



CENTRE DE RECERCA MATEMÀTICA

Memòria d'Activitats  
*Report of Activities*

2013

CENTRE DE RECERCA MATEMÀTICA



Centres de recerca  
de Catalunya

CENTRE DE RECERCA MATEMÀTICA  
MEMÒRIA D'ACTIVITATS 2013  
*REPORT OF ACTIVITIES 2013*

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](mailto:crm@crm.cat)  
[www.crm.cat](http://www.crm.cat)

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# Presentació

**D**urant l'any 2013, hi ha hagut al CRM unes quantes bones notícies i s'han apuntat algunes bones tendències. En el terreny econòmic, durant el 2013, el darrer del contracte-programa que el centre tenia vigent des del 2008, el CRM s'ha mantingut en *stand-by*, si més no com en l'exercici anterior, però la congelació de recursos s'ha vist compensada per algunes d'aquestes bones notícies.

Sens dubte la més important és l'aprovació per part de la Fundació de l'Obra Social de la Caixa del programa formatiu en Recerca Matemàtica Col.laborativa. Aquest suport permetrà el CRM d'ofrir competitivament en els propers anys uns quants contractes de formació doctoral i postdoctoral, de tres anys cadascun, per treballar en projectes de tipus col.laboratiu definits conjuntament pels grups de recerca del CRM i grups d'altres disciplines científiques. La primera crida d'aquest programa va fer-se a finals del 2013 i ja hi ha hagut les primeres incorporacions.

Així com l'ajut de l'Obra Social de la Caixa permetrà donar un impuls a la recerca duta a terme al CRM, durant el 2013 el CRM ha aconseguit altres mecenatges que permetran al seu torn donar un impuls a la tasca que fa el CRM com a centre de sistema. Així, la Simons Foundation va aprovar un "Simons visiting program" al CRM adreçat específicament a potenciar els programes de recerca intensius que el centre organitza des de fa anys. En la mateixa direcció, el Clay Mathematical Institute ha donat també suport al CRM en l'organització d'aquests programes. Finalment, en aquesta línia, l'IEC va acordar donar suport econòmic al programa Lluís Santaló, adreçat a investigadors d'Amèrica Llatina.

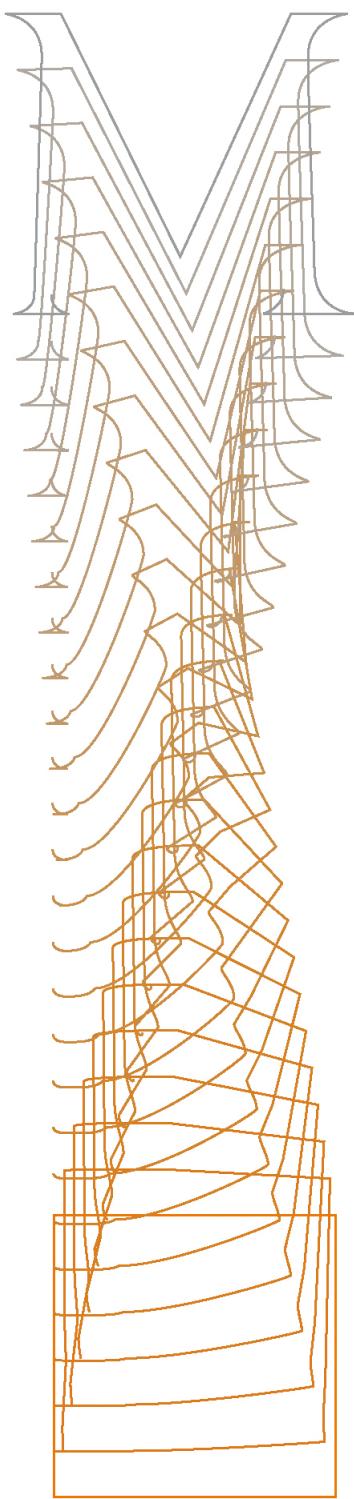
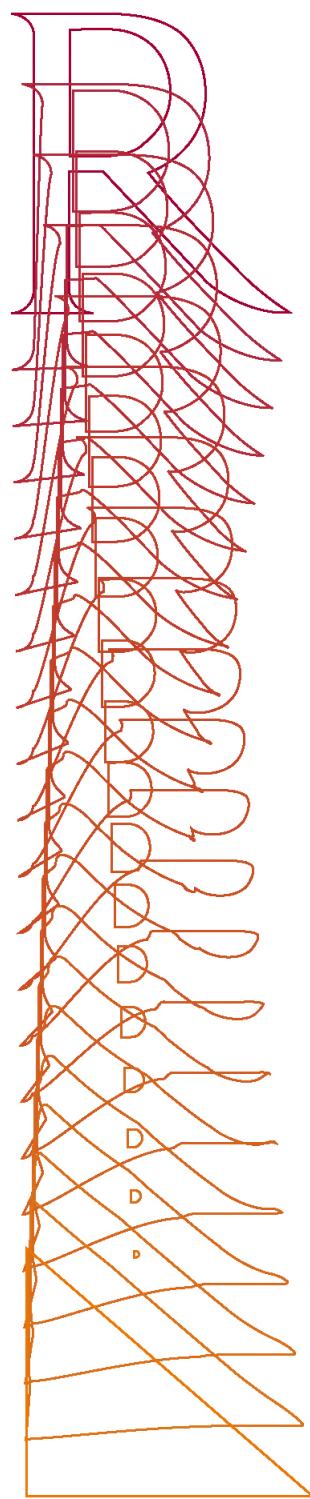
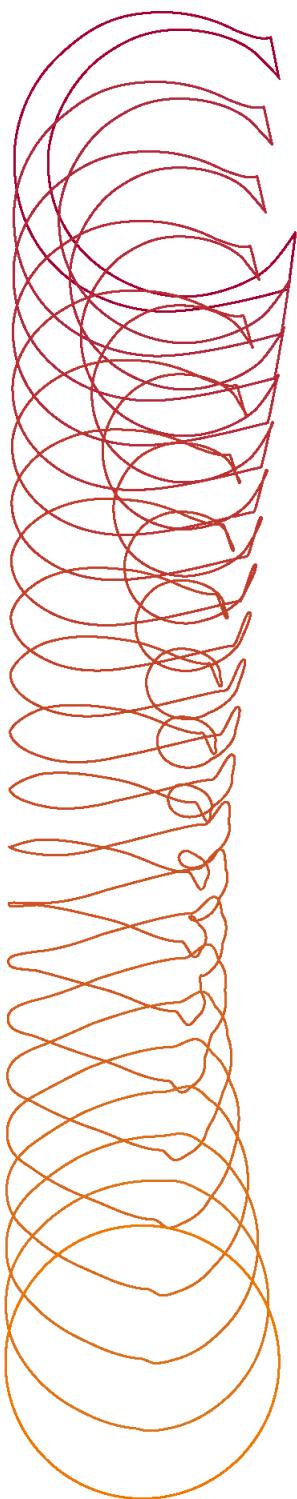
El 2013 ha vist també com algunes iniciatives començades el 2012 han estat exitoses, com la Dev-Math, adreçada a joves investigadors de països en vies de desenvolupament (cinc visites el 2013) i especialment el programa d'estades de recerca d'estudiants de grau i de màster (amb tres estades el 2013). Menció a part mereix el treball fet per la Unitat de Transferència de Tecnologia posada en marxa el 2012, que durant el 2013 ha completat dos projectes de consultoria, per a Ferrovial i Höhner, respectivament.

Però, és clar, no tot han estat bones notícies. Dos projectes que el CRM va presentar al programa de l'AGAUR en Doctorat Industrial, amb sengles empreses al darrera disposades a finançar el cost d'un contracte doctoral, s'han vist frustrats per la manca absoluta de candidats interessats, fet aquest que invita reflexionar sobre l'encaix amb el món laboral dels graduats en matemàtiques.

No puc acabar aquest resum sense referir-me a la notícia més important des del punt de vista institucional, que és la creació de la *Barcelona Graduate School of Mathematics* (BGSMath), de la qual el CRM n'és una entitat promotora, i que ja ha començat el curs 2013-14 oferint el seu propi programa formatiu a nivell doctoral. La BGSMath ha començat com a una iniciativa des de les bases, els grups de recerca, amb un marcat i admirable caràcter voluntarista per part de tothom. El pas següent ha de ser sens dubte dotar la BGSMath d'entitat jurídica pròpia i de recursos propis.

*Joaquim Bruna, Director*





## Presentation

**D**uring the year 2013 there have been some good news at CRM and we have envisaged some good trends. In the economic aspect, in 2013, last year of the contract that the center has had with Generalitat since 2008, the CRM has been in stand-by, as it was in 2012, but the freezing of funds has been compensated by some good news.

Undoubtedly the most important of those is the approval by the "la Caixa" Foundation of the training programme in Collaborative Mathematics. This support will enable CRM to offer competitively in the next few years doctoral and post- doctoral training contracts of three years each, to work on collaborative projects jointly defined by CRM research groups and groups from other scientific disciplines. The first call of this programme was launched at the end of 2013.

In the same way that the help of "la Caixa" Foundation will give a boost to research carried out at CRM, CRM has achieved in 2013 other sponsorships that will in turn reinforce the efforts made by CRM to work in favour of the whole of Mathematics in Catalunya. Thus, the Simons Foundation has approved a "Simons Visiting programme" at CRM specifically aimed at enhancing the intensive research programmes that the center organizes since long ago. In the same direction, the Clay Mathematical Institute and the US National Science Foundation have also given support to CRM in organizing these programmes. Finally in this vein, the Institut d'Estudis Catalans (IEC) agreed to financially support the Lluís Santaló programme aimed at researchers in Latin America.

During 2013, a number of initiatives that begun in 2012 have successfully consolidated, as for example the Dev-Math programme, aimed at young researchers from developing countries (five visits in 2013) and the internship programme for undergraduate and master's students (three stays in 2013). A special mention is to be done to the work completed by the Knowledge& Technology transference unit in 2012, that in 2013 has completed two consultancy projects for Ferrovial and Höhner, respectively.

But, of course, not all have been good news. Two doctoral projects presented by CRM to the Industrial Doctorate Plan of AGAUR, each with a sponsoring non-academic institution, have been frustrated by the complete lack of interested applicants, a fact that calls for some considerations about the training received by graduates in mathematics.

I can not conclude this summary without referring to the most important news from the institutional point of view, which is the birth of the Barcelona Graduate School of Mathematics (BGSMath), of which the CRM is a promoter, that in 2013-14 has already begun offering its own training program at doctoral level. The BGSMath has began as a bottom-up initiative, by an alliance of the Catalan research groups in Mathematics, with a great amount of enthusiasm and voluntarism by everyone involved. The next step should definitely be to provide the BGSMath with its own legal entity and structure.

*Joaquim Bruna, Director*



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CENTRE DE RECERCA MATEMÀTICA

## Descripció institucional

## *Institutional description*

### **1.1. Missió i objectius**

L'objectiu definit als estatuts del CRM és el foment de 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-ne grups propis.

