2011).

☐ ***Scientific activities***

Participation in Scientific activities

Invited lectures in conferences

• *J. Higes, Transfinite asympotic dimension as a decomposition game*, Israeli-Polish Mathematical Meeting, Lodz, September, 2011.

Seminars

• J. Higes, *Anti-Cech aproximations and infinite dimensional spaces*, Discrete Geometry Seminar, Freie Universität, Berlin.

Research stays

• *Departament of Mathematics, Freie Universitat*, Berlin, Germany. January 2011–October 2011.

Report by Gemma Huguet

My research projects have developed in the three lines I planned to work: computational neuroscience, Arnold diffusion and invariant objects. Next, I summarize the main accomplishments and the current status of the projects.

☐ *1. Computational Neuroscience.*

1.1. Type III excitability and coincidence detectors. With X. Meng (Maryland and China) and J. Rinzel (NYU) we worked on the modelization and mathematical analysis of single-cell models in the auditory system to understand the biophysical basis for sound localization, and more precisely the role of fast low threshold potassium currents in the neuronal mechanisms for coincidence detection in the Medial Temporal Olive (MSO). Partial results of this project have been published in the special issue dedicated to J. Guckenheimer at DCDS-A. We are currently exploring the role of other biophysical mechanisms in coincidence detection such as sodium inactivation.

1.2. Tristable perception in visual plaids. With J. Rinzel (NYU) I have worked in the modelization of the dynamics of visual alternations in ambiguous visual scenes to gain insights into the dynamics of perceptual multistability and their underlying neural mechanisms. Our model can account for the dynamical properties (transition probabilities, distributions of percept time durations, etc) observed in the experiments carried out with J.M. Hupé (CNRS, Toulouse) to whom we actively collaborate. Partial results of this project have been presented in several conferences (see conferences attended) and we are currently writing a paper.

☐ *2. Arnold diffusion.*

With A. Delshams we checked the conditions for the existence of Arnold diffusion for a classical example in the literature. Results were published in J. Diff. Equations.

☐ *3. Computation of invariant objects.*

3.1. Computation of invariant tori and whiskers. With R. de la Llave and Y. Sire we have developed fast numerical algorithms to compute whiskered and maximal invariant tori both primary and secondary as well as the associated whiskers. The paper has been accepted in DCDS-A.

3.2. A Newton method to compute the isochrons. With R. de la Llave we have developed a Newton method in the spirit of the ones developed in the previous project to compute the local approximation of the isochrons up to high orders that improves significantly the computation times. We have developed theoretical results and have carried out the numerical implementation of the algorithms. We are currently writing a paper with the results.

☐ Publications

Articles

• A. Delshams and G. Huguet, *A geometric mechanism of diffusion: Rigorous verification in a priori unstable Hamiltonian systems*, J. Differential Equations 250, 2601–2623 (2011).

Preprints

• G. Huguet, R. de la Llave and Y. Sire, *Computation of whiskered invariant tori and their associated manifolds: New fast algorithms*, to appear in Discrete Contin. Dyn. Syst. – Ser. A (2011).

• X. Meng, G. Huguet and J. Rinzel, *Type III excitability, slope sensitivity and coincidence detection*, to appear in Discrete Contin. Dyn. Syst. – Ser. A (2011).

☐ Research projects

• Grup de recerca consolidat *"Grup de Sistemes Dinàmics de la UPC"*, CIRIT 2009 SGR 859. From 2009 to 2013. Principal investigator: Amadeu Delshams.

• *Dinámica asociada a conexiones entre Objetos Invariantes, Astrodinámica*, Neurociencia y otras Aplicaciones, MCyT-FEDER MTM2009-06973. From 2010 to 2012. Principal investigator: Amadeu Delshams.

• *Dinámica, Atractores y Nolinealidad: Caos y Estabilidad*, Acción Complementaria MTM2009-06507-E. From 2010 to 2011. Principal investigator: Carmen Núñez (coordinator), Amadeu Delshams (co-coordinator UPC group).

☐ Activity in research training

• In Summer 2011 I co-mentored, with Professor John Rinzel, the master's student Xin Tian from the Biology Department at New York University for a summer project. Research topic: Study of excitability types in a two-compartment neuron model. Grade: A.

☐ Teaching activity

• Instructor. Courant Institute of Mathematical Sciences, New York University, New York. Instructing course Algebra and Calculus. Fall 2011.

☐ Scientific activities

Scientific activities organised

Participation in scientific activities

• Member of the Organizing Committee of the 15th general meeting of European Women in Mathematics (EWM) Centre de Recerca Matemàtica, Barcelona, September 2011.

Invited lectures in conferences

• G. Huguet, *Mathematical models in Neuroscience: Ambiguous visual stimuli and multistability*, Congreso de clausura del Proyecto i-MATH, CIEM, Castro Urdiales, September 2011.

Courses delivered

• Lectures at the New Directions Short Course: Invariant Objects in Dynamical Systems and their Applications. Institute for Mathematics and its Aplications (IMA), Minnesota, June 2011.

Communications in conferences

• G. Huguet and A. Guillamon, *A computational and geometric approach to transient PRCs*, New Developments in Dynamical Systems Arising from the Biosciences, MBI, Columbus, Ohio, March 22–26,2011.
• G.C. Garcia, G. Huguet and J. Rinzel, *The influence of stationary synaptic activity on the PRC*, Twentieth Annual Computational Neuroscience Meeting, Stockholm, July, 23–28, 2011.
• G. Huguet, J. M. Hupé and J. Rinzel, *A model for dynamical switching in tristable perception for visual plaids*, Sloan-Swartz Centers 2011 Annual Meeting, Janelia Farm, Ashburn, Virginia, July 11–14, 2011.
• G. Huguet, J. M. Hupé and J. Rinzel, *A model for dynamical switching in tristable perception for visual plaids*, Society for Neuroscience (SFN) Annual meeting, Washington DC, November 12–16 2011.
• X. Y. Meng, G. Huguet and J. Rinzel, *Type 3 excitability: Coincidence detection, par excellence*, Society for Neuroscience (SFN) Annual meeting, Washington DC, November 12–16, 2011.

Seminars

• G. Huguet, *Type III excitability, slope sensitivity and coincidence detection*, Joint Lab meeting Rinzel and Reyes lab, New York University.

Research stays

• *Institute for Mathematics and Its Applications*, Minnesota. June 15 – July 1, 2011.

Report by
Martin Koerwien

My work at the CRM is carried out in the framework of the Infinity Project whose goal is to find connections between distinct fields of mathematical logic. The two fields between which I attempt to find connections are model theory and set theory. The main focus was on investigating the absoluteness status of basic model theoretic properties for infinitary logic (specifically $L_{\omega_1,\omega}$) and Abstract Elementary Classes (AEC), introduced by S. Shelah. A property is absolute if it does not change its validity when we vary the set theoretiv universe (of ZFC) we work in, otherwise it is non-absolute. We focussed on the two properties of kappa-categoricity (having a unique model of cardinality kappa) and model existence in kappa (existence of a model of cardinality kappa).

The main result concerning categoricity was to define sufficient model theoretic properties for an AEC to have non-absolute $\aleph_1$-categoricity. More precisely we describe properties that imply $\aleph_1$-categoricity under Martin's Axiom at $\aleph_1$ which contrast well-known properties for having many model in $\aleph_1$ under the Weak Continuum Hypothesis (WCH). This work is based on prior work and examples of Saharon Shelah. Additionally, we show that consistently, a theory having those properties can be $\aleph_1$-categorical in a universe that fails Martin's Axiom at $\aleph_1$ and also consistently such a theory may have many models in $\aleph_1$ in a universe that fails WCH.

Concerning absoluteness of model existence which we investigated for sentences of $L_{\omega_1,\omega}$ we

found that model existence in $\aleph_1$ is absolute and we give examples of (incomplete) sentences with non-absolute model existence (relative to ZFC+GHC) in all cardinals $\aleph_\alpha$ for countable α except $\aleph = \omega$ which remains an open problem. Additionally we were able to construct a complete sentence with non-absolute model existence in $\aleph_3$ (relative to ZFC+GCH).

☐ Publications

Articles

• Sy-David Friedman and Martin Koerwien, *On Absoluteness of Categoricity in AEC's*, Notre Dame Journal of Formal Logic volume 52 (4), 395–402 (2011).

Preprints

• Sy-David Friedman, Tapani Hyttinen and Martin Koerwien, *The non- absoluteness of model existence in uncountable cardinals for* $L_{\omega 1,\omega}$, CRM preprint No. 1018 (2011).

☐ Scientific activities

Participation in scientific activities

Invited lectures in conferences

• M. Koerwien, *Absoluteness Considerations in* $L_{\omega 1,\omega}$, Infinity Conference, CRM, July 18–22, 2011.

Research stays

• *University of Maryland*, College Park. May, 2011.

Courses attended

• Recent Developments in Model Theory, Oléron, June 5–11, 2011.
• Logic Colloquium 2011, Barcelona, June 11–16, 2011.

Report by Nir Lev

My research is in the area of harmonic analysis, and concerns some problems on several subjects in this area: translation-invariant subspaces in function spaces, the uniqueness theory of trigonometric series expansions, sampling and interpolation of band-limited functions and Riesz bases of exponentials, and the theory of discrepancy and irregularities of distribution.

☐ Publications

Articles

• N. Lev and A. Olevskii, *Wiener's 'closure of translates' problem and Piatetski-Shapiro's uniqueness phenomenon*, Annals of Mathematics 174, 519–541 (2011).
• N. Lev, *Uniqueness theorems for Fourier transforms*, Bulletin des Sciences Mathématiques 135, 134–140 (2011).
• N. Lev and G. Kozma, *Exponential Riesz bases, discrepancy of irrational rotations and BMO*, Journal of Fourier Analysis and Applications 17, 879–898 (2011).

Preprints

• N. Lev, *Riesz bases of exponentials on multiband spectra*, to appear in Proceedings of the American Mathematical Society (2011).

☐ *Scientific activities*

Participation in scientific activities

Invited lectures in conferences

• N. Lev, *Sampling of multi-band signals and quasicrystals*, Workshop on Hilbert spaces of entire functions and spectral theory of self-adjoint differential operators, Centre de Recerca Matemàtica, May 30-June 4, 2011.

Report by Jonathan Low

My research has been in two areas of fluid mechanics: fluid flows in microchannels & fluid-boundary interaction in nanofluidics.

On microfluidics, the first part is deriving a mathematical model to simulate the flow and freezing process of a power-law fluid through a microchannel. We simulate the model for two power-law fluids, namely blood and polyethylene oxide. The conclusions are that, firstly, the flow rates of power-law fluids through the microchannel are many times higher than their Newtonian counterparts. Secondly, the shape of the solidification profiles for power-law fluids inside the channel are linear whereas they are generally flat and parallel to the channel wall for Newtonian fluids. The second part is solving the full model on fluid freezing in microchannels using computational fluid dynamics. We have developed bespoke finite-difference solvers in order to solve a test case scenario of water initially flowing freely in a channel with a cooler applied in the middle section of the channel to freeze the fluid. We are also looking into using a 'volume of fluids' method that is particular to solid-liquid phase change problems and adapting this to our model.

On nanofluidics, an investigation is carried out into the possible physical mechanisms that can explain the non-conventional property that, at the nano-scale, the fluid flow through a channel is many times faster than its counterpart at the macro-scale. An example is water flowing in carbon nanotubes. This research has mainly focused on looking at the interaction between the fluid particles and the wall boundary such as surface roughness and chemical properties. I have also assisted in validating continuum theories that attempt to model the increased flow rate in nanofluidics by matching test cases of continuum models to molecular dynamics data published elsewhere.

☐ *Publications*

Articles

• T.G. Myers and J. Low, *An approximate model for solidification of a flowing liquid in a microchannel*, Microfluid Nanofluid 11 (4), 417–428 (2011).

Preprints

• L. Cummings, T.G. Myers and J. Low, *Extensional flow of nematic liquid crystal under electric field gradient*, submitted to Eur J Appl Math (2011).

• J. Low and T. G. Myers, *Modelling the solidification of a power-law fluid flowing through a narrow pipe*, submitted to Int *J Therm Sci* (2011).

Scientific reports

• G. Chavez, S. Costa, M. De Decker, J. Low, E. Rodríguez and J. Rosado, *Bandwidth Consumption and Invoicing Models*, Grups d'Estudi de Matemàtica i Tecnologia (GEMT) 2010 (2011).

☐ Scientific activities

Scientific activities organised

• Co-organiser of the CRM Applied Mathematics and Physics, the weekly CRM seminar activity on topics in applied mathematics and physics, www.crm.cat/en/Activities/Pages/Research-Groups-seminars.aspx.

Participation in scientific activities

Communications in conferences

• J. Low, *Approximate mathematical model for solidification of a liquid in a microchannel*, British Applied Mathematics Colloquium, University of Birmingham, April, 11–14, 2011.

• J. Low, *Review of Activities within the CRM Industrial Mathematics Research group*, Trobada d'EDP's i Aplicacions, Universitat de Girona, June, 2-3, 2011.

Seminars

• J. Low, *Slippery Questions About Modelling Nano-Fluids*, CRM Applied Mathematics and Physics, Centre de Recerca Matemàtica.

Report by Vivek Mallick

Mirror symmetry is a very intriguing subject. Though it has its roots in physics, it has caught attention of mathematicians due to its prediction of Gromov-Witten invariants. Since then the subject evolved extensively and led to a few new fields and also a renewed interest in a few fields in algebraic geometry including complexified Kähler moduli space of Calabi-Yau threefolds, quantum cohomology, Givental's notion of quantum partial differential equations, Kontsevich's notion of a stable map.

Kontsevich's conjecture about mirror symmetry relates the derived category of coherent sheaves on an algebraic variety to a triangulated category constructed out of the Fukaya category of the dual pair. In the process of understanding the derived category, we got interested in the question of reconstructing a variety from its derived category. Paul Balmer's Spec construction is an important tool for the reconstruction. We studied the Spec construction more deeply and constructed the Spec of a few tensor triangulated categories coming from algebraic geometry. This work was done jointly with Dr. Umesh Dubey from Indian Institute of Mathematical Sciences.

Presently I am trying to prove results about mirror symmetry in a few open cases including an attempt to generalize Batyrev's work on toric varieties to T-varieties of complexity one. This is work in progress with Professor José Ignacio Burgos Gil, ICMAT Madrid, Professor Joan Carles Naranjo and Professor Martín Sombra of Universitat de Barcelona.

☐ Publications

Articles

• Umesh V. Dubey and Vivek M. Mallick, *Spectrum of some triangulated categories*, Electronic Research Announcements in Mathematical Sciences 18, 50–53 (2011).

Preprints

• Umesh V. Dubey and Vivek M. Mallick, *Reconstruction of Superschemes, submitted to J. of Ramanujan Mathematical Society* (2011).

☐ *Scientific activities*

Participation in scientific activities

Seminars

• V. Mallick. *Roitman's theorem for projective varieties in arbitrary characteristic*. Seminar Institut des Hautes Études Scientifiques, Bures-sur-Yvette. November 16, 2011.

Research stays

• *Indian Institute of Science Education and Research*, Mohali. December 15 – December 24, 2011.

Report by Moritz Müller

I have been a postdoc within the Infinity Project lead by Sy-David Friedman, for two years starting in September 2009, hosted at the CRM and supported by the John Templeton Foundation under Grant No. 13152, "The Myriad Aspects of Infinity".

☐ *Publications*

Articles

• Y. Chen, J. Flum, M. Mueller, *Lower bounds for kernelizations and other preprocessing procedures*, Theory of Computing Systems 48 (4), 803–839 (2011).
• S. Buss, Y. Chen, J. Flum, S.D. Friedman, M. Mueller, *Strong isomorphism reductions in complexity theory*, The Journal of Symbolic Logic 76, 1381-1402 (2011).
• Y. Chen, J. Flum, M. Mueller, *Consistency and optimality*, Proceedings of the 7th Computability in Europe (CiE), Springer LNCS 6735, 61–70 (2011).

Preprints

• A. Atserias, M. Mueller, *Partially definable forcing and bounded arithmetic*, CRM Preprint No. 1007 (2011).
• Y. Chen, J. Flum, M. Mueller, *On optimal probabilistic algorithms for SAT*, Preprint of the Department of Mathematics and Computer Science at the University Greifswald No. 6, 2010; CRM Preprint No. 1008 (2011).
• Y. Chen, J. Flum, M. Mueller, *Hard instances of algorithms and proof systems*, Electronic Colloquium on Computational Complexity (ECCC), TR11085; CRM Preprint No. 1024 (2011).

☐ *Scientific activities*

Participation in scientific activities

Invited lectures in conferences

• July 2011, invited talk on Partially Definable Forcing and Bounded Arithmetic at the Infinity Conference at the Centre de Recerca Matemàtica.

Communications in conferences

• June 2011, talk on Consistency and Optimality at Computability in Europe (CiE) in Sofia.
• February 2011, talk on Partially Definable Forcing at the annual meeting on Algorithmic Mode Theory (AlMoTh) at the University of Leipzig.

Courses attended

- July 2011, Infinity Conference, Centre de Recerca Matemàtica.
- July 2011, Workshop on Computability Theory 2011, part 2, Thematic Day in Computability at the Centre de Recerca Matemàtica.
- July 2011, Logic Colloquium, Barcelona.
- February 2011, Algorithmic Model Theory (AIMoTh) in Leipzig.

Report by
Radu Saghin

During the past year I did research in the area of Dynamical Systems. In particular, I studied together with Jaume Llibre to which extent the index of a fixed point of a smooth vector field or map is determined by the jet at that point. We obtained that for most (in some sense) vector fields, the index at a singularity is determined in fact by a finite jet. We also described some criteria which would help to find the jet determining the index, using quasi-homogeneous components and the Newton diagram. We wrote a paper in this subject which is published now in Journal of Differential Equations.

Also together with Jaume Llibre, we studied the analytic integrability of an ODE introduced by E.N. Lorenz in order to study some models coming from atmospherical sciences. We discovered that the system has exactly two independent analytic first integrals in the general case, and three in one degenerate case. We wrote a paper on this subject which is submitted to publication.

Together with Edson Vargas we studied the invariant measures of a specific kind of flows on surfaces, namely Cherry flows. We discovered a dichotomy, depending on the eigenvalues of the saddle of the flow. If the divergence at the saddle is smaller or equal to zero, then the flow has only two ergodic invariant measures, the Dirac measures at the two fixed points, and the one at the saddle is the physical measure (statistically most of the orbits spend most of the time near the saddle). In the case when the divergence at the saddle is strictly positive, we expect that there exists a third ergodic invariant measure supported on the quasi-minimal set, which is this time the physical measure of the system. Unfortunately we proved this fact only in some particular cases. We wrote a paper with these results, which is submitted and posted on arXiv.

During my stay at CRM I also completed a part of a study on the relationship between entropy, volume growth and Lyapunov exponents for C^1 partially hyperbolic diffeomorphisms. I proved an inequality which bounds the metric entropy of a partially hyperbolic diffeomorphism from above in terms of Lyapunov exponents and a specific kind of volume growth associated to the unstable foliation. From this result I obtained some interesting consequences about the entropy of partially hyperbolic diffeomorphisms when the dimension of the center bundle is one or two. Now the paper containing these results is finalized and posted on arXiv.

☐ *Publications*

Articles

- J. Llibre and R. Saghin, *The index of singularities of vector fields and finite jets*, Journal of Differential Equations 251, 2822–2832 (2011).
- J. Llibre and R. Saghin, *Topological entropy and periods for graph maps*, Journal of Difference Equations and Applications (on-line) (2011).

Preprints

- J. Llibre, R. Saghin and X. Zhang, On the analytic integrability of the 5-dimensional Lorenz system for the gravity-wave activity, submitted to Proc. of AMS (2011).

• R. Saghin and E. Vargas, *Invariant measures for Cherry flows*, submitted to Comm. Math. Phys. (2011).

☐ ***Research projects***

• *Smooth ergodic theory and partially hyperbolic diffeomorphisms*, Marie Curie Actions, European Union, IEF-234559. From 2009 to 2011. Principal investigator: Radu Saghin.

☐ ***Scientific activities***

Participation in scientific activities

Seminars

• R. Saghin, *Integrability of invariant distributions*, UB-UPC Dynamical systems seminar, Barcelona, February 2011.
• R. Saghin, *Integrability of invariant distributions*, Dynamical systems seminar, Univ. Paris Orsay, February 2011.
• R. Saghin, *The index of singularities of vector fields and finite jets*, Dynamical systems seminar, IME-USP, São Paulo, March 2011.
• R. Saghin, *The index of singularities of vector fields and finite jets*, Dynamical systems seminar, UAB, June 2011.

Research stays

• *IME-USP*, São Paulo. March 2011.
• *Northwestern University*, Evanston, IL. May 2011.

Courses attended

• RTNS Winter School in Dynamical Systems (DANCE). Vilanova i la Geltrú, January 2011.

Report by
Edgar Tchoundja

The purpose of our research was to investigate two topics in classical analysis: Hankel and Toeplitz operators. The stay was coinciding with the research programme "Complex analysis and related problems" that was held from January 10 to July 10, 2011 at the CRM. I got the opportunity to attend conferences and schools that have been organised within the above research programme. Thus, I learned about new topics in the areas of Hilbert spaces of entire spaces and have some new internationals contacts. I also pursue with my own research work which concern Toeplitz operator on Besov spaces and Hankel operators on Hardy-Orlicz spaces.

☐ ***Publications***

Preprints

• B. Sehba and E. Tchoundja, *Hankel operators with weighted Lipschitz symbols in the unit ball*, to appear in Math. Scand. (2011).
• B. Sehba and E. Tchoundja, *Hankel operators on Holomorphic Hardy-Orlicz spaces*, CRM Preprint No. 1020, to appear in Integral Equations and Operator Theory (2011).
• E. Tchoundja, *Toeplitz operators on holomorphic Besov spaces,* preprint (2011).

☐ *Scientific activities*

Participation in scientific activities

Communications in conferences

• E. Tchoundja, *Toeplitz operators on holomorphic Besov spaces*, Workshop on Hilbert Spaces of Entire Functions and Spectral Theory of Self-Adjoint Differential Operators, CRM, May 30 – June 04 , 2011.

Report by Marc Thurley

My research interests lie in the algorithmic and complexity theoretic aspects of constraint satisfaction problems (CSP). These problems form a general framework for formulating algorithmic problems. The goal in a constraint satisfaction problem is to assign values to given variables such that certain constraints are satisfied. A wide variety of problems can be formulated quite naturally in this way, for example, propositional satisfiability (SAT), graph colorability and planning problems. By its generality, constraint satisfaction is ubiquitous in several areas such as database theory and artificial intelligence. In complexity theory, the study of tractable cases of CSP is of prominent importance.

Following the proposal of my research project, my main aim in 2011 has been the study of the efficient approximability of counting problems in constraint satisfaction. The nature of the subject suggests at least two plausible approaches to this study, both of which have been considered. Firstly, the structural approach tries to identify different levels of computational hardness of CSPs by means of formal characterizations. In this direction I have been working on a combination of logical and algebraic characterizations. Secondly, following a more direct algorithmic approach, together with my coauthors, I have developed new algorithms to efficiently approximate CSPs. This work includes most importantly approximations of so-called Ising models which are important in statistical physics studies of phase transition phenomena.

☐ *Publications*

Preprints

• A. Sinclair, P. Srivastava, M. Thurley, *Approximation algorithms for two-state anti-ferromagnetic spin systems on bounded degree graphs*, to appear in Proceedings of the Twenty-Third Annual ACM-SIAM Symposium on Discrete Algorithms, SODA 2012 (2011).

• L. Moll, S. Tazari and M. Thurley, *Computing hypergraph width measures exactly*, to appear in Information Processing Letters 112 (6): 238-242 (2011).

• M. Thurley, *An Approximation Algorithm for #k-SAT*, to Appear in Proceedings of the 29th Symposium on Theoretical Aspects of Computer Science (STACS 2012) (2011).

Books or book chapters

• M. Grohe and M. Thurley, *Counting Homomorphisms and Partition Functions*, in Model Theoretic Methods in Finite Combinatorics, Contemporary Mathematics 558 (2011).

☐ *Research projects*

• *Algorithms and Complexity of Constraint Satisfaction Problems*, FP7-PEOPLE-2010-IEF-271959. From 2011 to 2012. Principal investigator: Marc Thurley.

2.2.4. Estudiants de doctorat

Mostrem a continuació l'activitat més rellevant dels estudiants de tesi dels grups de recerca del CRM.

2.2.4. PhD Students

Next we summarize the most relevant activity of the PhD students of the CRM research groups.

Anna Deluca

Albert Ferreiro

Francesc Font M.

Esther Ibáñez

Michelle MacDevette (Michelle De Decker)

Maite Naranjo

Luis Ortiz

Daniel Sánchez

☐ *Publications*

Articles

- Álvaro Corral, **F. Font Martínez** and Juan Camacho, *Non-characteristic half-lives in radioactive decay*, Phys. Rev. E 83, 066103 (2011).
- **A. Ferreiro-Castilla** and F. Utzet, *Lévy area for Gaussian processes: A double Wiener-Itô integral approach*, Statistics & Probability Letters 81 (9), 1380–1391 (2011).
- J.J. Masdemont and **L. Ortiz-Gracia**, *Haar wavelets-based approach for quantifying credit portfolio losses*, Quantitative Finance, DOI:10.1080/14697688.2011.595731 (2011).

Preprints

- **A. Ferreiro-Castilla** and W. Schoutens, *The β-Meixner model*, to appear in Journal of Computational and Applied Mathematics 236 (9), 2466–2476 (2012).
- **M.M. De Decker** and T.G Myers, *Contact melting of a three-dimensional phase change material on a flat substrate*, submitted to International Journal of Heat and Mass Transfer (2011).
- **L. Ortiz-Gracia** and J.J. Masdemont, *Credit risk contributions under the Vasicek one-factor model: a fast wavelet expansion approximation*, submitted to *Journal of Computational Finance* (2011).

Conference proceedings

- Mfanafikile Don Mhlongo, **F. Font Martínez**, Chandra Shekara G, Savina Joseph, Wei Liu, Ingrid Von Glehn, *The degradation and recovery of composite electrical insulators*, Report of the OCCAM 3rd Graduate Modelling Camp, University of Oxford (2011).

• F. Font Martínez, T. G. Myers and J. Low, *Microfluidic phase change valves*, Proceedings of the RSME Conference on Transfer and Industrial Mathematics, Publicacións Universidade de Santiago de Compostela (2011).
• T.G. Myers, M.M. De Decker, F. Font Martínez and J. Low, *Modelling solidification and melting with a flowing liquid layer*, Proceedings of the RSME Conference on Transfer and Industrial Mathematics, Publicacións Universidade de Santiago de Compostela (2011).
• M.M. De Decker and T.G. Myers, *3D Contact Melting*, Proceedings of the RSME, Conference on Transfer and Industrial Mathematics (2011).
• M.M. De Decker, V. Andrew, M. Hennessy, I. Ireka, J. Parker and Z. Wei, *Container-less solidification-modelling on the cusp*, Proceedings of the OCCAM modelling week (2011).
• M.M. De Decker, J. Herterich, T. Ristori, A. Kospach and J.M.G. Roldán, *Signal propagation in nonlinear optical fibers*, Proceedings of V Modelling Week, Universidad Complutense de Madrid (2011).

☐ *Activity in research training*

• L. Ortiz supervised the Master's Thesis *Semi-Analytical Implementation for the Name Concentration Measurement in a Credit Portfolio*, by Sandra Álvarez Jordan, Universitat Politècnica de Catalunya, 2011. Funded by La Caixa and the CRM.

☐ *Teaching activity*

• L. Ortiz was Assistant Professor (Professor Associat) (6 hours/week), at Universitat Autònoma de Barcelona, teaching on: *Eines Informàtiques per a les Matemàtiques*, from Feb. to September 2011, and *Laboratori de Probabilitats i Estadística*, from September to December 2011.

☐ *Scientific activities*

Scientific activities organised

• L. Ortiz promoted and co-ordinated a research seminar by Professor Cornelis W. Oosterlee, from *Delft University and Centrum Wiskunde and Informatica*, on *Efficient valuation methods for contracts in finance and insurance*, November 24, 2011.
• M. MacDevette started, organised and chaired the CRM PhD Seminar Series, from June to November 2011.

Participation in scientific activities

Communications in conferences

• A. Deluca, O. Peters, J. D. Neelin, C. Holloway, A. Corral, *Universality of rain event size distributions*, XVII Congreso de Física Estadística, FISES 2011, Barcelona, June 2 - 4, 2011.
• A. Deluca, O. Peters, J. D. Neelin, C. Holloway, A. Corral, *Universality of rain event size distributions*, Feza Gürsey Institute and Imperial College International Summer School and Research Workshop on Complexity, Istanbul, September 5 - 10, 2011.
• A. Deluca, N. Moloney, A. Corral, *Analysis of the predictability of local rain records from different climates*, AGU fall meeting 2011, San Francisco, December 5 - 9, 2011.
• A. Ferreiro-Castilla, F. Utzet, *CDS spreads valuation in meromorphic Lévy models*, Financial Engineering Summer School 2011, Barcelona, June, 14 - 17, 2011.

• M. MacDevette, *3D Contact Melting*, Jornadas Transfer and Industrial Mathematics, Universidade de Santiago de Compostela, 2011.
• M. MacDevette, *3D Contact Melting*, International Congress in Industrial and Applied Mathematics, University of British Columbia, Vancouver, 2011.