### **1.1. Mission and Statement**

*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**

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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 de Barcelona 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 participants 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).

## **1.3. Consell de Direcció**

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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.

## **1.2. Legal Status**

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*The CRM was founded in 1984 as a research center within 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 a process started to incorporate Universitat Autònoma de Barcelona 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 centres in the CERCA Institution of research centres sponsored by the Generalitat de Catalunya, and of the Associació Catalana d'Entitats de Recerca (ACER). The CRM is a member of both of ERCOM, a committee of the European Mathematical Society (EMS), and the European Post-Doctoral Institute (EPDI).*

## **1.3. Governing Board**

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*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.*

- El vicepresident, que és el president de l'IEC, o persona en qui delegui.
  - Tres vocals en representació de la Generalitat de Catalunya.
  - Dos vocals en representació de l'IEC.
  - Un vocal en representació de la UAB.
  - El director del CRM, que hi participa amb veu però sense vot.
- The vice president, who is president of the IEC, or his delegate.*
  - Three representatives of the Generalitat of Catalunya.*
  - Three representatives of the IEC*
  - The Director of CRM, who participates with a voice but not a vote.*

El Consell de Direcció es va reunir el dia 13 de desembre de 2013. En aquesta reunió, la Generalitat de Catalunya va estar representada per Josep Maria Martorell com a director general de recerca, que va presidir el Consell. L'IEC hi va estar representat pel seu president, Joandomènec Ros, i per Joan Girbau. Lluís Tort, vicerector de Projectes Estratègics i de Planificació de la UAB, va assistir a la sessió en representació del rector de la UAB.

*The Governing Board met on December 13, 2013. In that meeting, the Generalitat de Catalunya was represented by Josep Maria Martorell, in his capacity of Director General de Recerca, who assumed the position of Chairman of the Board. The IEC was represented by the president, Joandomènec Ros, and by Joan Girbau. Lluís Tort, the vice-rector of Strategic Projects and Planning of the UAB, assisted to the meeting in representation of the rector of the UAB.*



#### **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 celebrar la seva reunió anual presencial el 25 de gener de 2013. Al llarg de l'any es van fer diverses reunions no presencials.

La composició de l'actual Consell Científic Assessor, aprovada en reunió del Consell de Direcció del 23 de maig de 2011, és:

Stephen O'Brien, University of Limerick  
 Helen Byrne, University of Oxford  
 Wolfgang Dahmen, RWTH Aachen  
 Charles Fefferman, Princeton University



#### **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 25, 2013. Throughout the year, on-line meetings were held.*

*The Governing Board approved on May 23, 2011, a new composition of the Scientific Advisory Board:*

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



## **1.5. 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,

## **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*

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.

## **1.6. ERCOM**

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ERCOM és l'acrònim del comitè European Research Centres on Mathematics de la Societat Matemàtica Europea (EMS), format pels directors científics de diversos centres europeus de recerca en matemàtiques. 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. A finals de l'any 2009 va ser escollit president Gert-Martin Greuel, director del Mathematisches Forschungsinstitut Oberwolfach.

La reunió anual d'ERCOM de 2013 tingué lloc els dies 22 i 23 de març al Centre International de Rencontres Mathématiques, a Luminy.

Per a més informació: [www.ercom.org](http://www.ercom.org)

## **1.7. Beques EPDI**

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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, a Bures-sur-Yvette (el director del qual és el coordinador de l'EPDI); Max-Planck-Institut für Mathematik, a Bonn; Isaac Newton Institute for the Mathematical Sciences, a

*improvement. The development of the contract-programme is analysed and discussed in an annual meeting of a monitoring commission.*

## **1.6. ERCOM**

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*ERCOM is the acronym of the European Research Centres on Mathematics committee of the European Mathematical Society (EMS), composed of the scientific directors of European research centres in mathematics. 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, director of the Mathematisches Forschungsinstitut Oberwolfach, was elected new chair.*

*The annual meeting of ERCOM in 2013 was held on March 22 and 23 at the Centre International de Rencontres Mathématiques, in Luminy.*

*Further information: [www.ercom.org](http://www.ercom.org)*

## **1.7. EPDI Fellowships**

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*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: 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, a Leipzig; Institute Mittag-Leffler, Djursholm; Banach Center, a Varsòvia; Erwin Schrödinger Institut, a Viena; Forschungsinstitut für Mathematik, a Zuric; Mathematisches Forschungsinstitut a Oberwolfach; i el CRM.

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.

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, Mathematisches Forschungsinstitut in Oberwolfach, and CRM.

The EPDI annually awards two-year post-doctoral grants in mathematics and mathematical physics, which are offered to young researchers in European countries.



<http://www.ercom.org/EPDI.htm>

## 1.8. BGSMath

Barcelona té una reconeguda excel.lència, al més alt nivell, en recerca en matemàtiques. En els darrers anys, s'han incorporat, de manera significativa, en aquest àmbit nombrosos estudiants estrangers, a través dels programes de màster i de doctorat de les universitats catalanes. En aquest escenari, el 2013 s'ha creat la *Barcelona Graduate School of Mathematics* (BGSMath) amb la intenció d'aportar una formació en recerca doctoral coordinada, d'alta qualitat i amb visibilitat internacional. La BGSMath també té com a objectius millorar l'ocupació de titulats en matemàtiques a la indústria i en l'àmbit no acadèmic en general, i esdevenir una plataforma per a tots els agents actius en recerca matemàtica orientada al desenvolupament de projectes col.laboratius.

Les institucions promotores de la BGSMath són la Facultat de Matemàtiques de la Universitat de Barcelona, el Departament de Matemàtiques de la Universitat Autònoma de Barcelona, la Facultat de Matemàtiques i Estadística de la Universitat Politècnica de Catalunya i el Centre de Recerca

## 1.8. BGSMath

Barcelona has an internationally recognized excellence in mathematics research at the highest level. In the latest years, the number of foreign graduate students enrolled in the master's and doctoral programs in Mathematics offered by Catalan universities has increased significantly. In this scenario, the *Barcelona Graduate School of Mathematics* (BGSMath) was created in 2013 with the aim of providing coordinated and high quality research PhD training with international visibility. Other mission of the BGSMath are the enhancement of employment of mathematicians in industry and in non-academic environment in general, and becoming a platform for all active agents in mathematical research towards the development of collaborative projects.

The promoting institutions of the BGSMath are the Facultat de Matemàtiques de la Universitat de Barcelona, the Departament de Matemàtiques de la Universitat Autònoma de Barcelona, the Facultat de Matemàtiques i Estadística de la Universitat Politècnica de Catalunya and the

Matemàtica. L’Institut de Matemàtica de la Universitat de Barcelona també hi participa com a entitat de suport.

Centre de Recerca Matemàtica. The Institut de Matemàtica de la Universitat de Barcelona also participates as a research support entity.



<http://www.bgsmath.cat/>

### **1.9. Red Española Matemática-Industria**

El CRM signà el mes de maig de 2012 un conveni de col.laboració amb l’associació *Red Española Matemática-Industria* (Math-in). L’objectiu d’aquest conveni és impulsar la valorització dels resultats de la recerca realitzats dins dels propis grups de recerca del CRM.

La creació de la *Red Math-in* ha constituït una de les accions prioritàries del Pla de Transferència Tecnològica del projecte i-MATH, i pretén ser l’evolució de la plataforma MATHEMATICA CONSULTING i constituir-se com un fòrum de comunicació, d’intercanvi d’informació i d’experiències per a la promoció de la transferència dels resultats de recerca dins l’àmbit de les matemàtiques.

### **1.9. Red Española Matemática-Industria**

In May 2012, the CRM signed a collaboration agreement with the association *Red Española Matemática-Industria* (math-in). The goal of this agreement is the impulse of appraisal of the research values achieved by the CRM research groups.

The creation of the Red math-in network has been one of the priorities of the Technology Transfer Plan of the i-MATH project, and tries to be the evolution of the Mathematica platform CONSULTING. It is intended to become a forum for communication and exchange of information and experiences to promote the transfer of research results produced into the field of mathematics.



<http://www.math-in.net/>

### **1.10. Patrocinis**

En la conjuntura econòmico-financera en què es mou actualment el CRM, alguns dels projectes endegats els darrers anys corren el perill de quedar-se en via morta. Afortunadament, els esforços del centre per captar l’interès de patrocindors sensibles a la recerca en matemàtiques ha tingut alguns fruits al llarg de l’any 2013. El CRM

### **1.10. Sponsorships**

In the economic and financial situation in which the CRM is currently immersed, some of the projects undertaken in the last times would be in danger of continuity. Fortunately, the efforts of the center to attract the interest of sponsors sensitive to research in mathematics has had some success along 2013. The CRM is deeply

està molt agraït a les institucions que es detallen a continuació perquè amb la seva contribució es podrà mantenir i incrementar la qualitat d'algunes de les activitats consolidades del centre.

### **1.10.1. Obra Social “la Caixa”**

---

L'Obra Social “la Caixa” és una institució compromesa amb la societat a través de projectes de suport al benestar, als drets humans, a la pau, a la justícia i a la dignitat de les persones. Aquesta fundació treballa conjuntament amb institucions de recerca per tal de generar coneixements científics obrint nous horitzons de recerca. El principal objectiu de l'acció de l'Obra Social “la Caixa” és la de finançar la ciència aportant més seguretat a aquestes institucions a l'hora de planificar la seva recerca i facilitant sinergies entre els diferents centres. A finals de 2013, l'Obra Social “la Caixa”, en el marc d'un acord amb el Govern de la Generalitat de Catalunya, va aprovar el finançament d'un programa de formació en Recerca Matemàtica Col.laborativa presentat pel CRM. El programa finançarà beques predoctorals de 3 anys de durada, així com contractes postdoctorals, tots ells al voltant de projectes de Matemàtica Col.laborativa conjunts entre grups del CRM i grups d'altres centres CERCA.



**Obra Social**  
**Fundació "la Caixa"**

[http://obrasocial.lacaixa.es/laCaixaFoundation/home\\_en.html](http://obrasocial.lacaixa.es/laCaixaFoundation/home_en.html)

### **1.10.2. Clay Mathematics Institute**

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El Clay Mathematics Institute (CMI) és una fundació privada dedicada al foment i disseminació del coneixement matemàtic. Un dels programes del CMI és l'anomenat “*Enhancement and Partnership Proposals*”, creat amb la intenció d'enriquir activitats ja planificades, principalment a través del finançament de participants a nivell internacional. El CMI va aprovar una proposta del CRM, que s'ha iniciat al 2013, consistent en finançar tant

*grateful to the institutions listed below since their contribution can maintain and increase the quality of some of the activities consolidated in the center.*

### **1.10.1. “la Caixa” Foundation**

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*“la Caixa” Foundation is an institution committed to society through Welfare Projects, human rights, peace, justice and people's dignity. The foundation also works together with research institutions to generate new scientific knowledge by opening up research horizons. The main aim of the action of “la Caixa” Foundation in sponsoring science is giving research institutions more security when planning their research and facilitating the generation of synergies among different centres. At the end of 2013, “la Caixa” Foundation, in the frame of the agreement with the Catalan Government, approved funding of the training program on Collaborative Mathematics presented by the CRM. The program will finance 3-year long predoctoral fellowships and postdoctoral contracts around projects of Collaborative Mathematics shared by CRM research groups and research groups of other CERCA centres.*

### **1.10.2. Clay Mathematics Institute**

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*The Clay Mathematics Institute is a privately funded operating foundation dedicated to increasing and disseminating mathematical knowledge. One of the programs of the CMI is the “*Enhancement and Partnership Proposals*”, aiming at enhancing activities that are already planned, particularly by funding international participation. Starting 2013, a CRM proposal on this program was approved by CMI to support participation of*

investigadors rellevants sèniors com joves postdocs en el marc dels Programes Temàtics de Recerca. En el primer any d'aplicació, 20 investigadors s'han beneficiat ja del suport del CMI.

*senior outstanding researchers and young postdocs in the CRM Thematic Research Programs, and 20 researchers participating in the two research programs organized have already benefited from the CMI financial support.*



<http://www.claymath.org/>

#### **1.10.3. Simons Foundation**

La *Simons Foundation* és una fundació privada la missió de la qual és ampliar les fronteres de la recerca en matemàtica i en ciències bàsiques. A finals de 2013, la *Simons Foundation* va aprovar una proposta del CRM per potenciar els actuals Programes Temàtics de Recerca finançant visites d'entre 2 i 6 mesos a investigadors sèniors. Durant l'any 2014, doncs, el CRM llançarà la primera crida del *Simons Visiting Program*.

#### **1.10.3. Simons Foundation**

*The Simons Foundation is a private foundation whose mission is to advance the frontiers of research in mathematics and the basic sciences. During Fall 2013, a CRM proposal aimed at enhancing the existing Thematic Research Programs by offering financial support to senior researchers for visits from 2 to 6 months long was approved. In 2014, thus, the CRM will launch the first call of the Simons Visiting Program.*

### SIMONS FOUNDATION

<https://www.simonsfoundation.org/>

#### **1.11. Equip de Transferència de Coneixement**

L'equip de Transferència de Coneixement del CRM es va formar el 2012 amb l'objectiu d'aplicar el coneixement i el saber fer adquirits en la recerca que es desenvolupa al centre, donant prioritat a aquells projectes que apostin per la innovació o que tinguin més relació amb la base matemàtica dels grups de recerca del CRM. Aquest és un avantatge competitiu perquè ens permet treballar amb eines punteres i afrontar qualsevol necessitat de modelització matemàtica, optimització o investigació operativa entre altres. En aquest sentit, l'equip de transferència ha realitzat, durant el 2013, dos projectes d'innovació amb empreses privades i ha organitzat dues jornades tecnològiques

#### **1.11. Knowledge Transfer Team**

*L'equip de Transferència de Coneixement del CRM es va formar el 2012 amb l'objectiu d'aplicar el coneixement i el saber fer adquirits en la recerca que es desenvolupa al centre, donant prioritat a aquells projectes que apostin per la innovació o que tinguin més relació amb la base matemàtica dels grups de recerca del CRM. Aquest és un avantatge competitiu perquè ens permet treballar amb eines punteres i afrontar qualsevol necessitat de modelització matemàtica, optimització o investigació operativa entre altres. En aquest sentit, l'equip de transferència ha realitzat, durant el 2013, dos projectes d'innovació amb empreses privades i ha organitzat dues jornades tecnològiques*

per donar-se a conèixer i apropar la recerca del centre al sector empresarial.

Els projectes realitzats han estat: (1) un estudi per a l'empresa *Ferrovial Servicios*, amb la creació d'un model matemàtic i una interfície per a calcular rendiments de serveis i optimitzar procediments i processos de decisió; (2) un estudi per a l'empresa *Hohner Automàtics S.L.*, i creació d'una eina de càlcul automatitzada de generació de codis òptims per a enconders rotatoris incrementals.

Tanmateix, aquest equip ha impulsat i coordinat, dues jornades tecnològiques que s'han desenvolupat al centre: (1) la Jornada CRM-Empresa sobre Finances Quantitatives, amb la intenció de promoure i dinamitzar la cooperació entre els àmbits acadèmics i privats interessats en temes financers; (2) les II Jornades de Consultoria Estadística i Software, (en col.laboració amb el departament d'estadística aplicada de la UAB), amb l'objectiu d'esdevenir un punt de trobada on compartir experiències i inquietuds relacionades amb l'Estadística, i convertir-se en una plataforma on exposar noves aplicacions d'utilitat per a la comunitat, tant científica com professional, que té relació amb l'Estadística.

## **1.12. Estructura i administració**

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### **1.12.1. Equip de direcció**

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El director del CRM és nomenat pel Consell de Direcció, a proposta del president, per a un període de quatre anys. L'actual director 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.

*per donar-se a conèixer i apropar la recerca del centre al sector empresarial.*

*Els projectes realitzats han estat: (1) un estudi per a l'empresa *Ferrovial Servicios*, amb la creació d'un model matemàtic i una interfície per a calcular rendiments de serveis i optimitzar procediments i processos de decisió; (2) un estudi per a l'empresa *Hohner Automàtics S.L.*, i creació d'una eina de càlcul automatitzada de generació de codis òptims per a enconders rotatoris incrementals.*

*Tanmateix, aquest equip ha impulsat i coordinat, dues jornades tecnològiques que s'han desenvolupat al centre: (1) la Jornada CRM-Empresa sobre Finances Quantitatives, amb la intenció de promoure i dinamitzar la cooperació entre els àmbits acadèmics i privats interessats en temes financers; (2) les II Jornades de Consultoria Estadística i Software, (en col.laboració amb el departament d'estadística aplicada de la UAB), amb l'objectiu d'esdevenir un punt de trobada on compartir experiències i inquietuds relacionades amb l'Estadística, i convertir-se en una plataforma on exposar noves aplicacions d'utilitat per a la comunitat, tant científica com professional, que té relació amb l'Estadística.*

## **1.12. Structure and administration**

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### **1.12.1. Team of Directors**

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*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 Joaquim Bruna as the CRM Director for an additional period of four years, starting on April 1, 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 en la reunió del 25 de maig de 2011.

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.

### **1.12.2. Gerent**

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

ofernandez@crm.cat      telèfon 93 586 8424



### **1.12.3. Equip d'administració**

L'equip d'administració del CRM durant el 2013 ha

*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 Antoni Guillamon as Deputy Director was proposed and approved unanimously by the Governing Board in the meeting on May 25, 2011.*

*The director, the assistant 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 in 2007.*

### **1.12.2. Manager**

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

### **1.12.3. Management team**

*The following people made up the management*

estat format per les següents persones:

*team in 2013:*

Joaquim Berenguer	jberenguer@crm.cat	Tel: 93 586 8423
Ana García-Donas	agarcia@crm.cat	Tel: 93 581 2953
Núria Hernández	n hernandez@crm.cat	Tel: 93 586 8192
Raquel Hernández	r hernandez@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
Jordi Mullor	jmullor@crm.cat	Tel: 93 586 8496
Neus Portet	n portet@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

### **1.13. 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<sup>2</sup>, després de la darrera ampliació finalitzada l'octubre de 2010, amb el finançament de la Generalitat i del fons FEDER. Permeten la ubicació de l'administració, 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 personnes.

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

Durant l'any 2013, l'equipament informàtic del CRM constava d'una xarxa LAN Ethernet d'aproximadament unes vuitanta estacions de treball basades en sistemes Microsoft i Linux, i 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. Es va dotar, dins d'aquesta xarxa, de sistemes per a permetre el treball en remot utilitzant FTP, accés al correu web, accés via SSH a servidors dedicats al càlcul i una securització a través de VPN per accedir a la resta de serveis del centre. Disposava també de connexió a internet sense cables, de set canons de projecció i sistemes de gravació per a les

### **1.13. Equipment**

*The CRM facilities are located in a wing of the UAB Faculty of Sciences with a total floor space of 2,125 m<sup>2</sup>, after completion in October 2010 of the enlargement of CRM premises, made possible through Generalitat and FEDER funding. The facilities include management 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.*

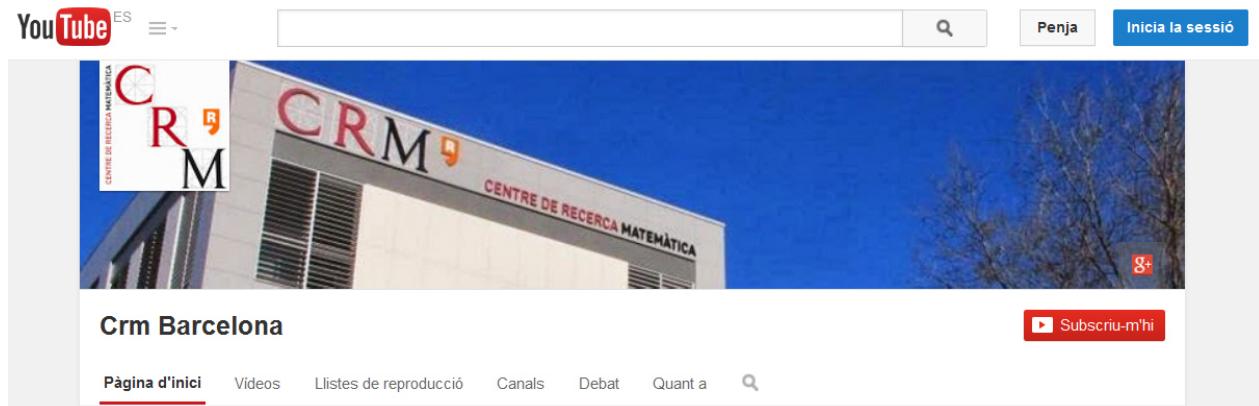
*During 2013, the CRM computer equipment was based on a LAN Ethernet net of, approximately, eighty workstations based both on Microsoft and Linux operating systems and structured under a Windows domain. Among other services, the net included an e-mail server, a printer server (managing the tasks of five printers), a file server and a Firewall/Router that linked it to the UAB infrastructure by means of a 1 Gb connection. The network was endowed with systems that allow the remote access via FTP, webmail access, SSH access to computing servers and a secure system through VPN to have access to the rest of center services. Facilities also included wifi internet connection, seven projectors and recording systems for all the meeting rooms, resources to videoconferencing, digital control systems for the*

aulas i sales de reunions, recursos per a establir videoconferència, sistemes digitals de control d'aulas, un panell tàctil de presentació del CRM i una infraestructura de retransmissió de gravacions, tant en directe com en diferit (*streaming*). Des d'aquest any, a més, el CRM compta amb el canal d'emissió

<https://www.youtube.com/user/CRMmatematica> on podreu trobar vídeos de conferències celebrades al centre.