Seminars

• A. Deluca, *Universality of rain event sizes distributions*, Group seminar Nonlinear Dynamics and Time Series Analysis, Max Planck Institute for the Physics of Complex Systems, Dresden.
• F. Font Martínez, *Mathematical Model for Drug Delivery*, CRM PhD Students Seminar, CRM, March 19, 2011.
• F. Font Martínez, *Microfluidic Phase Change Valves*, CRM PhD Students Seminar, CRM, July 15, 2011.
• M. MacDevette, *3D contact melting.*, PhD seminar, CRM, 2011.
• M. MacDevette, *Container-less solidification: modelling on the cusp.*, PhD seminar, CRM, 2011.

Courses attended

• Santa Fe Institute Complex Systems Summer School. Santa Fe, Jun 7–Jul 2, 2011. (A. Deluca)
• International Summer School and Research Workshop on Complexity. Istanbul, Sep. 5–Sep. 10, 2011. (A. Deluca)
• Summer School on Statistical Physics of Complex and Small Systems. IFISIC, Mallorca, September 12–23, 2011. (A. Deluca)
• 80th European Study Groups with Industry. University of Cardi, April 2011. (F. Font Martnez, M. MacDevette)
• Trobada d'EDPs i Aplicacions. Universitat de Girona, June 2011. (F. Font Martínez)
• International Congress in Industrial and Applied Mathematics. Vancouver, July 2011 (with poster presentation). (F. Font Martínez)
• First joint CRM-VHIR workshop on mathematical modelling and Biomedicine: Enabling collaboration between mathematics anb biology. Hospital Universitari Vall d'Hebron, April 27, 2011. (E. Ibáñez)
• Biomat 2011, Perspectives in Mathematics and Life Sciences. Granada, June 6–8, 2011. (E. Ibáñez, D. Sánchez)
• Exploratory Workshop on Emerging Infectious Diseases and Mathematical Modelling. Barcelona, July 11–15, 2011. (E. Ibáñez, D. Sánchez)
• Segona Jornada SCM de Joves Investigadors en Matematiques. Barcelona, October 14, 2011. (E. Ibañez, D. Sanchez)
• Net-Works 2011, international conference. El Escorial (Madrid), October 26–28, 2011. (E. Ibáñez, D. Sánchez).
• OCCAM Modelling Camp. University of Oxford, March 2011. (M. MacDevette)
• V Modelling Week. Universidad Complutense de Madrid, May, 2011. (M. MacDevette)
• Workshop on Mathematical Modeling of Blood Flow and the Baroreflex System. Centre de Recerca Matematica, 2011. (M. MacDevette)
• Summer School on Financial Engineering. Borsa de Barcelona, June 2011. (L. Ortiz)
• Optimization: Theory, Algorithms and Applications in Economics. Centre de Recerca Matemàtica, October 2011. (D. Sánchez)

Research stays

• *Department of Mathematics, Bath University*. May 2 – 6, 2011. (A. Ferreiro)

☐ ***Other***

Grants obtained

• (A. Deluca) Lodging grant, Max Planck Institute For Complex Systems, Dresden.
• (A. Deluca) Tuition and lodging grant, Santa Fe Institute, Santa Fe, California.
• (A. Deluca) Tuition and lodging grant, Gefenol School, Palma, Mallorca.
• (A. Deluca) Tuition and lodging grant, International Summer School and Research Workshop on Complexity, Istanbul.
• (A. Deluca) Travel grant, AGU fall Meeting 2011, San Francisco.
• (A. Deluca) OSPA (Outstanding Student Paper Awards) judge, AGU fall meeting 2011.
• (M. MacDevette) Travel and accommodation grant to attend OCCAM Modelling Camp, University of Oxford, March 2011.
• (F. Font Martínez) Travel and accommodation grant to attend OCCAM Modelling Camp, University of Oxford, March 2011.

Participation in committees

• Master's thesis committee. Study and Implementation of Some Quantitative Trading Models, by E. Sánchez López. Universitat Politècnica de Catalunya. July 2011. (L. Ortiz)
• Master's thesis committee. Semi-Analytical Implementation for the Name Concentration Measurement in a Credit Portfolio, by S. Sandra Álvarez Jordán. Universitat Politècnica de Catalunya. November 2011. (L. Ortiz)

2.3. Les xarxes temàtiques del CRM

Estar amatents a les àrees emergents en les matemàtiques i les seves aplicacions és un dels objectius prioritaris del CRM, així com oferir incentius i recursos de manera que els investigadors de les àrees més tradicionals o els investigadors més joves puguin introduir-se en aquests sectors emergents. Donat l'estat actual de la recerca, moltes de les àrees estratègiques o emergents en Ciència i Tecnologia estan relacionades amb noves aplicacions matemàtiques i permeten així la participació de les matemàtiques en projectes socials a gran escala.

2.3. CRM Thematic Networks

Monitoring emerging areas in mathematics and their applications is a priority objective for the CRM, as well as offering incentives and resources so that researchers in traditional areas or younger researchers can join these emerging sectors. Given the current state of research, many strategic or emerging areas are related to new mathematical applications, in partnership activities with other sciences or with technology, or allowing the participation of mathematics in large-scale social projects.

Amb aquest propòsit, el CRM dóna suport a diverses xarxes temàtiques, com a continuació d'altres iniciatives empreses en anys anteriors. Tenen per objectiu la formació multidisciplinària en recerca en àrees considerades d'interès i rellevants actualment. Les xarxes temàtiques del CRM són una estructura transversal que serveix de pal de paller als grups de recerca catalans actius en una determinada àrea, disposats a col·laborar entre ells a través d'activitats conjuntes, les qual típicament inclouen un seminari estable. El CRM dóna suport financer i administratiu a cada xarxa temàtica.

Les xarxes temàtiques actuals al CRM són les següents:

- Xarxa Temàtica en Neurociència Computacional
- Xarxa Temàtica en Matemàtica Industrial
- Xarxa Temàtica en Finances Quantitatives

Les activitats d'aquestes xarxes poden veure's a

With this purpose, the CRM supports several Thematic Networks, as a continuation of other initiatives undertaken in previous years. It aims at multidisciplinary research training and practice in areas considered to be of interest and relevant at the present time. The CRM Thematic Networks are a transversal activity that serves as a meeting point of research groups in Catalonia active in one of such areas, willing to collaborate through joint activities, which typically include a stable all-year seminar. The CRM gives financial and administrative support to each Thematic Network.

The current list of CRM Thematic Networks is the following:

- *Thematic Network in Computational Neuroscience*
- *Thematic Network in Industrial Mathematics*
- *Thematic Network in Quantitative Finance*

The activities of these networks can be checked at

www.crm.cat/en/Research/Pages/ThematicNetworks.aspx

2.4. Investigadors visitants

Diversos investigadors fan estades temporals al CRM durant cada curs acadèmic. La majoria d'aquests investigadors són participants invitats als programes de recerca del CRM i la resta s'acullen a les convocatòries públiques del CRM per a estades de recerca en col·laboració amb matemàtics/ques de les universitats catalanes, que són:

- Estades de recerca al Centre
- Estades de recerca en col·laboració
- Places Lluís Santaló per a visitants d'Amèrica Llatina

El llistat de visitants de 2011 es detalla a continuació. Aquest llistat no inclou el personal investigador propi del CRM ni els visitants que hagin fet estades inferiors a dues setmanes.

2.4. List of Visitors

A number of researchers visit the CRM temporarily every academic year. Most of them are invited participants at CRM research programmes, and the rest apply to competitive calls for research stays in collaboration with mathematicians in local universities, namely:

- *Visiting the CRM*
- *Research in pairs at CRM*
- *Lluís Santaló visiting positions for Latin-American researchers.*

The list of 2011 visitors is the following. This list does not include CRM staff researchers nor visitors whose stay was shorter than two weeks.

Rabia Aktas	Ankara University
Alexei Aleksandrov	Steklov Institute of Mathematics
Yacin Ameur	Luleå University of Technology
Ramon Antoine	Universitat Autonòma de Barcelona
Pere Ara	Universitat Autonòma de Barcelona
Dawn Archey	Marymount Manhattan College
Gerard Ascensi	Universität Wien
Anton Baranov	Chebyshev Laboratory, St. Petersburg
Alethea Barbaro	UCLA
Andrew T. Barker	Louisiana State University
Arnold Beckmann	Swansea University
Bo Berndtsson	Chalmers University of Technology
Joan Bosa	Universitat Autonòma de Barcelona
Mihai Bostan	Université de Franche-Comté
Nathanial P. Brown	The Pennsylvania State University
Jerry Buckley	Universitat de Barcelona
Jean François Burnol	Université de Lille 1
Samuel R. Buss	University of California at San Diego
Carme Calderer	University of Minnesota
Alin Ciuperca	Universtity of New Brunswick
Gonzalo Contreras	CIMAT, Guanajuato
Antonio Córdoba	Universidad Autónoma de Madrid
Guillermo Cortiñas	Universidad de Buenos Aires
Dmitry Chelkak	St. Petersburg State University
Michael Chi Weng Cheong	Purdue University
Vasileios Chousionis	University of Helsinki
Petr Chunaev	Vladimir State University
Marius Dadarlat	Purdue University
Feng Dai	University of Alberta
Zeev Ditzian	University of Alberta
Caleb Eckhardt	Purdue University
Kjersti Solberg Eikrem	Norwegian University of Science and Technology
George A. Elliott	University of Toronto
Ruy Exel	Universidade Federal de Santa Catarina
Jörg Flum	Universität Freiburg
Eva Gallardo	Universidad Complutense de Madrid
Thierry Giordano	University of Ottawa
Polina Glazyrina	Ural State University
Amiran Gogatishvili	Inst. of Mathematics, Czech Academy of Science
Kenneth Goodearl	University of California at Santa Barbara
Dmitry Gorbachev	Tula State University
Karlheinz Gröchenig	Universität Wien
Antti Haimi	Royal Institute of Technology, Stockholm
Håkan Hedenmalm	Royal Institute of Technology, Stockholm
Ilan Hirshberg	Ben Gurion University of The Negev
Ayagoz Jhantakbayeva	L.N. Gumilyov Eurasian National University
Ainur Jumabayeva	L.N. Gumilyov Eurasian National University
Takeshi Katsura	University of Copenhagen
David Kerr	Texas A&M University

Eberhard Kirchberg	Humboldt Universität zu Berlin
Julia F. Knight	University of Notre Dame
Shinichi Kotani	Kwansei Gakuin University
Lucas Lacasa	Universidad Politécnica de Madrid
Fernando Lledó	Universidad Carlos III de Madrid
José Luis Lugo	Purdue University
Yurii Lyubarskii	Norwegian University of Science and Technology
Nikolai Makarov	California Institute of Technology
Donald E. Marshall	University of Washington
Juan Carlos Martínez	Universitat de Barcelona
Xavier Massaneda	Universitat de Barcelona
Russell G. Miller	Queen's College, New York
Mishko Mitkovski	Georgia Institute of Technology
Evsey Morozov	Russian Academy of Sciences
Artur Nicolau	Universitat Autònoma de Barcelona
Shahaf Sigal Nitzan	Weizmann Institute of Science
Daulet Nurakhmetov	Al-Farabi Kazakh National University
Duane Nykamp	University of Minnesota
Rui Okayasu	Osaka Kyoiku University
Alexander Olevskii	Tel Aviv University
Jan-Fredrik Olsen	Lund University
Bohumir Opic	Charles University, Prague
Joaquim Ortega	Universitat de Barcelona
Enrique Pardo	Universidad de Cádiz
Francesc Perera	Universitat Autònoma de Barcelona
N. Christopher Phillips	University of Oregon
Alexei Poltoratski	Texas A&M University
Indrani Rao Nityanand	University of North Carolina
Leonel Robert	University of Copenhagen
Efren Ruiz	University of Hawaii at Hilo
Kristian Seip	Norwegian University of Science and Technology
David Sherman	University of Virginia
Mercedes Siles	Universidad de Málaga
Mikhail Sodin	Tel Aviv University
Vladimir Stepanov	Peoples' Friendship University of Russia
Karen Strung	University of Nottingham
Hannes Thiel	University of Copenhagen
Pascal Thomas	Université Paul Sabatier
Mark Tomforde	University of Houston
Andrew Toms	Purdue University
Walter Trebels	Technische Universität Darmstadt
Ignacio Uriarte	Michigan State University
Alexander Volberg	Michigan State University
Brian Wetton	The University of British Columbia
Stuart White	University of Glasgow
Wilhelm Winter	University of Nottingham
Yuan Xu	University of Oregon
Petro Yudytskiy	Johannes Kepler University Linz
Aleksey Zelenberg	The Pennsylvania State University

En total, el CRM ha hostatjat 223 mesos d'estada d'investigadors al llarg de l'any 2011.

Summing up, the CRM has hosted 223 months of stays of researchers during 2011.

2.5. La formació en recerca al CRM

Hi ha dues vessants de formació al CRM: doctoral i a nivell de màster.

2.5.1. Formació doctoral

El CRM atorga beques doctorals destinades a la realització de tesis doctorals en les especialitats especificades en el pla estratègic del Centre. Per gaudir d'una beca doctoral del CRM és indispensable matricular-se en un programa de doctorat d'una universitat catalana. A continuació, es detalla la llista de becaris predoctorals vinculats al CRM, amb especial èmfasi a les tesis llegides el 2011 (4); en l'apartat 2.2.4 hi ha informació més detallada d'aquells estudiants predoctorals que han estat contractats pel CRM durant aquest any.

2.5. Research Training at CRM

There are two aspects in training: at doctoral and master's level.

2.5.1. Doctoral Training

The CRM awards doctoral grants for PhD theses on topics specified in the CRM strategic plan. To benefit from a CRM PhD grant it is required to be registered in a PhD programme at a Catalan University. Next, we list the predoctoral researchers associated to the CRM, with special emphasis on those who have completed their training during 2011 (4). More information on predoctoral students that have been contracted by CRM during 2011 can be found in Section 2.2.4.

Luis Ortiz Gracia presented his PhD thesis on *Haar Wavelets-Based Methods for Credit Risk Portfolio Modeling*, funded by CRM and supervised by Josep J. Masdemont, in the UPC doctorate programme.

Juan José Rivaud Gallardo presented his PhD thesis on *Mathematical Models for Bacteria-Phage Interaction Experiments*, funded by CRM, UAB and i-MATH and supervised by Àngel Calsina, in the UAB doctorate programme.

Somayeh Heidarvand presented her PhD thesis on *Privacy-Providing Signatures and Their Applications*, funded by CRM and UPC and supervised by Jorge Villar, in the UPC doctorate programme.

Albert Ferreiro presented her PhD thesis on *Stochastic Calculus and Analytic Characteristic Functions. Applications to Finance*, funded by CRM and UAB and supervised by Frederic Utzet, in the UAB doctorate programme.

Lidia Almazán is working on her PhD thesis, supervised by José Antonio Carrillo since September 2009. Funded by CRM, UAB and i-MATH.

Michelle MacDevette (formerly, De Decker) is working on her PhD thesis, supervised by Tim Myers since February 2010. Funded by CRM.

Anna Deluca is working on her PhD thesis, supervised by Álvaro Corral since September 2009. Funded by CRM.

Francesc Font Clos is working on his PhD thesis, supervised by Álvaro corral since December 2011. Funded by CRM.

Francesc Font Martínez is working on his PhD thesis, supervised by Tim Myers since September 2010. Funded by CRM.

Pedro E. García is working on his PhD thesis, supervised by Antoni Guillamon since February 2007. Funded by CRM and UPF.

Maite Naranjo is working on his PhD thesis, supervised by Marta Sanz-Solé since October 2009. Funded by CRM.

2.5.2. Treballs de recerca de fi de màster

El CRM impulsa una convocatòria per promoure, entre els estudiants de màster en Matemàtiques de les universitats catalanes, l'elaboració de treballs de recerca en temes interdisciplinaris i aplicats. L'any 2011 s'han elaborat els treballs següents:

2.5.2. Master's Research Projects

The CRM launches a call to sponsor research projects in interdisciplinary applied areas addressed to master's students in Mathematics at Catalan Universities. In 2011 the following have been completed:

Nina Asadipour, *Modelling of Non-linear Viscoelastic Tissues with Bar Elements*, supervised by José Javier Muñoz Romero, UPC.

Sandra Álvarez Jordán, *Semi-Analytical Implementation for the Name Concentration Measurement in a Credit Portfolio*, supervised by Luis Ortiz, CRM.

Soheil Hajian, *An Energy Preserving Discontinuous Galerkin Method for Vlasov-Poisson System*, supervised by Blanca Ayuso, CRM.

Daniel Sánchez Taltavull, *Stabilty and Stochastic Models of Hierarchical Cell Populations*, supervised by Tomás Alarcón, CRM.

Miguel Teixidó Román, *Hamiltonian Methods in Stability and Bifurcations Problems for Artificial Satellite Dynamics*, supervised by Miguel C. Muñoz Lecanda and Miguel A. Rodríguez Olmos, UPC.

Emiliano Sánchez López, *Study and Implementation of some Quantitative Trading Models*, supervised by Josep J. Masdemont, UPC.

O. Valero, Y. Vives, B. Gómez-Anson, I. Corcuera, J. Pagonabarraga, *An Alternative Procedure to Generate a More Accurate GLM Model to Compare MRI Cortical Thickness to Study Neuro- degenerative Diseases*, supervised by Yolanda Vives, Port Info. Científica, IFAE-CIEMAT-UAB.

Michelle De Decker, *Methods for Solving 1D Stefan Problems with Application to Contact Melting*, supervised by Tim Myers, CRM, UPC.

Sundus Zafar, *Mathematical Modeling and Analysis of the Interaction of Populations of Bacteria and Bacteriophages within Chicken Intestine*, supervised by Àngel Calsina, UAB.

Francesc Font Martínez, *Probability Distribution of the Radionuclide Half-Lives*, supervised by Álvaro Corral, CRM.

Anna M. Kedzierska, *Bayesian Network Studies for Splicing Regulatory Elements*, supervised by Marta Casanellas, UPC.

2.5.3. Curs de màster

El màster de Matemàtiques per als instruments financers va tenir lloc per catorzena vegada el 2011 gràcies a la col·laboració del Departament de Matemàtiques de la UAB i el CRM amb diverses entitats: la Borsa de Barcelona (patrocinadora), els departaments d'Economia Aplicada, d'Eco-nomia de l'Empresa, i d'Economia i d'Història Econòmica de la UAB, i el Departament d'Estadística de la UB, juntament amb destacats especialistes que treballen en contacte directe amb els mercats. Les empreses col·laboradores que hi donen suport, mitjançant les beques per a la realització de pràctiques, aporten el component necessari d'aprenentatge pràctic. Així, s'estableix una línia directa de col·laboració entre els mons acadèmic i professional, que permet desenvolupar i ensenyar les últimes tècniques de valoració de productes financers derivats, càlcul d'estratègies de cobertura i avaluació i control de riscos.

El màster està estructurat en tres etapes: dues de teòriques (cadascuna amb 120 hores de docència) i una tercera etapa pràctica en una empresa de finances. La responsabilitat del màster recau en una Comissió Acadèmica i un Comitè Executiu. L'any 2011 han acabat el màster 15 alumnes.

2.5.3. Master's Course

The CRM master's course on Financial Mathematics was held for the fourteenth time in 2011 thanks to the collaboration of the Mathematics Department of the UAB and the CRM with several financial companies such as the Barcelona Stock Exchange, which is the sponsoring institution. Other collaborating institutions are the departments of Economics and Economics History, Applied Economics, and Business Economics of the UAB, the Statistics Department of the UB, and several outstanding specialists who work in direct contact with the markets. The collaborating companies promote practical training opportunities to the students by offering them grants. This facilitates a direct contact between the academic world and the professional world, allowing them to develop and teach innovative techniques about the valuation of derived financial products, calculation of coverage strategies, risk assessment and risk control.

The course is structured in three terms, two theoretical, each with 120 hours of teaching, and a third practical in a financial company. The master's responsibility lies on an Academic Commission and an Executive Committee. In 2011 a total of 15 students completed the master's course.

Organització d'activitats científiques

Organization of Scientific Events

3

El CRM organitza des de fa anys, sobre una base competitiva mitjançant convocatòries al seu web, quatre tipus d'activitats:

- ☐ Programes de recerca intensius
- ☐ Congressos internacionals i workshops
- ☐ Cursos avançats
- ☐ Jornades temàtiques

Les sol·licituds es presenten mitjançant les instruccions que es poden trobar a la secció d'Activitats de la web del CRM.

El CRM també organitza activitats divulgatives i seminaris de recerca.

Since long ago the CRM organizes on a competitive basis, through open calls in its website, four types of activities:

- ☐ *Intensive Research Programmes*
- ☐ *International Conferences and Workshops*
- ☐ *Advanced Courses*
- ☐ *Thematic Days*

Applications can be formulated by following the guidelines given in the Activities section at the CRM website.

Moreover, the CRM also organizes Dissemination Activities and Research Seminars.

3.1. Programes de recerca

Un programa de recerca del CRM consisteix en un període intensiu de recerca en una àrea determinada de les matemàtiques i les seves aplicacions, durant el qual s'apleguen al CRM investigadors procedents de diferents institucions d'arreu del món per treballar en problemes oberts del seu àmbit d'especialització i per analitzar-ne l'estat i les perspectives.

3.1. Research Programmes

The CRM Research Programmes consist of periods of intensive research in a given area of the mathematical sciences and their applications, bringing together researchers from different institutions to work on open problems in the chosen area and to analyse its present state and perspectives.

Els programes de recerca del CRM poden durar normalment entre tres mesos i un curs acadèmic sencer. S'estructuren en dos vessants: els investigadors visitants i les activitats programades. Cada programa té un comitè científic responsable de planificar les activitats incloses en el programa, elaborar la llista dels investigadors visitants i lliurar un informe final. Típicament, en un programa hi participen investigadors locals a temps complet, investigadors visitants a temps complet (per a estades d'una durada mínima d'un mes), becaris postdoctorals i estudiants de doctorat avançats. Les activitats d'un programa inclouen generalment un o dos seminaris setmanals, un workshop intensiu (preferentment obert a investigadors que no participin en el programa), un congrés internacional i un curs avançat dirigit a estudiants de doctorat.

Els programes de recerca del CRM es convoquen a nivell internacional amb dos anys d'antelació i són avaluats pel Consell Científic. A continuació es descriuen els programes de recerca organitzats durant l'any 2011. La informació general sobre els programes de recerca es pot trobar a

Research Programmes can run for periods from three months to a whole academic year. They are based on two aspects: visiting researchers and activities organised within. Every programme has a scientific committee, which is fully responsible for the planning of all activities included in the programme, elaboration of the list of participants, and submission of a final report. Typically, participants in a programme include local full-time researchers, visitors on a full-time basis (for stays of at least one month), post-doctoral fellows and advanced doctoral students. A research programme generally includes one or two weekly seminars, one intensive workshop (preferably open to researchers not participating in the programme), a conference and an advanced course addressed to graduate students.

The CRM Research Programmes are called internati- onally two years in advance and are evaluated by the Scientific Advisory Board. The CRM Research Programmes that took place in 2011 are described below. General information of Research Programmes can be found at

www.crm.cat/en/Activities/Pages/ResearchProgrammes.aspx

3.1.1. CRM Research Programme on Complex Analysis and Spectral Problem

January to July, 2011

Coordinators	**Xavier Massaneda**	Universitat de Barcelona
	Joaquim Ortega-Cerdà	Universitat de Barcelona
Scientific Committee	Håkan Hedenmalm	The Royal Institute of Technology in Stockholm
	Nikolai Makarov	CALTECH, USA
	Joaquim Ortega-Cerdà	Universitat de Barcelona
	Mikhail Sodin	Tel Aviv University
Seminar Coordinator	Konstantin Dyakonov	ICREA/Universitat de Barcelona

Summary

Research topics of the programme have focused on what is known as spectral complex analysis. The underlying element that gives unity to the various aspects of this broad field is the complex Fourier transform, which often translates real problems of harmonic analysis to the language of complex analysis. This will get new tools to address these problems, as well as a new approach to them. At first this circle of ideas included sampling problems, interpolation

and sets of uniqueness in Paley-Wiener space of entire functions and related properties of exponential systems in spaces of type L^2. Later incorporated various forms of the uncertainty principle, different notions of function and range of issues analysis and spectral synthesis. From the beginning this area has been deeply connected with many problems of classical analysis, such as the quasi-analyticity, the gap or polynomial approximation theorems or exponential weights. Later the theory was enriched by the contributions of the Fock-Bargmann spaces of entire functions, which appear naturally in quantum mechanics and the time-frequency analysis in signal theory, spectral theory and adjoint operator of Sturm-Liouville Weyl extension of the Fourier transform. In the decade of 1960, Beurling and Malliavin obtained fundamental results on multipliers and on the completeness of exponential systems. At the same time was developing a beautiful de Branges unifying theory on Hilbert spaces of entire functions. Since then de Branges spaces appear in all sorts of problems, such as the spectral theory of self-adjoint operators, canonical systems of second order, Krein strings, harmonic analysis and the theory of Gaussian processes.

After Beurling and Malliavin work, many powerful new methods in various areas of classical complex analysis have been developed. Some of these include: dimensions of the Hilbert transform and the Cauchy integral, dimensions of the harmonic measure, asymptotically holomorphic functions, subharmonic functions techniques in theory of entire functions, sampling and interpolation in Bargmann-Fock space on disk and in the plane, functional model of Nagy-Foias and Lax-Phillips or Aleksandrov-Clark measures. Many classical spectral problems that seemed out of reach thirty or forty years ago now seem accessible. In summary, in recent years, complex analysis has found again its central place in a number of areas of mathematics. Complex analysis methods have been crucial to advances in direct and inverse problems of spectral theory of self-adjoint differential operators in probability theory (Schramm-Loewner evolution), the analysis of Gabor signals in random matrix theory, in 2-dimensional lattice models of statistical mechanics, critical, or in accordance with field theory. This has given a huge boost to the complex analysis and, in particular its spectral aspects.

Visiting Researchers in 2011

Alexei Aleksandrov	Steklov Institute of Mathematics
Yacin Ameur	Luleå University of Technology
Gerard Ascensi	Universität Wien
Anton Baranov	Chebyshev Laboratory, St. Petersburg
Bo Berndtsson	Chalmers University of Technology
Aline Bonami	Université d'Orléans
Alexander Borichev	Université de Provence
Jerry Buckley	Universitat de Barcelona
Jean François Burnol	Université de Lille 1
Tom Carroll	University College Cork
Dmitry Chelkak	St. Petersburg State University
Konstantin Dyakonov	Universitat de Barcelona
Kjersti Solberg Eikrem	Norwegian University of Science and Technology
Eva Gallardo	Universidad Complutense de Madrid

Karlheinz Gröchenig	Universität Wien
Miklós Hórvath	Budapest Univ. of Techn. & Economics
Antti Haimi	Royal Institute of Technology, Stockholm
Håkan Hedenmalm	Royal Institute of Technology, Stockholm
Victor Katsnelson	Weizmann Institute of Science
Evgeny Korotyaev	Cardiff University
Shinichi Kotani	Kwansei Gakuin University
Jeffrey Lagarias	University of Michigan
Seung Yeop Lee	Seoul National University
Yurii Lyubarskii	Norwegian University of Science and Technology
Nikolai Makarov	California Institute of Technology
Donald E. Marshall	University of Washington
Xavier Massaneda	Universitat de Barcelona
Mishko Mitkovski	Georgia Institute of Technology
Artur Nicolau	Universitat Autònoma de Barcelona
Shahaf Sigal Nitzan	Weizmann Institute of Science
Alexander Olevskii	Tel Aviv University
Jan-Fredrik Olsen	Lund University
Joaquim Ortega	Universitat de Barcelona
Alexei Poltoratski	Texas A&M University
Eero Saksman	University of Helsinki
Kristian Seip	Norwegian University of Science and Technology
Mikhail Sodin	Tel Aviv University
Arne Stray	University of Bergen
Christoph Thiele	University of California at Los Angeles
Pascal Thomas	Université Paul Sabatier, Tolosa
Ignacio Uriarte	Michigan State University
Petro Yudytskiy	Johannes Kepler University Linz

☐ *Activities*

• Weekly Seminar

Speakers

Yacin Ameur (Royal Institute of Technology, Stockholm), Karlheinz Gröchenig (Universität Wien), Donald Marshall (University of Washington), Eugenia Malinnikova (NTNU), Kjersti Solberg Eikrem (NTNU), S. Kotani (Kwansei Gakuin University, Nishinomiya), Antti Haimi (Royal Institute of Technology, Stockholm), Tom Carroll (Cork University), Jordi Marzo (UB), Dmitry Chelkak (PDMI RAS, Steklov Institute, St. Petersburg), Jean-Francois Burnol (Université de Lille 1), Eero Saksman (University of Helsinki).

• Short courses and Workshop on Spectral Function Theory

March 14 to 19, 2011
Participants: 51

Lecturers

Alexander Borichev, Université de Provence
Asymptotically holomorphic functions

Karlheinz Gröchenig, Universität Wien
Gabor analysis

Alexander Olevskii, Tel Aviv University
Harmonic analysis of functions with disconneted spectrum

Eero Saksman, University of Helsinki
An introduction to Hardy spaces of Dirichlet series

Speakers

Yacin Ameur (Royal Institute of Technology, Stockholm), Daniel Blasi (UAB), Jeremiah Buckley (UB), Naomi Feldheim (Tel Aviv University), Antti Haimi (Royal Institute of Technology, Stockholm), Miklós Hórvath (Budapest University of Technology and Economics), Victor Katsnelson (Weizmann Institute of Science), Yuri Lyubarskii (Norwegian Institute of Technology, Trondheim), Donald E. Marshall (University of Washington), Artur Nicolau (UAB), Alon Nishry (Tel Aviv University), Evgeny Poletsky (Moscow State University), Bharti Pridhnani (UB), Daniel Seco (UAB), Arne Stray (University of Bergen), Alexander Ulanovskii (University of Stavanger).