*meeting rooms, a tactile CRM presentation panel and the infrastructure for live broadcasting and streaming. Moreover, the CRM has opened a broadcast channel at*

*<https://www.youtube.com/user/CRMmatematica> where you can find videos of lectures held in the center.*



## **1.14. Serveis externs**

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

## **1.14. External services**

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





## La recerca al CRM

## *Research at CRM*

### **2.1. CRM Research Groups**

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Tal i com s'ha esmentat 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 2013, s'han anant consolidant els següents grups de recerca del CRM:

- Sistemes Complexos / *Complex Systems*
- Biologia matemàtica i computacional / *Computational & Mathematical Biology*
- Neurociència Computacional / *Computational Neuroscience*
- Matemàtica Financera i Control de Riscos / *Financial Mathematics and Risk Control*
- Anàlisi Harmònica i Teoria de l'Aproximació / *Harmonic Analysis and Approximation Theory*
- Matemàtica Industrial / *Industrial Mathematics*
- Epidemiologia Matemàtica / *Mathematical Epidemiology*
- Anàlisi Numèrica i Computació Científica / *Numerical Analysis and Scientific Computing*

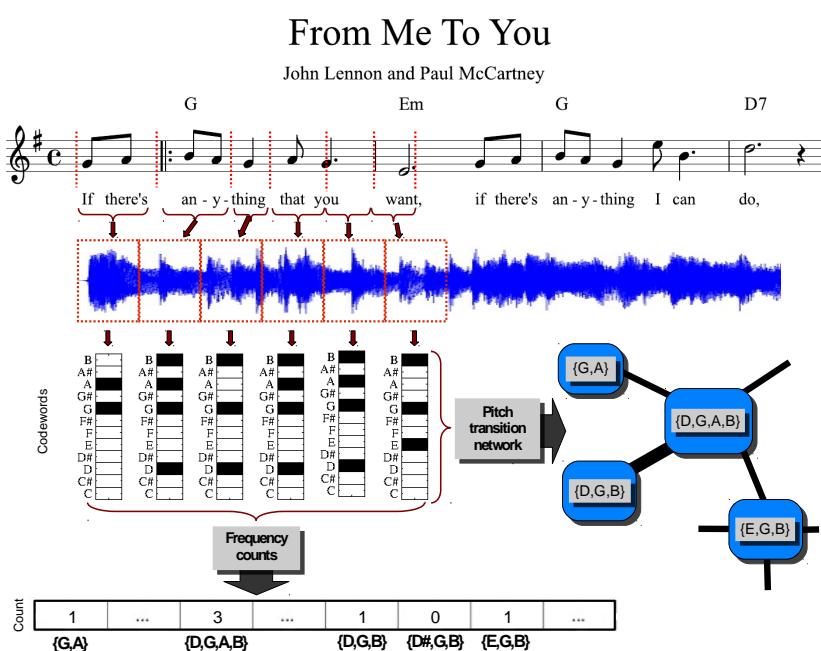
*As mentioned in Section 1.1, the scientific policy of the CRM has two main axes, the second one aiming at building its own research groups in underdeveloped areas in Catalonia. During 2013, the following CRM research groups continued their consolidation:*

## 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.

## 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.*



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. Pel que fa 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 peces musicals, per tal d'entendre millor com funcionen aquestes característiques tan exclusives del gènere humà i, per què no, esbrinar si les màquines les podrien reproduir.

*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 communicating agents. 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, modelling 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, to guess whether machines could reproduce them.*

### **Projectes vigents** *Current Projects*

- FIS2012-31324. *Scaling, complejidad y predictibilidad en fenómenos atmosféricos y formas de comunicación*, Ministerio de Economía y Competitividad, 2013–15. PI: Álvaro Corral.

### **Membres del grup** *Research Team*

- Álvaro Corral (team leader)
- Anna Deluca (PhD student)
- Francesc Font Clos (PhD student)
- Rosalba García (internship student)

### **Activitats relacionades** *Related Activities*

- European Conference on Complex Systems, ECCS 2013, Barcelona
- Joint CRM Imperial College School and Workshop on Complex Systems, 2013, CRM

### **Col.laboradors**

- |                         |                                      |
|-------------------------|--------------------------------------|
| ● Josep Lluís Arcos     | IIIA                                 |
| ● Gemma Boleda          | University of Texas at Austin        |
| ● Ramon Ferrer i Cancho | Universitat Politècnica de Catalunya |
| ● Antoni Planes         | Universitat de Barcelona             |
| ● Joan Serrà            | IIIA                                 |
| ● Eduard Vives          | Universitat de Barcelona             |

## **Group Activity in 2013**

*The activity of the year has gravitated around several major events, like the Joint CRM Imperial College School and Workshop on Complex Systems, the European Conference on Complex Systems, ECCS13, the ECCS Warm-up School on Complex Networks, or the contribution of A. Corral to an invited course of the SeisMath Intensive Programme. However, the most remarkable of all events has been that the group member Anna Deluca finished her doctoral thesis and got her PhD degree cum laude. The related research published in 2013 consists of a paper dealing with the fit and testing of power-law distributions, that has appeared in Acta Geophysica. Research including the other group member, Francesc Font-Clos, has been published in New Journal of Physics, dealing with an extension of Zipf's law, including dependence with text length, and its relation with "Heaps' law". An external collaboration has yielded the publication of a paper in Physical Review Letters, about the relationship between fractures in the laboratory and earthquakes. Undergraduate student Rosalba García joined the group in July and has worked intensively on branching processes since then.*

*Several collaborators or visitors of the group have contributed to the CRM CAMP seminars, including Eduard Vives, Universitat de Barcelona (Criticality during boiling crisis: Acoustic emission avalanches); Nicholas Moloney, London Mathematical Laboratory (An information-theoretic model for communication); Jörn Davidsen, University of Calgary (Inferring Causal Connections and Functional Networks); and Nico Stolenwerk, University of Lisbon (Fokker-Planck- and Hamilton-Jacobi-approximations in parameter estimation of complex epidemiological systems).*

## **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 per a sistemes biològics són més modestos. Aquesta circumstància es deu a què la unitat fonamental en sistemes vius (la cè.lula) és molt més complexa que les corresponents unitats en

### **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,*

sistemes inerts. Per tant, es necessiten tant models com mètodes nous per analitzar els processos 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.

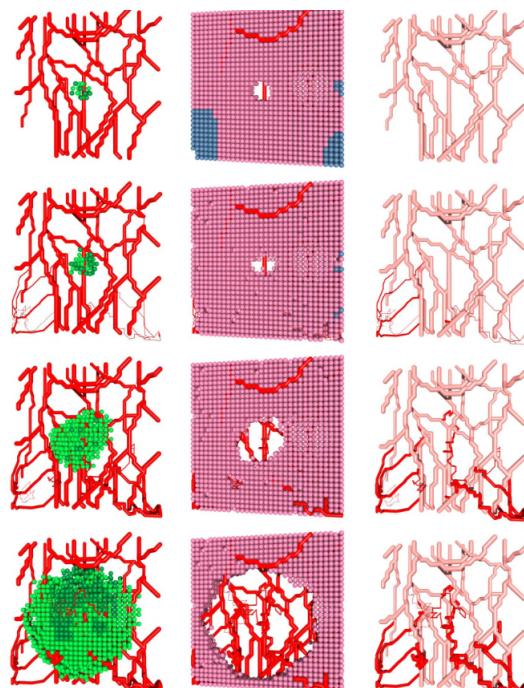
L'activitat del nostre grup s'articula al voltant de les línies de recerca següents:

- Modelització de múltiples escales de creixement tumoral i angiogènesi.
- Dinàmica evolutiva de poblacions amb estructura complexa, en particular, de poblacions de cèl.lules amb estructura jeràrquica i mapa entre genotip i fenotip.
- Modelització del cicle cel.lular.
- Modelització estocàstica de receptors tirosina-quinasa.
- Tumors latents.

*new methods and models are needed to analyse multi-scale 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.*

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

- *Multiscale modelling of tumour growth and tumour-induced angiogenesis.*
- *Evolutionary dynamics of populations with complex structure, in particular populations of cells with hierarchical structure and genotype-phenotype map.*
- *Mathematical modelling of the cell-cycle.*
- *Stochastic modelling of tyrosine-kynase receptors.*
- *Tumour dormancy.*



**Projectes vigents**  
*Current Projects*

- MTM2011-29342. *Mathematical models of biological population dynamics with complex structure*, 2011. PI: Tomás Alarcón.

**Membres del grup**  
*Research Team*

- Tomás Alarcón (team leader)
- Pilar Guerrero (post-doctoral researcher)
- Roberto de la Cruz (PhD student)
- 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 Autónoma de México
- Karen M. Page University College London
- Juan Soler Universidad de Granada
- Rui Travasso Universidade de Coimbra

**Group Activity in 2013**

*During 2013, research of the Computational & Mathematical Biology Group has been focused on furthering our four ongoing projects, namely, development of stochastic multiscale modelling of cell populations leading to the formulation of age-structured stochastic populations models with applications to tumour growth, investigating of the stability of stochastic structured populations leading to the formulation of new mechanism for extinction in hierarchically organised populations, the formulation of evolutionary models of the 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, and, modelling the dynamics of latent HIV-1 infections, in particular the origins and clinical significance of the so-called viral blips. Additionally, I have opened a new research line consisting of an experimental investigation of rheological properties of blood at the microscale.*

*Regarding research output, the group has published 6 papers (4 published, 2 to appear) in ISI journals, 5 of them within the first quartile and 1 within the second quartile of their respective categories. I have also been invited to several national and international conferences, workshops and summer schools, including invited talks at the Workshop in Tumour Modelling held in Oxford and the Mathways into Cancer conference.*

## Computational Neuroscience

### Àmbit de recerca

La neurociència computacional és un subcamp de la neurociència en el qual els models computacionals s'usen per a entendre millor com funciona el sistema nerviós. Es tracta d'un camp molt vast, que disposa de molts tipus diferents de model, des dels estadístics o probabilístics, fins a les equacions diferencials. Com que la major part del treball experimental en neurociència requereix algun grau de modelatge, encara que només sigui a nivell d'anàlisi de dades, no hi ha una divisió clara entre la neurociència experimental i la computacional. Això implica que una col.laboració estreta entre teòrics i experimentalistes és molt important, i fa que la tasca computacional estigui molt condicionada per les dades experimentals.