• Advanced Course on Krein-de Branges Spaces of Entire Functions and Old and New Spectral Problems
May 2 to 6, 2011
Participants: 27

Lecturers

Nikolai Makarov	Caltech University
Alexei Poltoratski	Texas A&M University
Mikhail Sodin	Tel Aviv University

• Short courses and Workshop on Hilbert Spaces of Entire Functions and Spectral Theory of Self-adjoint Differential Operators
May 31 to June 4, 2011
Participants: 48

Lecturers

Shinichi Kotani, Kwansei Gakuin University
Grassmann manifold and spectral theory of 1-D Schrödinger operators

Alexei Poltoratski, Texas A&M University
Spectral gaps and completeness of complex exponentials

Christoph Thiele, University of California at Los Angeles
Analogues of classical estimates for the nonlinear Fourier transform

Pedro Yudytskiy, Johannes Kepler University of Linz
de Branges' theorem on inverse monodromy problem and Hardy spaces in Widom domains

Workshop Speakers

Aleksei Aleksandrov (Steklov Institute of Mathematics), Gerard Ascensi (Universität Wien), Anton Baranov (St. Petersburg State University), Yurii Belov (St. Petersburg State University), Jean-François Burnol (Unversité de Lille 1), Konstantin Dyakonov (UB), Eva A. Gallardo (Universidad Complutense de Madrid), Amadeo Irigoyen (UB), Evgeny Korotyaev (Cardiff University), Jeffrey Lagarias (University of Michigan), Nir Lev (Weizmann Institute for Science), Eugenia Malinnikova (NTNU), Mishko Mitkovski (Georgia Institute of Technology), Shahaf Nitzan (Tel Aviv University), Philippe Poulin (United Arab Emirates University), Edgar Tchoundja (CRM), Harald Woracek (Institut für Analysis und Scientific Computing), Dmitry Yakubovich (Universidad Autónoma de Madrid).

3.1.2. CRM Research Programme on The Cuntz semigroup and the classification of C^*-algebras

January to July, 2011

Coordinators	**Pere Ara**	Universitat Autònoma de Barcelona
	Francesc Perera	Universitat Autònoma de Barcelona
Scientific Committee	Nathanial P. Brown	Pennsylvania State University
	Joachim Cuntz	Universität Münster
	Marius Dardarlat	Purdue University
	George Elliott	University of Toronto
	Mikael Rørdam	University of Copenhagen
	Andrew S. Toms	York University

Summary

In 1976 Elliott, building on work of J. Glimm and O. Bratteli, gave a classification of locally finite-dimensional C^*-algebras in terms of their ordered K-theory. His discovery led him to conjecture, around 1989, that separable nuclear C^*-algebras would be classified by K-theoretic invariants. He gave great impetus to the conjecture by proving, with D. Evans, that the C^*-algebras associated to an irrational rotation on the circle were so classified. His results were seized upon by several talented mathematicians who continue to work on Elliott's programme today. Their work has been recognised by several ICM talks and numerous publications in elite journals. Highlights of the classification programme include the Kirchberg-Phillips classification of purely infinite simple C^*-algebras via graded topological K-theory, the Elliott-Gong-Li classification of simple approximately homogeneous C^*-algebras of bounded dimension, and Lin's work leading up to the classification of real rank zero C^*-dynamical systems.

The Elliott Programme has enjoyed a resurgence of late, owing to the discovery by M. Rørdam (and later, in a different direction, A. Toms), that K-theory, at least in its naive topological formulation, does not suffice for the classification of all simple separable nuclear C^*-algebras. There are two ways forward: restrict the class of C^*-algebras considered, or enlarge the proposed invariant. Both of these courses have been pursued vigorously over the past few years. Some of them have led to several breakthroughs in Elliott's programme. An account of these goings-on can be found in the April 2008 issue of the Bulletin of the American Mathematical Society. Since then, there has been further groundbreaking progress on these matters, as numerous results testify.

The – rather dramatic – failure of the classification conjecture not only at its boldest (that is, using the Elliott invariant as above), but also after enlarging the invariant by a whole swath of topological invariants (including the real rank and the stable rank) could be demonstrated by using the Cuntz semigroup. This is an object built out of equivalence classes of positive elements in the stabilization of the algebra A in very much the same way as the projection semigroup $V(A)$ is (the latter is a precursor of the Grothendieck group K_0). Thus, as with the Murray-von Neumann equivalence of projections, the Cuntz semigroup aims at capturing the "rank" of a positive operator in a C^*-algebra. Its recent popularity is due to its extreme sensitivity as an invariant. In contrast to the pro-

jection semigroup $V(A)$, the Cuntz semigroup $\mathrm{Cu}(A)$ comes equipped with an order of an analyitic nature, which is not algebraic, except in the finite dimensional case. Within this scientific framework, this research programme has addressed activities around structure, classification and dynamics of C^*-algebras.

Visiting Researchers	Ramon Antoine	Universitat Autònoma de Barcelona
	Pere Ara	Universitat Autònoma de Barcelona
	Dawn Archey	Marymount Manhattan College
	Joan Bosa	Universitat Autònoma de Barcelona
	Nathanial P. Brown	The Pennsylvania State University
	José Carrión	Purdue University
	Alin Ciuperca	Universtity of New Brunswick
	Guillermo Cortiñas	Universidad de Buenos Aires
	Michael Chi Weng Cheong	Purdue University
	Marius Dadarlat	Purdue University
	Caleb Eckhardt	Purdue University
	George A. Elliott	University of Toronto
	Ruy Exel	Universidade Federal de Santa Catarina
	Thierry Giordano	University of Ottawa
	Kenneth Goodearl	University of California at Santa Barbara
	Siri-Malén Høynes	Norwegian University of Science and Technology
	Taylor Hines	Purdue University
	Ilan Hirshberg	Ben Gurion University of The Negev
	Masaki Izumi	Kyoto University
	Takeshi Katsura	University of Copenhagen
	David Kerr	Texas A&M University
	Eberhard Kirchberg	Humboldt Universität zu Berlin
	Huaxin Lin	University of Oregon
	Fernando Lledó	Universidad Carlos III de Madrid
	Terry Loring	University of New Mexico
	José Luis Lugo	Purdue University
	Hiroki Matui	Chiba University
	Ping Wong Ng	University of Louisiana at Lafayette
	Rui Okayasu	Osaka Kyoiku University
	Enrique Pardo	Universidad de Cádiz
	Francesc Perera	Universitat Autònoma de Barcelona
	N. Christopher Phillips	University of Oregon
	Leonel Robert	University of Copenhagen
	Efren Ruiz	University of Hawaii at Hilo
	David Sherman	University of Virginia
	Mercedes Siles	Universidad de Málaga
	Peter Sjögren	Chalmers University of Technology
	Karen Strung	University of Nottingham
	Hannes Thiel	University of Copenhagen
	Mark Tomforde	University of Houston
	Andrew Toms	Purdue University
	Alexander Ulanovskii	University of Stavanger
	Maria Grazia Viola	Lakehead University, Ontario

Stuart White	University of Glasgow
Wilhelm Winter	University of Nottingham
Aleksey Zelenberg	The Pennsylvania State University

☐ *Activities*

• Weekly Seminar

Speakers

Joan Bosa (UAB), Nate Brown (The Pennsylvania State University), Guillermo Cortiñas (Universidad de Buenos Aires), Marius Dadarlat (Purdue University), George A. Elliott (University of Toronto), Ruy Exel (Universidade Federal de Santa Catarina), Ken Goodearl (University of California at Santa Barbara), Ilan Hirshberg (Ben Gurion University of The Negev), Masaki Izumi (Kyoto University), Takeshi Katsura (University of Copenhagen), Eberhard Kirchberg (Humboldt Universität zu Berlin), Fernando Lledó (Universidad Carlos III), Rui Okayasu (Osaka Kyoiku University), N. Christopher Phillips (University of Oregon), Hannes Thiel (University of Copenhagen).

• Workshop on Dynamics and C^*-Algebras

April 6 to 8, 2011
Participants: 29

Speakers

Ramon Antoine (UAB), José Carrión (Purdue University), Alin Ciuperca (University of New Brunswick), George A. Elliott (University of Toronto), Ruy Exel (Universidade Federal de Santa Catarina), Kenneth Goodearl (University of California at Santa Barbara), Taylor Hines (Purdue University), Ilan Hirshberg (Ben Gurion University of the Negev), Eberhard Kirchberg (Humboldt Universität zu Berlin), Ping Wong Ng (University of Louisiana at Lafayette), Enric Pardo (Universidad de Cádiz), Luis Santiago (UAB), Karen Strung (Nottingham University), Hannes Thiel (University of Copenhagen), Thomas Timmermann (Universität Münster), Joachim Zacharias (University of Nottingham).

• Conference on Structure and Classification of C^*-Algebras

June 6 to 10, 2011
Participants: 64

Invited Speakers

Nathanial P. Brown (The Pennsylvania State University), Marius Dadarlat (Purdue University), George A. Elliott (University of Toronto), Ilan Hirshberg (Ben Gurion University of The Negev), Eberhard Kirchberg (Humboldt Universität zu Berlin), Huaxin Lin (University of Oregon), Christopher N. Phillips (University of Oregon), Leonel Robert (University of Copenhagen), Mikael Rordam (University of Copenhagen), Luis Santiago (UAB), Takeshi Katsura (University of Copenhagen), Mark Tomforde (University of Houston), Andrew Toms (Purdue University), Wilhelm Winter (University of Nottingham).

Contributed Talks

Dawn Archey, Ahmed Al-Rawashdeh, Étienne Blanchard, Joan Bosa, José R. Carrión, Christina Cerny, Caleb Eckhardt, Taylor Hines, David Kerr, Alla Kuznetsova, Hyun Ho Lee, Xin Li, Hiroki Matui, Eduard Ortega, Cornel Pasnicu, Efrén Ruiz, Yasuhiko Sato, Mikhail Shchukin, David Sherman, Tatiana Shulman, Mitsuharu Takeori, Hannes Thiel, Stuart White.

• Advanced Course on Dynamical Systems
June 14 to 23, 2011
Participants: 41

Lecturers

Thierry Giordano, University of Ottawa
Minimal topological systems and orbit equivalence

David Kerr, Texas A&M University
C^*-algebras and topological dynamics: finite approximation and paradoxicality

N. Christopher Phillips, University of Oregon
Ottawa summer school course on crossed product C^*-algebras (Draft)

Andrew Toms, Purdue University
The Cuntz semigroup and the classification of C^*-algebras

3.1.3. CRM Research Programme on Approximation Theory and Fourier Analysis

September 2011 to February 2012

Coordinators	**Sergey Tikhonov**	Centre de Recerca Matemàtica / ICREA
	Konstantin Dyakonov	Universitat de Barcelona / ICREA
Scientific Committee	Kazaros Kazarlan	Universidad Autónoma de Madrid
	Stefan Samko	Universidade do Algarve
	Vladimir Temlyakov	University of South Carolina
	Alexander Volberg	Michigan State University
Seminar Coordinator	Albert Clop	Universitat Autònoma de Barcelona
	Sergey Tikhonov	Centre de Recerca Matemàtica / ICREA

Summary

The six-month research programme "Approximation Theory and Fourier Analysis" took part at the Centre de Recerca Matemàtica. The main idea of the programme was to bring together methods, ideas and results from both areas (Constructive Approximation and Harmonic Analysis) and promote interdisciplinary research. The programme started in September 2011 and it will be finished in the end of February 2012. The main topics of the programme include approximation inequalities; nonlinear approximation; m-term approximation; greedy approximation; weights; function spaces; spaces with variable exponent; Fourier series/transforms.

As part of the programme there were several events organised: the International Conference "Function Spaces, Weights and Variable exponent analysis", the Advanced course on Approximation theory, the ICREA Conference on Approximation Theory and Fourier Analysis and the Weekly seminar at the Centre de Recerca Matemática.

The conference "Function Spaces, Weights and Variable exponent analysis" was aimed at discussing the current state of the theory of function spaces. In particular, the conference covered the following topics: function spaces of real

variables (Lebesgue, Lorentz, Orlicz), embedding/duality theorems, weights, weighted inequalities and generalized Lebesgue-Sobolev spaces of variable order.

An advanced course on Approximation theory focused on non-linear approximation, approximation on sphere, PDEs and variable Lebesgue space.

The ICREA conference was the main event of the programme. The main topics of the programme were Constructive Approximation and Harmonic Analysis.

A weekly seminar at the Centre de Recerca Matemática was organised on Monday or Tuesday at 15:00 almost every week from September till February. The goal of the seminar was to encourage the participants of the programme to present their own research.

Visiting Researchers

Rabia Aktas	Ankara University
Jonathan Bennett	University of Birmingham
Viktor Burenkov	Ysgol Mathemateg Caerdydd
Albert Cohen	Université Pierre et Marie Curie, Paris
Petr Chunaev	Vladimir State University
Feng Dai	University of Alberta
Zeev Ditzian	University of Alberta
Polina Glazyrina	Ural State University
Amiran Gogatishvili	Inst. of Mathematics, Czech Academy of Sciences
Dmitry Gorbachev	Tula State University
Ayagoz Jhantakbayeva	L.N. Gumilyov Eurasian National University
Ainur Jumabayeva	L.N. Gumilyov Eurasian National University
Kazaros Kazarian	Universidad Autónoma de Madrid
Viktor Kolyada	Karlstad University
Sergei Konyagin	Steklov Institute of Mathematics
Kirill Kopotun	University of Manitoba
Andrei Lerner	Bar-Ilan University
Elijah Liflyand	Bar-Ilan University
Hrushikesh Mhaskar	California State University
Paul Nevai	Ohio State University
Daulet Nurakhmetov	Al-Farabi Kazakh National University
Yerlan Nursultanov	Lomonosov Moscow State University
Bohumir Opic	Charles University, Prague
Stefan Samko	Universidade do Algarve
Gary Sampson	Auburn University
Javier Soria	Universitat de Barcelona
Vladimir Stepanov	Peoples' Friendship University of Russia
Vladimir Temlyakov	University of South Carolina
Vilmos Totik	University of Szeged
Walter Trebels	Technische Universität Darmstadt
Alexander Volberg	Michigan State University

☐ ***Activities***

	Yuan Xu	University of Oregon

Speakers

• Weekly Seminar

Bohumir Opic (Charles University), M. L. Goldman (Peoples' Friendship University of Russia), A. Gogatishvili (Institute of Mathematics of the Czech Academy of Sciences), Z. Ditzian (University of Alberta), V. Stepanov (Peoples Friendship University of Russia), Polina Glazyrina (Ural Federal University), Ainur Jumabayeva (CRM/UAB), Dmitry Gorbachev (Tula State University), Petr Chunaev (CRM), Svitlana Mayboroda (University of Minnesota), Laura de Carli (Florida International University), Dany Leviatan (Tel Aviv University), Kirill Kopotun (University of Manitoba), Borislav Draganov (Institute of Mathematics and Informatics, Sofia).

• International Conference on Function Spaces, Weights and Variable Exponent Analysis

September 26 to 30, 2011
Participants: 54

Lecturers

Viktor Burenko (Cardiff University), María Jesús Carro Rossell (Universitat de Barcelona), Lars Diening, (Universität München), Zeev Ditzian (University of Alberta), Michael Ganzburg (Hampton University), Amiran Gogatishvili (Inst. of Mathematics, Czech Academy of Sciences), Dorothee D. Haroske (Friedrich-Schiller-Universität), Peter Alexander Hästö (University of Oulu), Kazaros Kazarian (Universidad Autónoma de Madrid), Viktor Kolyada (Karlstads Universitet), Andrei Lerner (Bar-Ilan University), Elijah Liflyand (Bar-Ilan University), José Maria Martell Berrocal (Universidad Autónoma de Madrid), Joan Mateu (Universitat Autònoma de Barcelona), Joaquim Martín (Universitat Autònoma de Barcelona), Bohumir Opic (Charles University), Carlos Pérez (Universidad de Sevilla), Lubos Pick (Charles University), Stefan Samko (Universidade do Algarve), Gary Sampson (Auburn University), Javier Soria (Universitat de Barcelona), Walter Trebels (Technische Universität Darmstadt).

Workshop Speakers

Eduardo Gatto (DePaul University, Chicago), Mikhail Goldman (Peoples' Friendship University of Russia) Ron Kerman, Hannes Luiro (University of Jyväskylä), Lev Markhasin (Friedrich-Schiller-Universität), Gladis Pradolini, Marcel Rosenthal (Friedrich Schiller University), Elena Ushakova (University of York).

• Advanced Course on Approximation Theory

November 7 to 11, 2011
Participants: 55

Lecturers

David Cruz-Uribe	Trinity College
Feng Dai	University of Alberta
Michael Ruzhansky	Imperial College London
Vladimir Temlyakov	University of South Carolina

Yuan Xu University of Oregon

• ICREA Conference on Approximation Theory and Fourier Analysis

December 12 to 16, 2011

Participants: 73

Lecturers

Jonathan Bennett (University of Birmingham), Aline Bonami (Université d'Orléans), Albert Cohen (Université Pierre et Marie Curie), Tamás Erdélyi (Texas A&M University), Hans Feichtinger (Universität Wien), Jean-Pierre Kahane, Sergei Konyagin (Moscow State University), Michael Lacey (Georgia Institute of Technology), Dany Leviatan (Tel Aviv University), Doron Lubinsky (University of Georgia), Yurii Lyubarskii (NTNU), Hrushikesh Mhaskar (California State University), Alexander Olevskii (Tel Aviv University), Ed Saff (Vanderbilt University, Nashville), Peter Sjögren (Chalmers University of Technology), Vilmos Totik (University of South Florida), Alexander Volberg (Michigan State University), Yuan Xu (University of Oregon).

Workshop Speakers

Özlem Baksi (Yildiz Technical University), Dmitry Bilyk (University of Minnesota-Minneapolis), AndriiBondarenko (National Taras Shevchenko University), Kenier Castillo (Universidad Carlos III), Feng Dai (University of Alberta), Borislav R. Draganov (University of Sofia), Petr Honzik (Institute of Mathematics ASCR), Sergei Kalmykov (Far Eastern Branch, Russian Academy of Sciences), Filiz Kanbay (Yildiz Technical University), Ekaterina Karatsuba (Steklov Institute of Mathematics), Gerard Kerkyacharian (LPMA), Vjekoslav Kovač (University of Zagreb), Natan Kruglyak (Linköping University), Vladimir Lebedev (Moscow State Institute of Electronics & Math.), Albert Mas (Euskal Herriko Unibertsitatea), Svitlana Mayboroda (University of Minnesota-Minneapolis), Béla Nagy (HAS-Univ. of Szeged), Margit Pap (Universität Wien), Bharti Pridhnani (Universitat de Barcelona), M. Carmen Reguer (University of Lund), Eugene Shvarts (California State University), Nikos Stylianopoulos (University of Cyprus), Bogdan Szal (University of Zielona Gora), Armen Vagharshakyan (Georgia Institute of Technology),

3.1.4. The Infinity Project

September 2010 to July 2011[1]

Coordinator **Sy-David Friedman** Kurt Gödel Center, Wien

Summary

This is a multidisciplinary research project, funded by the John Templeton Foundation. The Infinity Postdocs joined the Invited Research Visitors, the Project Director and Barcelona logicians to discover radically new connections between different areas of logic in the context of the six project themes.

1. History and Philosophy of Set Theory (Loren Graham, Jean-Michel Kantor, Tatiana Arrigoni). The Luzin archive, Cartesianism vs. Luzinism in modern set

[1]The Infinity Project lasted from September 2009 to July 2011. In this document, only the activity from January 2011 is reported.

theory, Grothendieck's concept of naming, the concept of maximality in set theory.

2. Sets and Computations (Albert Atserias, Arnold Beckmann, Sam Buss, Yijia Chen, Joerg Flum, Moritz Mueller). Forcing in complexity theory, isomorphism relations on finite models.

3. Sets and Proofs (Lars Kristiansen, Michael Rathjen, Albert Visser, Andreas Weiermann). Classes of provably recursive functions, proof-theoretic operators, relativised ordinal analysis.

4. Sets and Models (John Baldwin, Fred Drueck, Rami Grossberg, Tapani Hyttinen, Martin Koerwien, Vadim Kulikov, Andrés Villaveces). Higher descriptive set theory and first-order model theory, abstract elementary classes and axioms for set theory.

5. Computations and Proofs (Arnold Beckmann, Sam Buss, Yijia Chen, Joerg Flum, Moritz Mueller). Optimal algorithms, bounds on cut-elimination, theories and algorithms.

6. Computations and Models (Katia Fokina, Julia Knight, Russell Miller, Antonio Montalbán). Isomorphism relations on computable models.

Visiting Researchers

Tatiana Arrigoni	Fondazione Bruno Kessler, Trento
Joan Bagaria	ICREA-Universitat de Barcelona
John T. Baldwin	University of Illinois at Chicago
Arnold Beckmann	Swansea University
Samuel R. Buss	University of California at San Diego
Yijia Chen	Shanghai Jiao Tong University
Fred Drueck	University of Illinois at Chicago
Jörg Flum	Universität Freiburg
Ekaterina Fokina	Kurt Gödel Research Center, Wien
Sy David Friedman	Kurt Gödel Research Center, Wien
Loren Graham	Harvard University
Tapani Hyttinen	University of Helsinki
Jean-Michel Kantor	Université de Paris VII
Julia F. Knight	University of Notre Dame
Lars Kristiansen	University of Oslo
Vadim Kulikov	University of Helsinki
Juan Carlos Martínez	Universitat de Barcelona
Colin S. McLarty	Case Western Reserve University
Russell G. Miller	Queen's College, New York
Antonio Montalbán	University of Chicago
Michael Rathjen	University of Leeds
Andrés Villaveces	Universidad Nacional, Colombia
Albert Visser	Universiteit Utrecht
Andreas Weiermann	Universiteit Gent
Philip Welch	University of Bristol

☐ ***Activities***

• Infinity Project Seminar

Speakers

Arnold Beckmann (University College of Swansea), Sam Buss (University of California at San Diego), Julia Knight (University of Notre Dame), Russell Miller (City University of New York), Antonio Montalbán (University of Chicago), Albert Visser (Universiteit Utrecht).

• Infinity Conference

July 18 to 22, 2011
Participants: 49

Speakers

Tatiana Arrigoni (Fondazione Bruno Kessler), Joan Bagaria (ICREA), John T. Baldwin (University of Illinois at Chicago), Arnold Beckmann (Swansea University), Samuel R. Buss (University of California at San Diego), Yijia Chen (Shanghai Jiao Tong University), Jörg Flum (Universität Freiburg), Ignasi Jané (Universitat de Barcelona), Tapani Hyttinen (University of Helsinki), Julia F. Knight (University of Notre Dame), Martin Koerwien (CRM), Lars Kristiansen (University of Oslo), Colin S. McLarty (Case Western Reserve University), Russell G. Miller (City University of New York), Antonio Montalbán (University of Chicago), Moritz Müller (CRM), Michael Rathjen (University of Leeds), Andrés Villaveces (Universidad Nacional de Colombia), Andreas Weiermann (Universiteit Gent), Philip Welch (University of Bristol).

3.2. Congressos i Workshops

En aquest apartat es detallen els congressos i *workshops* que va organitzar el CRM durant l'any 2011 al marge dels programes de recerca.

3.2. Conferences and Workshops

This section lists the congresses and workshops organised by CRM during 2011 not included in research programmes.

2011 Barcelona Computational and Systems Neuroscience Meeting

June 14–15, 2011
Participants: 70

Speakers

Ralph Andrzejak (Universitat Pompeu Fabra), Francesc Artigas (Hospital Clínic - IDIBAPS), Albert Compte Braquets (Hospital Clínic - IDIBAPS), Jordi Costa Faidella (Universitat de Barcelona), Jaime de la Rocha Vázquez (Hospital Clínic - IDIBAPS), Julita de la Vega Arias (g.tec medical engineering), Gustavo Deco (Universitat Pompeu Fabra), Pablo Fuentealba (Fundació Sant Joan de Déu), Àlex Gómez-Marín (Centre de Regulació Genòmica), Toni Guillamon (Universitat Politècnica de Catalunya), Matthias Keil (Universitat de Barcelona), Encarni Marcos (Universitat Pompeu Fabra), Rosemarie Nagel (Universitat Pompeu Fabra), Javier Orlandi (Universitat de Barcelona), Antonio Javier Pons (Universitat Politècnica de Catalunya), David Robbe (Hospital Clínic - IDIBAPS), Mavi Sánchez-Vives (Hospital Clínic - IDIBAPS), Núria Sebastian Gallés (Universitat Pompeu Fabra), Hans Supèr (Universitat de Barcelona).

Exploratory Workshop on Emerging Infectious Diseases and Mathematical Modelling

July 11–15, 2011
Participants: 23

Speakers

Julien Arino (University of Manitoba), Jean-Baptiste Burie (Université Victor Segalen Bordeaux 2), Arnaud Ducrot (Université Victor Segalen Bordeaux 2), William Fitzgibbon (University of Houston), Mimmo Iannelli (Università degli Studi di Trento), Michel Langlais (Université de Bordeaux 2), Michael Li (University of Alberta), Horst Malchow (Universität Osnabrück), Fabio Milner (Arizona State University), Andrea Pugliese (Università degli Studi di Trento), Shigui Ruan (The University of Miami), Joan Saldaña (Universitat de Girona), Gauthier Sallet (INRIA Loraine and Université de Metz), Cristóbal Vargas (CINVESTAV, México), Glenn F. Webb (Vanderbilt University).

European Women in Mathematics (EWM)

September 5–9, 2011
Participants: 73

Speakers

Pilar Bayer (Universitat de Barcelona), Annette Huber-Klawitter (Freiburg Universität), Laure Saint-Raymond (Université de Paris VI), Caroline Series (University of Warwick), Catharina Stroppel (Universität Bonn), Susanna Terracini (Università di Milano Bicocca), Corinna Ulcigrai (University of Bristol), Karen Vogtmann (Cornell University).

International Conference on Optimization, Theory, Algorithms and Applications in Economics

October 24–28, 2011
Participants: 133

Coordinators

Aris Daniilidis	Universitat Autònoma de Barcelona
Joydeep Dutta	Indian Institute of Technology Kanpur
Albert Ferrer	Universitat Politècnica de Catalunya
Marta Kornafel	Krakow University of Economics

Speakers

C. Aghayeva, Lino Alvarez, Hedy Attouch, Didier Aussel, Adil Baghirov, Miguel-Angel Ballester, Radu Bot, Jordi Caballé, Andrea Calogero, Emilio Carrizosa, Eduardo Casas, Agata Caserta, Jordi Castro, Ouayl Chadly, Jean-Pierre Crouzeix, Anulekha Dahra, Ioannis Dassios, Joydeep Dutta, Z. Dzalilov, Ayça Ebru, Laureano Escudero, Francisco Facchinei, Francesca Faraci, Fabian Flores-Bazán, Johannes Gierlinger, Miguel-Angel Goberna, Sorin Grad, Cesar Gutiérrez, Joaquim Gwinner, Nicholas Hadjisavvas, Andreas Hamel, F.J. Heredia, Beatriz Hernández, Carmen Herrero, Carlos Hervés-Beloso, J.B. Hiriart-Urruty, Lidia Huerga, Alexander Ioffe, Vladimir Jacimovic, Abderrahim Jourani, Angel A. Juan, Refail Kasimbeyli, Gabor Kassay, M. Kornafel, Y. Kucuk, Marc Lassonde, Cristian Litan, M. Lotfipour, Andreas Löhne, A. Manapova, M. Marechal, Antonio Martinón, Vyacheslav Maximov, Marc Mazade, Jelena Minovic, Boris Mordukovich, Jeffrey Pang, Juan Parra, Daniel Pasca, Jean-Paul Penot, Rita Pini, Nicolae Popovici, Justo Puerto,

Vicente Pérez, Margarita Rodríguez, S. Sagratella, M. Sama, Manuel Santos, Gonzalo Seco, Alberto Seeger, Yoshi Sekigushi, Hristo Sendov, Christian Tammer, Lionel Thibault, Michel Théra, Maxim Todorov, Gert Wanka, Alberto Zaffaroni, Alain Zemkoho.

Workshop on Computational Security

November 28 – December 2, 2011
Participants: 41

Speakers

Daniel Augot (Laboratoire d'informatique, École Polytechnique), Claude Carlet (Université Paris 8), Josep Domingo (Universitat Rovira i Virgili), Amparo Fúster-Sabater (Instituto de Física Aplicada, CSIC), Marcus Greferath (UCD Science Centre), Llorenç Huguet (Universitat de les Illes Balears), Josep M. Miret (Universitat de Lleida - Escola Universitària Politècnica), Jorge Ramió (Universidad Politécnica de Madrid), Joachim Rosenthal (Universität Zürich), Juan Tena (Universidad de Valladolid), Henk C.A. van Tilborg (Technische Universiteit Eindhoven).

3.3. Cursos avançats

En aquest apartat es detallen els cursos avançats que va organitzar el CRM durant l'any 2011 al marge dels programes de recerca.

3.3. Advanced Courses

This section lists the advanced courses organised by CRM during 2011, not included in research programmes.

Advanced Course on Constructive Approximation and Harmonic Analysis

March 10–20, 2011
Participants: 10

Organiser and Speaker	**Sergey Y. Tikhonov**	Centre de Recerca Matemàtica

Financial Engineering Summer School 2011

June 14–17, 2011
Participants: 82

Coordinators	**Joan del Castillo**	Universitat Autònoma de Barcelona
	Paul MacManus	Analistas Financieros Internacionales
Lecturers	Paul Embrechts	ETH Zurich
	Christopher Finger	MSCI, Inc
	Dilip Madan	University of Maryland
	Antoon Pelsser	Maastricht University

3.4. Jornades temàtiques

El CRM promou també trobades intensives de recerca sota la denominació de "jornades temàtiques". El 2011 es van celebrar les següents:

3.4. Thematic Days

The CRM also promotes intensive research meetings generically named "thematic days". In 2011 the following have been hosted:

☐ *Sixth Barcelona Weekend in Group Theory, April 15 and 16, 2011.*

Speakers Olga Kharlampovich (McGill University, Montréal), Jérôme Los (CNRS and Université d'Aix-Marseille I, Marseille), Gustavo Adolfo Fernández Alcober (Euskal Herriko Unibertsitatea, Bilbao), Collin Bleak (University of St. Andrews, Scotland, UK), Pedro Silva (Universidade do Porto, Portugal), Biel Cardona (Universitat de les Illes Balears).