En el Grup de Neurociència Computacional del CRM, ens centrem principalment en la dinàmica de microcircuits corticals, és a dir, conjunts de centenars o milers de neurones de l'escorça cerebral. En particular, s'estudia la paper de la connectivitat recurrent en la conformació de l'activitat espontània en models de microcircuits corticals. Aquest tema de recerca molt oportú en aquests moments perquè les dades de connectivitat cortical han anat en augment en l'última dècada, i s'han produït millores notables en mesures d'activitat simultània d'un gran nombre de neurones. Un objectiu futur seria identificar quins aspectes de la connectivitat de la xarxa són més importants per al processament cortical en els models, i llavors dirigir els experiments a buscar patrons similars en el cervell. Addicionalment, estem desenvolupant models de formació i consolidació de la memòria per tal d'explorar els límits

### Research Field

*Computational neuroscience is a sub-field of neuroscience proper in which computational models are used to learn something about how the nervous system works. It is a broad field, encompassing many different types of models, from statistical or probabilistic models, to differential equations. As most experimental work in neuroscience already requires some degree of modeling, if only at the level of data analysis, there is no clear divide between experimental and computational neuroscience. This means that close collaboration between theorists and experimentalists is important. At the very least, modeling work must be constrained by experimental data.*

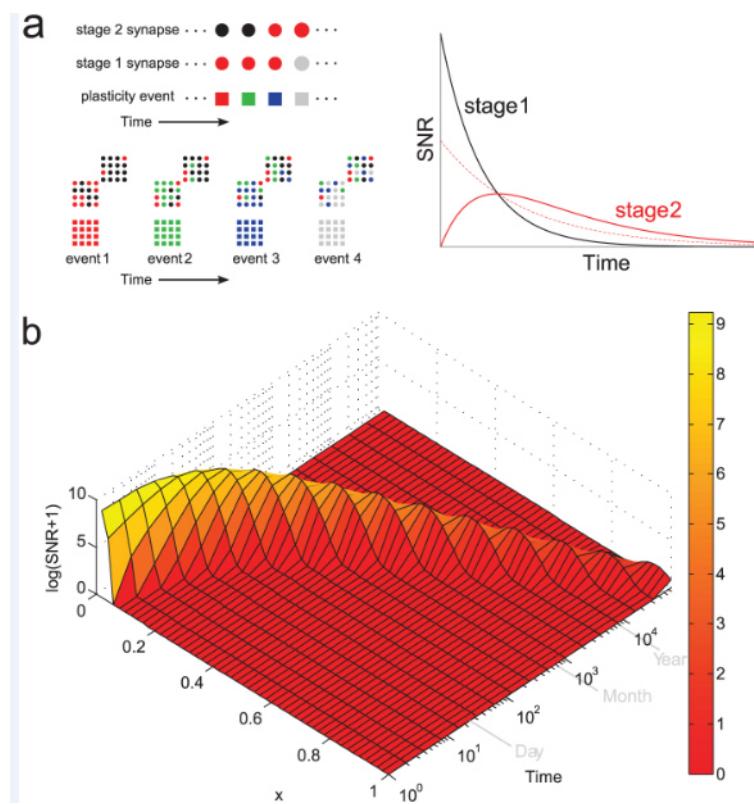
*In the Computational Neuroscience group at the CRM, we focus mainly on the dynamics of cortical microcircuits, that is ensembles of hundreds or thousands of neurons in the cerebral cortex. In particular, we study the role of the recurrent connectivity in shaping spontaneous activity in models of cortical microcircuits. This is a timely topic because data on cortical connectivity has been increasing over the past decade, as well as improved measurements of the simultaneous activity of large numbers of neurons. A future goal would be to identify which aspects of network connectivity are most important for cortical processing in models, and then direct experimentalists to look for similar patterns in the brain. Additionally we are developing models of memory formation and memory consolidation in order to explore the computational limits of biological memory systems and shed light on the physiological*

computacionals dels sistemes de memòria biològics i orientar sobre els mecanismes fisiològics involucrats en la memòria del cervell animal.

El grup de Neurociència Computacional es va iniciar el maig de 2012. Durant l'any 2013, s'hi han incorporat diversos membres. En particular, Marina Vegué, distingida amb una de les prestigioses beques de la Fundació La Caixa, s'ha unit al grup com a estudiant doctoral per a treballar en models de connectivitat cortical. Un segon estudiant de doctorat, Bernat Rovira, s'ha incorporat al grup gràcies a una beca de formació del Ministeri d'Economia i Competitivitat (equivalent a les antigues FPI) associada al projecte de recerca d'Alex Roxin. Amb aquest mateix projecte es finança un contracte postdoctoral per treballar en models de formació i consolidació de la memòria. Aquesta plaça serà ocupada per Panagiota Theodoni, a partir de març 2014.

*mechanisms involved in memory in the animal brain.*

*The group of Computational neuroscience was started in May 2012. Several new members joined the Computational Neuroscience Group in 2013 and early 2014. Specifically, Marina Vegué, the winner of a prestigious doctoral grant from the Caixa Foundation, joined the group as a PhD student to work on models of cortical connectivity. A second PhD student, Bernat Rovira, joined the group through a student traineeship grant (formerly FPI) associated with the PIs research project from the Spanish Ministry of Economics and Competitiveness. The same grant also funds a postdoctoral position to work on models of memory formation and consolidation. This position has been filled by Panagiota Theodoni, who will begin work in March 2014.*



<b>Membres del grup Research Team</b>	<ul style="list-style-type: none"> <li>• Alex Roxin (team leader)</li> <li>• Marina Vegué (PhD student)</li> <li>• Bernat Rovira (PhD student)</li> <li>• George Paul Cribari (Masters Student, Neuroscience UAB)</li> <li>• Mauro Martínez (Undergraduate student, Physics UAB)</li> </ul>
<b>Colaboradors Collaborators</b>	<ul style="list-style-type: none"> <li>• Albert Compte IDIBAPS</li> <li>• Jaime de la Rocha IDIBAPS</li> <li>• Ernest Montbrió Universitat Pompeu Fabra</li> <li>• Duane Nykamp University of Minnesota</li> </ul>
<b>Projectes vigents Current Projects</b>	<ul style="list-style-type: none"> <li>• BFU2012-33413. <i>Memory encoding and consolidation: a computational study</i>, 2013–2015. PI: Alex Roxin.</li> </ul>
<b>Group Activity in 2013</b>	<p>Two new doctoral students began their thesis work in the group in Fall 2013. Marina Vegué began work on models of cortical connectivity with a grant from the Caixa, while Bernat Rovira is working on models of memory formation and consolidation. The group regularly participates in a joint journal club with researchers at the Institut d'Investigacions Biomèdiques August Pi i Sunyer, with whom the PI also collaborates. The PI co-organized two conferences: the 2013 Barcelona Computational and Systems Neuroscience conference and the European Science Foundation Exploratory Workshop entitled “Noise in decision making: theory meets experiment”. The PI published a paper in PLoS Computational Biology on simple models of memory consolidation in collaboration with Stefano Fusi of Columbia University.</p>

## Financial Mathematics and Risk Control

### Àmbit de recerca

Les Finances Computacionals es troben en la intersecció entre el numèric i l'estocàstic. Un aspecte important de la recerca en aquest camp és millorar el rendiment dels mètodes de valoració i medició del risc. Un dels interessos particulars del nostre grup és l'aproximació numèrica de densitats rellevants en Finances a partir de la funció característica, mitjançant tècniques basades en ondícules. Els camps d'aplicació són la valoració d'opcions, de derivats de crèdit, així com el càlcul de les mesures de risc de mercat i de crèdit.

Alguns dels problemes que estudiem són:

- Risc de crèdit i modelització del capital

### Research Field

*Computational Finance lies at the intersection of numerics and stochastics. An important aspect of research in this field is to further increase the performance of pricing and risk measurement methods. Of particular interest to our group is the approximation of relevant densities in Finance from the characteristic function by means of wavelets-based techniques. Fields of interest are option pricing, credit derivatives and computation of the market and credit risk measures.*

*Some of the problems that we are studying are:*

- *Credit risk and economic capital modeling.*

econòmic. Mètodes numèrics eficients per calcular les mesures de risc a nivell de cartera.

- Valoració de derivats de crèdit.
- Mètodes de Fourier i d'ondícules en valoració d'opcions a partir de la fórmula del valor esperat del *payoff* descomptat.
- Medició del risc de mercat en Carteres no lineals. Valor-en-risc i *Expected Shortfall* per a Carteres d'opcions.

**Membres del grup**  
*Research Team*

- Luis Ortiz

*Efficient numerical methods to compute the risk measures at portfolio level.*

- *Credit derivatives pricing.*
- *Fourier and wavelet methods in option pricing by means of the discounted expected pay-off formula.*
- *Market risk measurement in non-linear portfolios. Value-at-risk and Expected Shortfall for portfolios of options.*

(team leader)

**Activitats relacionades**  
*Related Activities*

- Seminari de Finances Quantitatives, Xarxa temàtica del CRM.
- Jornada CRM-Empresa sobre Finances Quantitatives, Xarxa temàtica del CRM, February 22nd, 2013.
- Financial Engineering Summer School, June 2013, Borsa de Barcelona.

**Col.laboradors**  
*Collaborators*

- Cornelis W. Oosterlee Centrum voor Wiskunde en Informatica and Delft University
- Elisa Alòs Universitat Pompeu Fabra

## 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, física, probabilitat 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 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 un àrea establerta de les matemàtiques en fase de creixement per la varietat de les seves aplicacions, no solament en matemàtiques (anàlisi numèrica,

### Research Field

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

anàlisi en ondetes) sinó també en ciències de la computació, tractament del senyal, biomedicina, 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.

*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.

**Membres del grup**  
*Research Team*

- Sergey Tikhonov (team leader)
- Ramazan Akgun (post-doctoral researcher)
- Petr Chunaev (PhD student)
- Ainur Jumabayeva (PhD student)

**Activitats relacionades**  
*Related Activities*

- Barcelona Analysis Seminar (every Monday, CRM or UB).
- Approximation Theory Seminar (every Monday or Tuesday; from September 2011).

**Col.laboradors**  
*Collaborators*

- Feng Dai University of Alberta
- Andrey Bondarenko Norwegian University of Science and Technology
- Feng Dai University of Alberta
- Laura De Carli Florida International University
- Erlan Nursultanov Eurasian University
- Michael Ruzhansky Imperial College London
- Walter Trebels Technische Universität Darmstadt

**Group Activity in 2013**

*During 2013 the members of the group studied the following topics:*

*Fourier series, function spaces, embedding theorems, weighted norm for integral transforms, polynomial inequalities, energy minimization, moduli of smoothness, regularity problems of the Monge-Ampère equation.*

*In particular, R. Akgun studied polynomial inequalities with weights. P. Chunaev studied the Hardy-type inequalities for some special classes of sequences. 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 has been working on sharp Remez and Nikol'skii inequalities and weighted norm inequalities for Fourier-type transforms.*

## 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 grup de recerca en MI del CRM treball actualment en tres àrees principals:

- Nanomatemàtica. La Nanotecnologia és un àmbit de recerca apassionant en ràpida expansió en el qual apareixen nous reptes constantment. La recerca en aquest camp està dominada per l'experimentació i la computació. El grup de MI està treballant en impulsar l'aplicació de la matemàtica als problemes de la nanociència. Els projectes actuals del grup se centren en la modelització del canvi de fase a la nanoescala, en el flux de nanofluids i en descobrir la natura, a les capes frontera, del flux d'un fluid damunt una superfície sòlida.
- Canvi de fase. Les transicions de fase ocorren en un gran nombre de situacions naturals i industrials, com ara la formació del gel, la formació de metalls a partir de l'estat fos, la fabricació de discs 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. El grup de MI està investigant actualment en aplicacions pràctiques del canvi de fase com ara la solidificació de líquids subrefredats, els efectes a la nanoescala i la descongelació per microones, així com en aspectes teòrics com l'aplicació de mètodes aproximats i qüestions relacionades amb la conservació d'energia.