☐ *First joint CRM-VHIR Workshop on Mathematical Modelling and Biomedicine, April 27, 2011.*

Speakers Alex Sánchez Pla (UEB), Mariàngels Serrano (UB), Juan Soler (Universidad de Granada), Tomás Alarcón (CRM), David Reguera (UB), Carme Calderer (University of Minnesota).

☐ *Thematic Day in Computability, July 17, 2011.*

Speakers Klaus Ambos-Spies(Universität Heidelberg), Andrey Frolov (Kazan State University), Valentina Harizonov (George Washington University), Margarita Leontyeva (Novosibirsk State University), Andrey Morozov (Novosibirsk State University), Paul Shafer (Appalachian State University).

☐ *III Jornadas Matemáticas en la Sociedad de la Información, September 16–17, 2011.*

Speakers Michael M. Marcellin (University of Arizona), Joan Ametller (INDRA), Ramon Eixarch (Maths for More), Diego Napp, Juan Jacobo Simón (Universidad de Murcia), Klara Stokes (URV), Jordi Puiggalí (Scytl), Benoît Libert (Université Catholique de Louvain), Josep Domingo (URV).

☐ *Jornada: Complejidad y Nolinealidad en Geociencia, October 6, 2011. Participants: 21*

Speakers Álvaro Corral (CRM), Henar Herrero, (Universidad de Castilla-La Mancha), Cristóbal López, Emilio Hernández-García (Institut de Física Interdisciplinar i Sistemes Complexos, Mallorca), Ana María Mancho (Instituto de Ciencias Matemáticas, Madrid), Cristina Masoller (Universitat Politècnica de Catalunya), Diego Pazó, Miguel Angel Rodríguez, Juan Manuel López (Instituto de Física de Cantabria), Vicente Pérez-Muñuzuri (MeteoGalicia & Universidade de Santiago de Compostela), Ana Maria Tarquis (Universidad Politécnica de Madrid), Antonio Turiel (Institut de Ciències del Mar, Barcelona).

☐ *Homenaje a Josep Gascón y VIII Seminario de Investigación TAD de Barcelona, November 25 –26, 2011.*

☐ *Workshop on Nanofluid Flows, December 14, 2011.*

Speakers Jon Summers (Institute of Engineering Thermofluids, University of Leeds), Tim Myers (Centre de Recerca Matemàtica), Andrew Sleigh (School of Civil Engineering, University of Leeds), Harvey Thompson (Institute of Engineering Thermofluids, Surfaces and Interfaces School of Mechanical Engineering, University of Leeds).

☐ *Col·loqui sobre Matemàtiques i Ciències de l'Espai, December 14, 2011.*

Speakers Emili Elizalde (ICE/CSIC & IEEC), Josep J. Masdemont (UPC), Jorge Núñez (UB) and Jean-Luc Starck (CosmoStat Lab, CEA/Saclay).

3.5. Activitats divulgatives

El CRM promou activitats de divulgació en l'àmbit de la matemàtica, a diferents nivells formatius. Durant el 2011 s'han organitzat xerrades científiques interdisciplinars, s'ha inaugurat una exposició que combina art fotogràfic amb l'esperit de la matemàtica i s'ha difós la recerca entre estudiants preuniversitaris.

☐ Conferències SCM-CRM de Matemàtiques i Ciència.

- Agustí Lledós, Catedràtic de Química Física, UAB. La química de la vida, l'energia i la sostenibilitat (explicada a un professor de matemàtiques), 7 d'abril de 2011.
- Tim Myers, Investigador Sènior, CRM, *Does the football really matter?*, 14 d'abril de 2011.

☐ *Ments Abstractes: un projecte fotogràfic a l'entorn de les matemàtiques*, exposició fotogràfica proposada per Francesc Creixell i Fernando Rascón. Del 18 al 27 de novembre de 2011, a l'IEC, en el marc de la XVI Setmana de la Ciència.

☐ Participació en el Saló de l'Ensenyament del 21 al 25 de març de 2011. Oferta de tutorització de treball de recerca de batxillerat.

3.5. Dissemination Activities

The CRM promotes dissemination activities around mathematics, at different specialization levels. During 2011, interdisciplinary scientific lectures have been organised, an exhibition combining photographic art and mathematical spirit has been launched, as well as informative actions for high-school students.

☐ *SCM-CRM Lectures on Mathematics and Science.*

- *Agustí Lledós, Professor of Physical Chemistry, UAB. La química de la vida, l'energia i la sostenibilitat (explicada a un professor de matemàtiques), April 7, 2011.*
- *Tim Myers, Senior Researcher, CRM, Does the football really matter?, April 14, 2011.*

☐ *Abstract Minds: a photographic project around mathematics; exhibition proposed by Francesc Creixell and Fernando Rascón. From November 18 to 27, 2011, at IEC, included in the activities of the XVI Science Week.*

☐ *Participation in the Saló de l'Ensenyament, March 21 to 25, 2011. Call for tutoring high-school research projects.*

3.6. Seminaris del CRM

El CRM difon l'activitat de tots els seminaris de recerca matemàtica de Catalunya, però també actua com a organitzador de seminaris en àrees emergents, bé a través de les seves xarxes temàtiques o bé a través dels investigadors del centre.

3.6. CRM Seminars

The CRM disseminates the activity of all the research seminars in mathematics in Catalonia, but it also organizes seminars in emergent areas, either through its thematic networks or through the CRM's research staff.

Seminar Cycle on Quantitative Finance

1. February 3, 2011. Juan-Pablo Ortega, Université de Franche-Comté, *Valoración por minimización del riesgo local de productos derivados con activo subyacente modelizado con GARCH*.

2. February 24, 2011. Youngjo Lee, Seoul National University, *H-Likelihood approach to finance and risk management*.

3. May 5, 2011. Omiros Papaspiliopoulus, Universitat Pompeu Fabra, *SMC2: A sequential Monte Carlo algorithm with particle Markov chain Monte Carlo updates* (with N. Chopin, P. Jacob).

4. June 2, 2011. Rama Cont, Columbia University, *Modeling endogenous risk*

Seminar Cycle on Computational and Systems Neuroscience

1. January 14, 2011. Stefano Panzeri, Istituto Italiano di Tecnologia, *The time scales of the primary cortical representation of naturalistic stimuli.*

2. February 4, 2011. Gianluigi Mongillo, Université Paris V, *Spatio-temporal irregularity and multi-stability in balanced networks with short-term synaptic plasticity*.

3. March 18, 2011. Miguel Maravall, Institut de Neurociències d'Alacant, UMH-CSIC, *Modes of thalamocortical communication in the whisker system*.

4. April 1, 2011. Paul Tiesinga, Radboud University Nijmegen, *Cortical enlightenment: models for attention*.

5. June 3, 2011. Alfonso Renart, Champalimaud Neuroscience Programme, Lisbon, Portugal, *Temporal correlations in cortical circuits*.

6. July 11, 2011. Christos Constantinidis, Wake Forest University School of Medicine Winston-Salem, *Changes in prefrontal cortical activity after learning to perform a working memory task*.

7. December 16, 2011. Tom Tetzlaff, Institute of Neuroscience and Medicine (INM-6), *Decorrelation of neural-network activity by inhibitory feedback.*

The CRM Applied Mathematical and Physics (CAMP) seminar

1. March 23, 2011. Marian Boguñà, Universitat de Barcelona, *The metric properties of the Internet.*

2. March 30, 2011. Mariàngels Serrano, Universitat de Barcelona, *Network-based scoring system for genome-scale metabolic reconstructions.*

3. March 31, 2011. Henrik Jensen, Imperial College, London, *Emergence of complex structure through co-evolution: The tangled nature model of evolutionary ecology.*

4. April 20, 2011. Carme Calderer, University of Minnesota, *Liquid crystal elastomers as models of the cytoskeleton.*

5. May 4, 2011. José. A. Cañizo, Universitat Autònoma de Barcelona, *Mean-field limits in PDEs and collective behaviour models.*

6. May 11, 2011. Adeline de Villardi de Montlaur, Escola Politècnica Superior de Castelldefels, UPC, *High-order discontinuous Galerkin methods for incompressible flow.*

7. May 25, 2011. Carlos Antonio Lugo Vélez, Universitat Politècnica de Catalunya, *Modelling the dynamics of Calcium release in the human heart: from single cell to tissue.*

8. June 1, 2011. Oriol Pont, EPI GeoStat, INRIA Bordeaux Sud-Ouest, Heartbeat and geophysical *turbulence: Nonlinear singularity exponents for multiscale inference and reconstruction of complex signals.*

9. July 5, 2011. Geoff Mercer, National Centre for Epidemiology and Population Health, Australian National University, *Spray droplet bounce, shatter and adhesion on a leaf surface.*

10. July 5, 2011. Geoff Mercer, National Centre for Epidemiology and Population Health, Australian National University, *Modelling disease transmission via contaminated water sources: A case study of hepatitis E in Uganda.*

11. September 14, 2011. Alvaro Kohn-Luque, Universidad Complutense de Madrid, *Modelling vascular morphogenesis.*

12. September 28, 2011. Clara Picallo, Universitat de Barcelona, *Fracture and plasticity in disordered media.*

13. October 19, 2011. Brian Wetton, University of British Columbia, *Two phase transport in porous media.*

Publicacions del CRM

CRM Publications

4

La publicació de documents de recerca és un dels canals de difusió del coneixement matemàtic per part del CRM. El CRM compta amb diverses sèries de publicacions estables: Advanced Courses in Mathematics, CRM Documents, Quaderns, Preprints, Series on Popularization, treballs finals de màster i tesis doctorals.

Per tal de coordinar aquesta activitat, s'ha creat, a finals de 2011, el Comitè Editorial del CRM, format per Carles Casacuberta (editor en cap del CRM), Antoni Guillamon (en representació de l'Equip de Direcció), Javier Gutiérrez (editor adjunt) i Raquel Hernández (responsable d'edició). El Comitè Editorial es reuneix bimensualment.

A continuació se citen els volums editats pel CRM durant l'any 2011.

The publication of research documents is one of the CRM channels for spreading mathematical knowledge. Apart from editing some singular texts, the CRM has several stable publication series: Advanced Courses In Mathematics, CRM Documents, Quaderns, Preprints, Series on Popularization, master's projects and PhD theses.

With the purpose of coordinating this activity, the CRM Editorial Board has been created in November 2011, formed by Carles Casacuberta (Editor in-Chief of CRM), Antoni Guillamon (representing the Team of Directors), Javier Gutiérrez (Assistant Editor) and Raquel Hernández (edition tasks). The Editorial Board meets every two months.

Next, we mention the volumes edited by the

4.1. Advanced Courses in Mathematics CRM Barcelona

Els volums d'aquests sèrie, publicada per l'editorial suïssa Birkhäuser, recullen el contingut d'alguns dels cursos avançats impartits al CRM, a partir de les notes prèvies lliurades als participants i reelaborades pels autors. Es tracta de llibres de text, especialment adreçats a estudiants de doctorat avançats i a investigadors postdoctorals.

The volumes of this series, published by the Swiss publishing company Birkhäuser, cover the content of some of the advanced courses taught by specialists at the CRM. They are based on notes handed out to students and later reworked by the authors. These volumes are especially addressed to advanced doctoral and young postdoctoral students.

Des de setembre de 2008, l'editor responsable d'aquesta sèrie és Carles Casacuberta. Ha substituït en aquest càrrec a Manuel Castellet, que va iniciar la sèrie l'any 2001.

Since 2008, the responsible editor of this series is Carles Casacuberta. He replaced Manuel Castellet, who started the series in 2001.

L'any 2011 han aparegut tres volums d'aquesta sèrie:

The following volumes of this series were published in 2011:

☐ L.A. Caffarelli, F. Golse, Y. Guo, C.E. Kenig, and A. Vasseur, *Nonlinear Partial Differential Equations*, edited by X. Cabré and J. Soler, ISBN 978-3-0348-0190-4.

☐ R. Cominetti, F. Facchinei, and J.B. Lasserre *Modern Optimization Modelling Techniques*, edited by edited by A. Daniilidis and J.E. Martnez-Legaz, ISBN 978-3-0348-0290-1.

☐ G. Citti, L. Grafakos, C. Perez, A. Sarti, and X. Zhong *Harmonic and Geometric Analysis*, edited by J. Mateu, ISBN 978-3-0348-0407-3.

4.2. CRM Documents

El CRM va iniciar una nova sèrie de volums amb ISBN l'any 2008, anomenada *Documents*. En aquesta sèrie s'hi publiquen monografies, actes de jornades o congressos, informes de projectes de recerca i altres reculls de material de qualitat.

The CRM launched a new series of volumes with ISBN in 2008, called Documents. These include monographs, proceedings of events, reports of research programmes, and other quality material.

Els volums de la sèrie publicats aquest any 2011 han estat els següents:

The following volumes were published in 2011:

☐ M. Bosch et al., *Un panorama de la TAD*, vol. 10, 2011.

☐ A. Alabert, T. Myers and J. Saludes, *Grups d'Estudi de Matemàtica i Tecnologia (GEMT 2010)*, vol. 9, 2011.

☐ P. Ramos and V. Sacristán, *XIV Spanish Meeting on Computational Geometry*, vol. 8, 2011.

☐ M. Dzamonja and B. Velickovic, *Young Set Theory Workshop 2009*, edited by D. Asperó, N. Castells, M.Á. Mota, and J. Veldman, vol. 7, 2011.

4.3. Quaderns

La sèrie *Quaderns* recull el contingut d'activitats especialitzades, principalment els apunts lliurats prèviament pel professorat de cursos avançats del CRM. Durant l'any 2011 s'han publicat els exemplars següents:

Booklets in the Quaderns series contain specialized texts, mostly preliminary notes delivered by lecturers of CRM Advanced Courses. The following issues were printed in 2011:

☐ A. Borichev, N. Makarov, A. Poltoratski, M. Sodin, P. Yuditskii. *Advanced Course on Krein-de Branges Spaces of Entire Functions and Old and New Spectral Problems*, vol. 61, May 2011.

☐ D. Kerr, C.N. Phillips, A.S. Toms, T. Giordano. *Advanced Course on Dynamical Systems*, vol. 62, June 2011.

☐ D. Cruz-Uribe, Feng Dai, M. Ruzhansky, V. Temlyakov and Y. Xu. *Advanced Course on Approximation Theory*, vol. 63, November 2011.