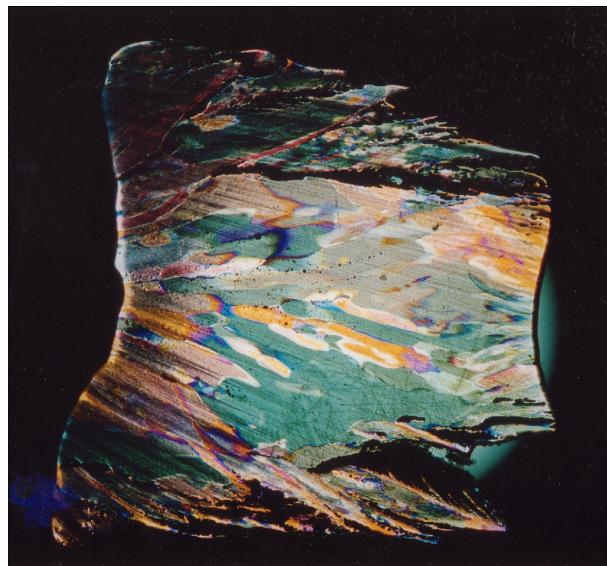
### Research Field

*“Industrial mathematics” is a rather loose term, basically covering any application of mathematics in an industrial context. The research group at CRM currently has three 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 currently 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 discovering the nature of the boundary layer flow of a fluid over a solid surface.*
- *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, 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. The group is currently investigating practical applications of phase change such as solidification of supercooled melts, nanoscale effects and microwave defrosting, as well as theoretical issues such as the application of approximate methods and energy conservation issues.*

□ Fluxos de pel·lícula fina. Aquesta mena de fluxos pot incloure el moviment de lubrificants, pintures, l'aigua que llisca 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, obviament, té moltes aplicacions. Aquesta recerca involucra tant fluids newtonians com no newtonians.

□ *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. This work involves both Newtonian and non-Newtonian fluids.



**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*, 2011–2014. PI: Tim Myers.

**Membres del grup**  
*Research Team*

- |                      |                                 |
|----------------------|---------------------------------|
| ● Tim Myers          | (team leader)                   |
| ● Teresa Cao         | (post-doctoral researcher)      |
| ● Vincent Cregan     | (post-doctoral researcher)      |
| ● Michelle De Decker | (PhD student)                   |
| ● Francesc Font      | (PhD student)                   |
| ● Helena Ribera      | (research assistant)            |
| ● Sarah Mitchell     | University of Limerick          |
| ● Ebrahim Momoniat   | University of the Witwatersrand |

**Col.laboradors**  
*Collaborators*

- |                              |                                    |
|------------------------------|------------------------------------|
| ● Linda Cummings, Lou Kondic | New Jersey Institute of Technology |
| ● James Hill                 | University of Adelaide             |

- Jon Summers      University of Leeds
- Harvey Thompson      University of Leeds
- Brian Wetton      University of British Columbia

### **Group Activity in 2013**

*The IM group has primarily focussed on modelling of nano-phenomena, with a few forays into more traditional industrial problems, such as microwave defrosting and elastic deformation. Specific details of all activities are given below.*

**1. Research:** *Francesc Font focussed on phase change 'beyond the classical Stefan problem', with applications to the solidification of supercooled melts and melting of nanoparticles. Michelle MacDevette continued working on nanofluids but has recently concentrated on the application of a particular solution method. Teresa Cao worked on microwave defrosting. She was subsequently replaced by Vincent Cregan who is currently working on the use of nanofluids in solar energy capture.*

**2. Dissemination:** *The group published 6 journal articles this year, on topics such as contact melting, energy conservation in Stefan problems and football motion through the air. A further 6 papers were submitted (of which 1 has already been accepted and another 1 published). Talks on these and other topics were given at conferences and in seminar series in Belgium, Ireland, Netherlands, Spain, UK and the US.*

*Tim Myers formed part of a team at Universitat Politècnica de Catalunya teaching a mathematical modelling course to undergraduates. He also (successfully) supervised a short term research visitor (who stayed for 10 months), Helena Ribera, a graduate of Universitat de Barcelona. A post-doctoral visitor, Vassil Tzanov, joined the group for a month.*

**3. Visitors:** *Prof. Lou Kondic of New Jersey Institute of Technology spent 1 month at CRM, Dr Mitchell of the University of Limerick visited to provide numerical and analytical advice in the field of phase change.*

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## **Mathematical Epidemiology**

### **Àmbit de recerca**

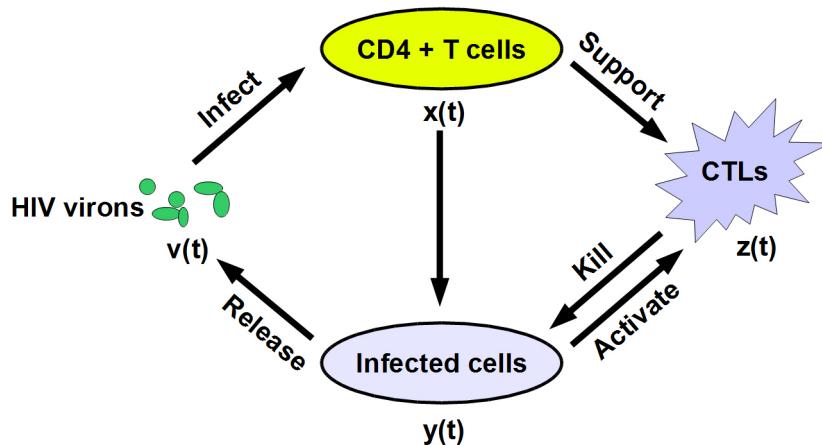
Els models matemàtics de les malalties infeccioses dels éssers humans, els animals domèstics i silvestres i les plantes constitueixen una àrea de recerca molt rellevant i en ràpida expansió. L'objectiu del recentment creat grup de recerca en Epidemiologia Matemàtica és l'estudi matemàtica de l'aparició i propagació de malalties infeccioses.

### **Research Field**

*The mathematical modelling of infectious diseases of the humans, domestic and wild animals and plants is a rapidly expanding and a highly practically relevant area of research, and the aim of the newly established Mathematical Epidemiology Research Group is to study the emergence and spread of infectious diseases from a mathematical point*

El grup investiga en diferents direccions, com ara l'aparició de nous agents patògens, la seva evolució, la dinàmica de les malalties infeccioses en una població, així com la dinàmica de microparàsits dins d'un hoste. També treballem en l'elaboració d'una descripció matemàtica de la resposta immune, per analitzar-ne fallades com la que es dóna en la infeció per VIH. Estem interessats, a més, en el control d'infeccions, tant a nivell d'un sol hoste com a nivell de població i, com a tasca de particular importància, ens proposem col.laborar amb epidemiòlegs i biòlegs en el desenvolupament d'estrategies racionals per al control de malalties infeccioses.

*of view. The group is working towards a number of directions of research such as the emergence of new pathogens, evolution of pathogens, the dynamics of infectious diseases in a population, as well as the dynamics of microparasites within a host. It is also dealing with mathematical description of immune response, as well as with its failure, as in the case of HIV infection. We are also interested in methods to control of infections, at both a single host and a population levels, and consider assisting the epidemiologists and biologists in the development of rational strategies for control of infectious diseases as a task of particular importance.*



Des del grup d'Epidemiologia Matemàtica treballem en estret contacte amb científics experimentals i amb el grup de recerca en Biologia Computacional i Matemàtica del CRM. En la nostra recerca emprem models matemàtics i tècniques de la teoria de sistemes dinàmics per a descriure i estudiar la dinàmica de les malalties infeccioses. Els nostres interessos particulars se centren en la invasió de les infeccions emergents, en l'estabilitat i persistència d'un agent patogen, així com l'estabilitat de la resposta immune. Estem també interessats en l'evolució viral i microbiana, que és probablement el factor més important responsable de l'aparició de noves infeccions i per al desenvolupament de soques resistentes als medicaments, i la prevenció d'un desenvolupament de medicaments i vacunes eficaces. Una de les direccions que actualment estem explorant activament

*The Mathematical Epidemiology group, working in close contact with experimental scientists and the Computational & Mathematical Biology Research Group, employs mathematical modelling and the mathematical technique of the Dynamical Systems Theory to describe and study the dynamic of infectious diseases. Our particular interests are in the invasion of emerging infections, in the stability and persistence of a pathogen, as well as the stability of immune response. We also interested in viral and microbial evolution, which is probably the most important single factor responsible for emergence of new infections and for development of drug resistant strains, and preventing a development of effective drugs and vaccines. One of the directions, which we are currently actively exploring, is application of the tools and methods of the Optimal Control Theory*

és l'aplicació de les eines i mètodes de la teoria de control òptim per al control de malalties infeccioses.

*to the control of infectious diseases.*

### Membres del grup

#### *Research Team*

- Andrei Korobeinikov (team leader)
- Carles Barril Basil (PhD student)

### Activitats relacionades

#### *Related Activities*

- Workshop on Emergence, Spread and Control of Infectious Diseases, CRM, Bellaterra, June 10 to 11, 2013

### Col.laboradors

#### *Collaborators*

- |                       |  |
|-----------------------|--|
| ● Juana Díez          | Universitat Pompeu Fabra                               |
| ● Santiago F. Elena   | Instituto de Biología Molecular y Celular de Plantas   |
| ● Lourdes Esteva      | Universidad Nacional Autónoma de México                |
| ● Jordi Garcia Ojalvo | Universitat Pompeu Fabra                               |
| ● Ellina Grigorieva   | Texas Woman's University                               |
| ● Tomas Kelly         | University College Cork                                |
| ● Evgenii Khailov     | the Moscow State University                            |
| ● Elena Lara          | Institut de Ciències del Mar-CMIMA, CSIC               |
| ● Andreas Meyerhans   | Universitat Pompeu Fabra                               |
| ● Michael O'Callaghan | University College Cork                                |
| ● Alexander Pimenov   | Weierstrass Inst. for Applied Analysis and Stochastics |
| ● Dmitry Rachinskiy   | the University of Texas at Dallas                      |
| ● Elisabet Sa         | Institut de Ciències del Mar-CMIMA, CSIC               |
| ● Josep Sardanyés     | Universitat Pompeu Fabra                               |
| ● Leonid Shaikhet     | Donetsk State University of Management, Donetsk        |
| ● Elena Shchepakina   | Samara State Airspace University, Samara               |
| ● Vladimir Sobolev    | Samara State Airspace University, Samara               |
| ● Konstantin Starkov  | Instituto Politécnico Nacional-CITEDI                  |
| ● Yasuhiro Takeuchi   | Shizuoka University                                    |
| ● Dolors Vaqué        | Institut de Ciències del Mar-CMIMA, CSIC               |
| ● Cruz Vargas de León | Universidad Nacional Autónoma de México                |
| ● Graeme Wake         | Massey University                                      |