4.4. Preprints

La sèrie de prepublicacions del CRM s'ha incrementat amb els 97 títols següents durant l'any 2011:

The CRM preprint series grew with the following 97 issues in 2011:

☐ S.-D. Friedman, M. Koerwien. *On absoluteness of categoricity in abstract elementary classes*, preprint No. 01/2011

☐ E. B. Fokina, S.-D.Friedman, V. Harizanov, J. F. Knight, C. McCoy, A. Montalbán. *Isomorphism relations on computable structures*, preprint No. 02/2011

☐ N. Castellana, V. Franjou, A. Jeanneret, Jérôme Scherer. *Spaces with Noetherian cohomology*, preprint No. 03/2011

☐ S.-D.Friedman, T. Hyttinen, A. C. Walczak-Typke. *Potential isomorphism of elementary substructures of a strictly stable homogeneous model*, preprint No. 04/2011

☐ A. Bondarenko, D. Radchenko, M. Viazovska. *Optimal asymptotic bounds for spherical designs*, preprint No. 05/2011

☐ A. Atserias, M. Müller. *Partially definable forcing and bounded arithmetic*, preprint No. 06/2011

☐ Y. Chen, J. Flum, M. Müller. *On optimal probabilistic algorithms for Sat*, preprint No. 07/2011

☐ S. Buss, Y. Chen, J. Flum, S.-D. Friedman, M. Müller. *Strong isomorphism reductions in complexity theory*, preprint No. 08/2011

☐ T.G. Myers, S.L. Mitchell. *Application of the combined integral method to Stefan problems*, preprint No. 09/2011

☐ T.G. Myers, J. Low. *An approximate mathematical model for solidification of a flowing liquid in a microchannel*, preprint No. 10/2011

☐ Álvaro Corral, Albert Ossó, Josep Enric Llebot. Scaling of tropical-cyclone dissipation, preprint No. 11/2011

☐ S.L. Mitchell, T.G. Myers. Improving the accuracy of heat balance integral methods applied to thermal problems with time dependent boundary conditions, preprint No. 12/2011

☐ Y. Chen, J. Flum, M. Müller. Consistency and optimality, preprint No. 13/2011

☐ Ju. González-Meneses, E. Ventura. *Twisted conjugacy in braid groups*, preprint No. 14/2011

☐ L.J. Cummings, J. Low, T.G. Myers. *Extensional flow of nematic liquid crystal under electric field gradient*, preprint No. 15/2011

☐ J.J. Masdemont, L. Ortiz-Gracia. *Haar wavelets-based approach for quantifying credit portfolio losses*, preprint No. 16/2011

☐ S.-D. Friedman, T. Hyttinen, M. Koerwien. *The non-absoluteness of model existence in uncountable cardinals for* $L_{w1,w}$, preprint No. 17/2011

☐ N.P. Brown. *Generalized inductive limits of quasidiagonal* C^* *algebras*, preprint No. 18/2011

☐ B. Sehba, E. Tchoundja. *Hankel operators on holomorphic Hardy-Orlicz spaces*, preprint No. 19/2011

☐ M.M. De Decker, T.G. Myers. *Contact melting of a three-dimensional phase change material on a flat substrate*, preprint No. 20/2011

☐ L. Ortiz-Gracia, J.J. Masdemont. *Credit risk contributions under the Vasicek one-factor model: a fast wavelet expansion approximation*, preprint No. 21/2011

☐ A. Corral, F. Font, J. Camacho. *Non-characteristic half-lives in radioactive decay,* preprint No. 22/2011

☐ Y. Chen, J. Flum, M. Müller. *Hard instances of algorithms and proof systems*, preprint No. 23/2011

☐ S.-D. Friedman, T. Hyttinen. *On Borel equivalence relations in generalized Baire space*, preprint No. 24/2011

☐ T. Carroll, J. O'Donovan, J. Ortega-Cerdà. *On Lundh's percolation diffusion*, preprint No. 25/2011

☐ J.-F. Burnol. *Deux extensions de Théorèmes de Hamburger (portant sur l'équation fonctionnelle de la fonction dzêta)*, preprint No. 26/2011

☐ I. Hirshberg, E. Kirchberg, S. White. *Decomposable approximations of nuclear C^*-algebras*, preprint No. 27/2011

☐ P.J. Thomas. *Green vs. Lempert functions: a minimal example*, preprint No. 28/2011

☐ T.G. Myers. *An approximate solution method for boundary layer flow of a power law fluid over a flat plate*, preprint No. 29/2011

☐ A. Ferreiro-Castilla, W. Schoutens. *The β-Meixner model*, preprint No. 30/2011

☐ J.-F. Burnol. *On the system of the functions $x(s)/(s-r)^k$* , preprint No. 31/2011

☐ L. Moll, S. Tazari, M. Thurley. *Computing hypergraph width measures exactly*, preprint No. 32/2011

☐ J. Ortega-Cerdà, K. Seip. *A lower bound in Nehari's theorem on the polydisc*, preprint No. 33/2011

☐ K. Seip. *Interpolation and sampling in small Bergman spaces*, preprint No. 34/2011

☐ E. Christensen, A.M. Sinclair, R. R. Smith, S. White. *C*-algebras nearly contained in type I algebras*, preprint No. 35/2011

☐ M. Thurley. *An approximation algorithm for #k-SAT*, preprint No. 36/2011

☐ A. Sinclair, P. Srivastava, M. Thurley. *Approximation algorithms for two-state anti-ferromagnetic spin systems on bounded degree graphs*, preprint No. 37/2011

☐ S.-D. Friedman. *Equivalence relations in set theory, computation theory, model theory and complexity theory*, preprint No. 38/2011

☐ E. B. Fokina, S.-D. Friedman. *On $\Sigma^1_{1,1}$ equivalence relations over the natural numbers*, preprint No. 39/2011

☐ S. Pinto de Carvalho, R. Ramírez-Ros. *Non persistence of resonant caustics in perturbed elliptic billiards*, preprint No. 40/2011

☐ P. Ara, G. Cortiñas. *Tensor products of Leavitt path algebras*, preprint No. 41/2011

☐ R. Antoine, M. Dadarlat, F. Perera, L. Santiago. *Recovering the Elliott invariant from the Cuntz semigroup*, preprint No. 42/2011

☐ Y. Ameur, J. Ortega-Cerdà. *Beurling-Landau densities of weighted Fekete sets and correlation kernel estimates*, preprint No. 43/2011

☐ E. Nursultanov, S. Tikhonov. *A sharp Remez inequality for trigonometric polynomials*, preprint No. 44/2011

☐ E. Liflyand. *Complex and real Hausdorff operators*, preprint No. 45/2011

☐ V. Chousionis, J. Mateu, L. Prat, X. Tolsa. *Calderón-Zygmund kernels and rectifiability in the plane*, preprint No. 46/2011

☐ A. Gogatishvili, R.Ch. Mustafayev. *New pre-dual space of Morrey space*, preprint No. 47/2011

☐ V.D. Stepanov. *On a supremum operator*, preprint No. 48/2011

☐ P. Ara, R. Exel, T. Katsura. *Dynamical systems of type (m,n) and their C^*-algebras*, preprint No. 49/2011

☐ E. Liflyand, S. Samko, R. Trigub. *Absolute convergence of Fourier integrals*, preprint No. 50/2011

☐ B. Ayuso de Dios, F. Brezzi, O. Havle, L. Donatella Marini. *L^2-estimates for the DG IIPG-0 scheme*, preprint No. 51/2011

☐ A.M. Stokolos, W. Trebels. *Moduli of smoothness and rate of a.e. convergence for some convolution operators*, preprint No. 52/2011

☐ B. Ayuso de Dios, M. Holst, Y. Zhu, L. Zikatanov. *Multigrid preconditioner for nonconforming discretization of elliptic problems with jump coefficients*, preprint No. 53/2011

☐ B. Ayuso de Dios, A. Lombardi, P. Pietra, L. Zikatanov. *A block solver for the exponentially fitted IIPG-0 method*, preprint No. 54/2011

☐ B. Ayuso de Dios, I. Georgiev, J. Kraus, L. Zikatanovs. *A subspace correction method for dis-*

continuous Galerkin discretizations of linear elasticity equations, preprint No. 55/2011

☐ P.F. Antonietti, B. Ayuso de Dios, S. C. Brenner, L.-Y Sung. *Schwarz methods for a preconditioned WOPSIP method for elliptic problems*, preprint No. 56/2011

☐ J. Antezana, J. Buckley, J. Marzo, J.-F. Olsen. *Gap probabilities for the cardinal sine*, preprint No. 57/2011

☐ F. Lledó. *On spectral approximation, Følner sequences and crossed products*, preprint No. 58/2011

☐ F. Lledó. *Operator algebras: an informal overview*, preprint No. 59/2011

☐ A. Poltoratski. *Bernstein's problem on weighted polynomial approximation*, preprint No. 60/2011

☐ A.V. Bondarenko, D.P. Hardin, E.B. Saff. *Minimal N-point diameters and f-best-packing constants in Rd*, preprint No. 61/2011

☐ A.V. Bondarenko, D. Leviatan, A. Prymak. *Pointwise estimates for 3-monotone approximation*, preprint No. 62/2011

☐ R. Aktas, Y. Xu. *Sobolev orthogonal polynomials on a simplex*, preprint No. 63/2011

☐ I. Moale, P. Yuditskiik. *Parametrization of spectral surfaces of a class of periodic 5-diagonal matrices*, preprint No. 64/2011

☐ A. Baranov, Y. Belov, A. Borichev. *Hereditary completeness for systems of exponentials and reproducing kernels*, preprint No. 65/2011

☐ V.D. Stepanov. *Reduction theorems for operators on the cones of monotone functions*, preprint No. 66/2011

☐ N.C. Phillips. Equivariant semiprojectivity, preprint No. 67/2011

☐ A. Vagharshakyan. Chebyshev-type quadrature formulas for new weight classes, preprint No. 68/2011

☐ Á. Corral. *Hurricanes as weatherquakes and their response to climate change*, preprint No. 69/2011

☐ Á. Corral. *Tropical cyclones as a critical phenomenon*, preprint No. 70/2011

☐ Á. Corral, A. Turiel. *Variability of North Atlantic hurricanes: seasonal versus individual-event features*, preprint No. 71/2011

☐ Á. Corral, A. Ossó, J.E. Llebot. *Supplementary information scaling of tropical-cyclone dissipation*, preprint No. 72/2011

☐ Á. Corral. *Statistical tests for scaling in the inter-event times of earthquakes in California*, preprint No. 73/2011

☐ Á. Corral, R. Ferrer-i-Cancho, A. Díaz-Guilera, G. Boleda. *Universal complex structures in written language*, preprint No. 74/2011

☐ R. Calleja, A. Celletti, R. de la Llave. *KAM theory for conformally symplectic systems*, preprint No. 75/2011

☐ A. Jumabayeva, E. Smailov, N. Tleukhanova. *On spectral properties of the modified convolution operator*, preprint No. 76/2011

☐ M.G. Gadoev, S.A. Iskhokov. *Spectral properties of degenerate elliptic operators with matrix coefficients*, preprint No. 77/2011

☐ H. Thiel, W. Winter. *The generator problem for Z-stable C*-algebras*, preprint No. 78/2011

☐ K.N. Ospanov, R.D. Akhmetkaliyeva. *On separation of a degenerate differential operator in Hilbert space*, preprint No. 79/2011

☐ N.C. Phillips. *Analogs of Cuntz algebras on L^p spaces*, preprint No. 80/2011

☐ A.V. Bondarenko, D.V. Radchenko. *On a family of strongly regular graphs with* $\lambda = 1$, preprint No. 81/2011

☐ S. Kotani. *Krein's strings whose spectral functions are of polynomial growth*, preprint No. 82/2011

☐ U.V. Dubey, V.M. Mallick. *Reconstruction of a superscheme from its derived category*, preprint No. 83/2011

☐ U.V. Dubey, V.M. Mallick. *Spectrum of some triangulated categories*, preprint No. 84/2011

☐ V.V. Arestov, P.Yu. Glazyrina. *Integral inequalities for algebraic and trigonometric polynomials*, preprint No. 85/2011

☐ M. Sodin, P. Yuditskii. *Another approach to de Branges' theorem on weighted polynomial approximation*, preprint No. 86/2011

☐ N. Makarov, A. Poltoratski. *Beurling-Malliavin theory for Toeplitz kernels*, preprint No. 87/2011

☐ D. Kerr. *C*-algebras and topological dynamics: finite approximation and paradoxicality*, preprint No. 88/2011

☐ J. Campos, P. Guerrero, Ó. Sánchez, J. Soler. *On the analysis of travelling waves to a nonlinear flux limited reaction–diffusion equation*, preprint No. 89/2011

☐ A.S. Toms. T*he Cuntz semigroup and the classification of C*-algebra*, preprint No. 90/2011

☐ D. Gorbachev, S. Tikhonov. *Moduli of smoothness and growth properties of Fourier transforms: two-sided estimates*, preprint No. 91/2011

☐ D. Cruz-Uribe. *Variable Lebesgue spaces: Foundations and harmonic analysis*, preprint No. 92/2011

☐ F. Dai. *Weighted polynomial approximation on the sphere and related domain*, preprint No. 93/2011

☐ M. Ruzhansky. *Asymptotic behaviour of solutions to hyperbolic partial differential equations*, preprint No. 94/2011

☐ V. Temlyakov. *Greedy approximation*, preprint No. 95/2011

☐ Yuan Xu. *Approximation theory and harmonic analysis on the unit sphere*, preprint No. 96/2011

☐ P. Guerrero, J.L. López, J. Montejo-Gómez, J. Nieto. *Wellposedness of a nonlinear, logarithmic Schrödinger equation of Doebner–Goldin type modeling quantum dissipation*, preprint No. 97/2011

4.5. Other publications

Les altres sèries editades pel CRM (tesis doctorals, treballs de recerca de màster i materials de divulgació) es troben en format electrònic a la secció de Publicacions de la web del Centre. En aquesta memòria, podeu trobar el llistat de tesis doctorals de treballs de recerca de màster a la secció 2.5.

The rest of series edited by CRM (PhD theses, master's research projects and popularization materials) can be found in electronic format at the Publications section of the CRM website. In this report, PhD theses and master's research projects are listed in Section 2.5.

www.crm.cat/en/Publications/Pages/

Resum econòmic

Financial Summary

5

5.1. Ingressos — *5.1. Income*

Ingressos competitius *Competitive funding*	1.038.797,77 €
Ingressos no competitius *Non-competitive funding*	1.012.095,08 €
TOTAL	**2.050.892,85 €**

5.2. Despeses — *5.2. Expenses*

Despeses de personal *Personnel expenses*	1.162.319,65 €
Despeses d'explotació *Operating expenses*	583.164,22 €
Amortització inmobilitzat *Depreciation of intangibles*	181.701,08 €
Resultat financer (despesa) *Financial outcome (expenditure)*	31.302,00 €
Resultat exercici *Annual profit*	92.405,90 €
TOTAL	**2.050.892,85 €**