### Group Activity in 2013

*During 2013, research activities of the group was mostly focused towards following directions:*

1. *Stability, persistence and global property of models in mathematical epidemiology, and in mathematical biology in general. This direction is a continuation of the earlier research of Prof. Korobeinikov*

2. *Viral and microbial evolution. The goal of this project is mathematical study of pathogen evolution, including plant pathogens. Project is in collaboration with Santiago Elena (Evolutionary Systems Virology Group, Instituto de Biología Molecular y Celular de Plantas, Valencia), Josep Sardanyés (Institut de Biología Evolutiva, UPF, Barcelona), and with participation of Vladimir Sobolev and Elena Shchepakina (the Samara State Airspace University, Russia) and Graeme Wake (Massey University, New Zealand).*
3. *Optimal control of infectious diseases, at a population and a single host levels (including antiviral and cancer therapy). The goal is to employ the methods and tools of the optimal control theory to assist in the developing of the optimal (in a certain sense) antiviral therapy and rational strategies for control of infectious diseases. In collaboration with Prof. Ellina Grigorieva of Texas Woman's University, and Prof. Evgenii Khailov of the Moscow State University.*
4. *Immune response, its failure, and development of AIDS. In collaboration with Prof. Yasuhiro Takeuchi of Shizuoka University, Japan, and Prof. Leonid Shaikhet of the Donetsk State University of Management, Ukraine.*

*The group was visited by Prof. Sobolev and Prof. Shchepakina, who stay at the CRM for five weeks each.*

*Group organized and hosted organizer of a Workshop on Emergence, Spread and Control of Infectious Diseases, hold at the CRM on June 10 to 11. This workshop is viewed as the first event of this kind in a planned CRM series of workshops and advanced courses “Mathematics in Natural and Life Sciences”.*

## Numerical Analysis and Scientific Computing

### Àmbit de recerca

El nostre interès científic es concentra 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 focus 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 Contínuos i, més recentment, en les equacions cinètiques en Física de Plasma. En particular, treballem o hem treballat:

### Research Field

*Our primary scientific interest is 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 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:*

- Mètodes d'elements finits (conforme, disconforme i mixt).
  - Mètodes de Galerkin discontinu.
  - Domini dels mètodes de descomposició.
  - Solucionadors iteratius multinivell i multigrau.
  - Aproximació numèrica d'equacions cinètiques.
  - Tècniques d'estabilització en problemes d'advecció-difusió.
  - Post-procés de tècniques per a equacions de Navier-Stokes en mecànica de fluids.
- Finite element methods (conforming, non-conforming and mixed).
  - Discontinuous Galerkin methods.
  - Domain decomposition 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

- MTM2011-27739-C04-04. *Métodos Numéricos para Ecuaciones en Derivadas Parciales: Técnicas de discretización novedosas y “solvers” eficientes*, 2012–2014. PI: Blanca Ayuso de Dios.

### Membres del grup

### Research Team

- Blanca Ayuso (Ramón y Cajal fellow)

### Colaboradors

### Collaborators

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

The chalkboard contains several mathematical expressions:

- $\sum_{n \in \mathbb{Z}} f(n) = \sum_{n \in \mathbb{Z}} \hat{f}(n)$
- $\text{Cat}(n) = \frac{1}{n+1} \binom{2^n}{n}$
- $\int_S K dA = 2\pi$
- $e^{\pi i} + 1 = 0$
- $F(B_s) = \int_0^t F'(B_s) dB_s + \frac{1}{2} \int_0^t F''(B_s) ds + F(0)$

## **2.2. CRM Research Staff**

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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).

### **2.2.1. Investigadors Sèniors**

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**Tomás Alarcón**

During 2013, my research activity has been devoted to further four research lines already opened during 2011, namely, development of stochastic multiscale modelling of cell populations leading to the formulation of age-structured stochastic populations models with applications to tumour growth, investigating the stability of stochastic structured populations leading to the formulation of new mechanism for extinction in hierarchically organised populations, the formulation of evolutionary models of the 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, and, modelling the dynamics of latent HIV-1 infections, in particular the origins

*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**

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and clinical significance of the so-called viral blips. Additionally, I have opened a new research line consisting of an experimental investigation of rheological properties of blood at the microscale.

Regarding research output, I have completed 6 papers (4 published, 2 to appear) in ISI journals, 5 of them within the first quartile and 1 within the second quartile of their respective categories. I have also been invited to several national and international conferences, workshops and summer schools, including invited talks at the Workshop in Tumour Modelling held in Oxford and the Mathways into Cancer conference.

Additionally, during 2013, in collaboration with the group of Prof. Aurora Hernández-Machado (School of Physics, Universitat de Barcelona), we have further developed our collaboration based on experiments carried out with the Micro-rheology of Biofluids Laboratory. The aim of these experiments is to determine the rheological properties of blood and other biological fluids at the microscale.

#### **□ Publications**

##### **Articles**

- J.A. Menendez, J. Joven, S. Cufí, B. Corominas-Faja, C. Oliveras-Ferraro, E. Cuyas, B. Martin-Castillo, E. Lopez-Bonet, T. Alarcon and A Vazquez-Martin, *The Warburg effect version 2.0: Metabolic reprogramming of cancer stem cells*, Cell Cycle **18**, 1166–1179 (2013).
- L. Willis, T.A. Graham, T. Alarcon, M.R. Alison, I.P.M. Tomlinson and K.M. Page, *What can be learnt about disease progression in breast cancer dormancy from disease-free survival data?*, PLoS One **8**, e62320 (2013).

- B. Corominas-Faja, S. Cufí, C. Oliveras-Ferraros, E. Cuyas, E. Lopez-Bonet, R. Lupu, T. Alarcon, L. Vellon, J.M. Iglesias, O. Leis, A.G. Martin, A. Vazquez-Martin and J.A. Menendez, *Nuclear reprogramming of luminal-like breast cancer cells generates Sox2-overexpressing cancer stem-like cellular states harboring transcriptional activation of the mTOR pathway*, Cell Cycle **12**, 3109–3124 (2013).
- T. Alarcon, *Comment on “Morphogenetic action through flux-limited” by Verbeni, Sanchez, Mollica, Siegl-Cachedenier, Carleton, Guerrero, Ruiz-i-Altaba, and Soler*, Physics of Life Reviews **10**, 493–494 (2013).
- F. Spill, P. Guerrero, T. Alarcon, P.K. Maini and H.M. Byrne, *Mesoscopic and continuum modelling of angiogenesis*, to appear in *J. Math. Biol.*
- D. Sanchez-Taltavull and T. Alarcon, *Robustness of differentiation cascades with symmetric stem cell division*, to appear in *J. R. Soc. Interface*.

### **Preprints**

- R.A. Barrio, C.B. Picallo, C. Varea, T. Alarcon and A. Hernandez-Machado, *Membrane rigidity controls pinching of the bacterial membrane*, submitted to *Phys. Rev. Lett.*
- E. Ibañez-Marcelo and T. Alarcon, *The topology of robustness and evolvability in evolutionary systems with genotype-phenotype map*, submitted to *J. Theor. Biol.*
- T. Alarcon, Ph. Getto and Y. Nakata., *Stability analysis of a renewal equation for cell population dynamics with quiescence*, submitted to *SIAM J. Appl. Math.*
- T. Alarcon, *Stochastic quasi-steady state approximations for asymptotic solutions of the Chemical Master Equation*, submitted to *J. Chem. Phys.*
- T. Alarcon, *Stochastic multiscale models of cell population dynamics: Asymptotic and numerical methods*, submitted to *Math. Model. Nat. Phen.*

### **□ Research projects**

- *Mathematical modelling of biological populations with complex structure*, MICINN, MTM2011-29342. From 2012 to 2014. Principal investigator: Tomás Alarcón.
- *Mathematical modelling and analysis of discrete and continuous structured population dynamics*, BCAM. From 2011 to 2013. Principal investigator: Tomás Alarcón (when awarded; no longer a member of the project).
- *Grup de Recerca Consolidat en Equacions en Derivades Parcials i Aplicacions de la UAB-UPC-UdG*, Catalan government within the programme: Grup de recerca consolidat en el marc del IV Pla de Recerca de Catalunya (2009-2013), 2009SGR345. From 2009 to 2013. Principal investigator: José Antonio Carrillo de la Plata, Departament de Matemàtiques, Universitat Autònoma de Barcelona.

## □ Activity in research training

### Supervision of research students

- |                              |   |
|------------------------------|---|
| Graduate project supervision | • Miquel Raich, Mathematics, MSc Thesis, Universitat Politecnica de Catalunya. September 2013 – Present (CRM internship).   |
| PhD supervision              | • Roberto de la Cruz (CRM). <i>Stochastic multiscale modelling of tumour growth</i> , from January 2013. Funded by the CRM.<br>• Esther Ibáñez-Marcelo (CRM). <i>Dynamics of cell populations with genotype-phenotype map</i> , from January 2011. Funded by the CRM.<br>• Daniel Sánchez-Taltavull (CRM). <i>Evolutionary dynamics of hierarchically-structured cell populations</i> , from January 2011. Funded by the CRM. |
| Postdoc supervision          | • Pilar Guerrero (CRM). <i>Stochastic multi-scale modelling of micro-metastases in tumour dormancy</i> , from January 2011 until June 2013. Funded by the CRM.<br>• Ivon Rodriguez-Villarreal (CRM). <i>Experimental microrheology</i> , from June 2011. Funded by the CRM.   |

## □ Teaching activity

- Module on Stochastic Modelling in Population Dynamics as part of the course on Mathematical Models in Biology of the Master in Advanced Mathematics & Mathematical Engineering, Universitat Politècnica de Catalunya, 2012–2013.

## □ Scientific activities

- |                     |   |
|---------------------|---|
| <b>Organisation</b> | • Organiser and member of the scientific committee of the <i>Joint CRM–Imperial College Advanced Course on Complex Systems</i> held in the Centre de Recerca Matemàtica, Bellaterra, Barcelona, April 2013. |
|---------------------|---|

### Participation

- |  |   |
|--|---|
| <b>Invited lectures in conferences</b> | <ul style="list-style-type: none"><li>• T. Alarcón, <i>Stochastic multiscale modelling of cell populations</i>, Workshop on Tumour Growth, Oxford, January 2013.</li><li>• T. Alarcón, <i>From invasion to latency: Intracellular noise and cell motility as key controls of the competition between resource-limited cellular populations</i>, Biannual Conference of the Royal Spanish Society for Mathematics (RSME), Santiago de Compostela, February 2013.</li><li>• T. Alarcón, <i>Muti-scale modelling of tumour growth and therapy</i>, MathMods MsC, Universitat Autònoma de Barcelona, May 2013.</li><li>• T. Alarcón, <i>Stochastic multiscale modelling of cell populations</i>, Mathways into Cancer II, Sevilla, May 2013.</li><li>• T. Alarcón, <i>Are viral blips in HIV-1-infected patients clinically relevant?</i>, Workshop on Emergence, Spread and Control of Infectious Diseases, CRM, Barcelona, June 2013.</li></ul> |
|--|---|

## Seminars

- T. Alarcón, *Stochastic multiscale modelling of tumour growth*, Centre for Systems Biology, Universität Stuttgart, June 2013.
- T. Alarcón, *Computational & Mathematical Biology at the CRM*, Universidade da Coruña, July 2013.

## Blanca Ayuso



The scientific activity of B. Ayuso turns around different topics in numerical analysis: design and analysis of discontinuous Galerkin (DG) Methods, numerical approximation of kinetic equations, as well as solvers for DG methods including

domain decomposition techniques and multilevel and subspace correction methods.

During 2013, the work of B. Ayuso has specially emphasized in pre-conditioners and correction methods for DG discretizations and applications of DG methods to Vlasov-Poisson systems. Apart from a strong activity in conferences and research stays, she was also advising a student inside the CRM Internship program.

## □ Publications

### Articles

- B. Ayuso de Dios, I. Georgiev, J. Kraus and L. T. Zikatanov, *A Subspace Correction Method for Discontinuous Galerkin discretizations of Linear Elasticity equations*, Math. Model. Numer. Anal. (M2AN) **47**(5), 1315-1333 (2013).

### Preprints

- B. Ayuso de Dios and L Zikatanov, *Space Decompositions and Solvers for Discontinuous Galerkin Methods*, to appear in the *Proceedings of the XXI Domain Decomposition Conference*.
- B. Ayuso de Dios, A. Lombardi, P. Pietra and L. T. Zikatanov, *A block solver for the exponentially fitted IIPG-0 method*, to appear in *Domain Decomposition Methods in Science and Engineering XX*, Series: Lecture Notes in Computational Science and Engineering, 2013. Technical report: arXiv:1107.2831v1.
- B. Ayuso de Dios, M. Holst, Y. Zhu and L.T. Zikatanov, *Multigrid Preconditioner for Nonconforming Discretization of Elliptic Problems with Jump Coefficients*, to appear in *Domain Decomposition Methods in Science and Engineering XX*, Series: Lecture Notes in Computational Science and Engineering, 2013. Technical report: arXiv:1107.2160v1.

## □ Activity in research training

### Supervision of research students

#### Doctoral advisees

- Kamana Porwal, (PhD student of T. Gudi). Topic: *Finite element approximation to Variational Inequalities and Free Boundary problems*, March-June 2013. 3-months research visit through Dev-math program.

## □ Teaching activity

- |                                   |  |
|-----------------------------------|--|
| <b>Lectures and short courses</b> | <ul style="list-style-type: none"><li>• Lecturer. Master Course in Mathematics: <i>Advanced Partial Differential Equations</i>, Facultat de Matemàtiques i Estadística, Universitat Politècnica de Catalunya (Spring 2013, taught with Prof. Xavier Cabré).</li><li>• <i>Workshop on Numerical Methods for the Kinetic Equations of Plasma Physics</i>, Max-Planck-Institut für Plasmaphysik, Garching, Munich, September 2nd-6th, 2013.</li><li>• <i>Basics in Probability Theory</i> (6 hours) and <i>Multigrid Methods-Domain Decomposition Methods</i> (3 hours), pre-courses for the CIMPA-UNESCO-MESR-MINECO-INDIA research school: “Trends in Computational Methods for PDEs”, Bangalore. June 24th-July 7th, 2013.</li><li>• <i>A Combined Preconditioning Strategy for Nonsymmetric Systems, Workshop: Multilevel Computational Methods and Optimization</i>. Weizmann Institute of Science, Rehovot, April 29th-May 2nd, 2013.</li></ul> |
|-----------------------------------|--|

## □ Scientific activities

- |  |   |
|--|---|
| <b>Organisation</b>                    | <ul style="list-style-type: none"><li>• CIMPA-UNESCO-MESR-MINECO-INDIA research school: “Trends in Computational Methods for PDEs”, Bangalore, July 8th-13th, 2013.</li><li>• <i>Solution techniques for Discontinuous Galerkin Methods</i>, at DD22, Lugano, 2013 (8 speakers). Co-organiser: S.C. Brenner.</li></ul>  |
| <b>Participation</b>                   |   |
| <b>Invited lectures in conferences</b> | <ul style="list-style-type: none"><li>• <i>Energy Stability for a family of discontinuous Galerkin methods for elastodynamic problems</i>, invited talk in the Minisymposia: “Computational challenges in Discontinuous Galerkin methods”, at the Mathematics of Finite Element Methods 2013 (MAFELAP13), Brunel Institute of Computational Mathematics, London, June 10th-14th, 2013.</li><li>• <i>Application of Sparse Grid techniques for discontinuous Galerkin approximation of the Vlasov-Poisson system</i>, invited talk in Minisymposia: “Numerical Modeling of Fluids and Structures”, at the 9th International Conference on Large-Scale Scientific Computations (LSSC), Sozopol, June 3th-7th, 2013.</li><li>• <i>Application of Sparse Grid techniques for discontinuous Galerkin approximation of the Vlasov-Poisson system</i>, Finite Element Fair, ACMAC, Heraklion, May-June 2013.</li><li>• <i>A simple preconditioner for an <math>H(\text{div}; \Omega)</math>-DG method for the Stokes problem</i>, AMS Joint Math Meeting, San Diego, January 2013.</li></ul> |
| <b>Seminars</b>                        | <ul style="list-style-type: none"><li>• <i>Discontinuous Galerkin approximation for the Vlasov-Poisson system</i>, at Center for Uncertainty Quantification in Computational Science &amp; Engineering, (CEMSE), KAUST, Saudi Arabia, November 2013.</li><li>• <i>Discontinuous Galerkin Methods for the Vlasov-Poisson system</i>, Department of Mathematics, University of California at San Diego, January 2013.</li></ul>   |

## Research stays

- November 2013. Center for Uncertainty Quantification in Computational Science & Engineering, (CEMSE), KAUST, Saudi Arabia (1 week).
- September 2013. SAM - Seminar for Applied Mathematics, ETH, Zurich (5 days).
- September 2013. Max-Planck-Institut für Plasmaphysik, Garching, Munich (12 days).
- May-June 2013. Archimedes Center for Modeling, Analysis & Computation (ACMAC), Heraklion, Crete (10 days).
- January 2013. Department of Mathematics, University of California at San Diego (10 days).

## Álvaro Corral



The papers published this year deal with three very different topics. One of them is about the statistics of fracture experiments, which, for the particular material studied, presents strong resemblance with earthquakes. This was commented in a viewpoint article by I. Main, <http://physics.aps.org/articles/v6/20>. The second article is about the statistics of repetitions of words in texts, and how these counts change with the length of the text. A very simple scaling law

describes this change, and allows to evaluate the growth of vocabulary as a text evolves. Third, a paper about an objective way to fit and test power-law distributions, with illustrations in geoscience, is proposed as an alternative to previous proposals.

In addition to papers, two big events have influenced the center of gravity of my attention: The *Joint CRM Imperial College School and Workshop on Complex Systems*, organized together with Tomás Alarcón, bringing more than 100 participants to CRM. The *European Conference on Complex Systems*, co-organized with the members of the network complexitat.cat, which attracted more than 700 researchers.

## □ Publications

### Articles

- J. Baró, A. Corral, X. Illa, A. Planes, E. K. H. Salje, W. Schranz, D. E. Soto-Parra and E. Vives, *Statistical similarity between the compression of a porous material and earthquakes*, Physical Review Letters **110**, 088702 (2013).
- A. Deluca and A. Corral, *Fitting and goodness-of-fit test of non-truncated and truncated power-law distribution*, Acta Geophysica **21(6)**, 1351–1394 (2013).
- F. Font-Clos, G. Boleda and A. Corral, *A scaling law beyond Zipf's law and its relation to Heaps' law*, New Journal of Physics **15**, 093033 (2013).

### Preprints

- A. Deluca and A. Corral, *Scale Invariant Events and Dry Spells for Medium Resolution Local Rain Data*, accepted in *Nonlinear Processes in Geophysics*.
- A. Corral and F. Font-Clos, *Processos de ramificació, criticitat i auto-organització: aplicació als desastres naturals*, accepted in *Butlletí de la Societat Catalana de Matemàtiques*.

**Books or chapters** • A. Corral and F. Font-Clos, *Criticality and self-organization in branching processes: application to natural hazards*, in Self-organized criticality systems (2013).

### Conference proceedings

- F. Font-Clos and A. Corral, *Stability of strength and weight distributions for time-evolving word co-occurrence networks*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- A. Deluca, P. Puig and A. Corral, *Testing universality and goodness-of-fit test of power-law distribution*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- A. Deluca, N. R. Moloney and A. Corral, *Criticality on Rainfall: Statistical observational constrains for the onset of strong convection modelling*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).

### □ Research projects

- *Scaling, complejidad y predictibilidad en fenómenos atmosféricos y formas de comunicación*, Ministerio de Economía y Competitividad, FIS2012-31324. From 2013 to 2015. Principal investigator: Álvaro Corral.
- *Consolidated Research Group on Statistical Physics*, Generalitat de Catalunya, 2009SGR-164. From 2009 to 2013. Principal investigator: David Jou i Mirabent.

### □ Activity in research training

#### Supervision of research students

##### PhD supervision

- Anna Deluca Silberberg, PhD student (CRM).
- Francesc Font Clos, PhD student (CRM, Generalitat de Catalunya FI grant).

### □ Diffusion activity

- The article in *Physical Review Letters* about laboratory earthquakes received the attention from *Catalunya Ràdio, La Poma de Newton*, April 8th, 2013. <http://www.catradio.cat/programa/1471/La-poma-de-Newton>.

## □ Scientific activities

### Organisation

- Member of the scientific committee of the *International Course of Mathematical Models in Seismology, SeismMath*. L'Aquila, July 2013.
- Member of the organising committee of the *Joint CRM Imperial College School and Workshop on Complex Systems*. CRM, April 2013.
- Member of the scientific committee of the *GEFENOL (Grupo Especializado en Física Estadística y Nolineal) Doctorate School*. Palma, Mallorca, September 2013.
- Chairman of the organising committee of *European Conference on Complex Systems*, Barcelona, September 2013.
- Chairman of the scientific committee of the network *complexitat.cat*.

### Participation

#### Communications in conferences

- A. Corral, *Criticality and Self-organization in Models of Earthquake Occurrence*, SeisMath IP 2013, Mathematical Models in Seismology, Università dell'Aquila, July 2013.
- A. Corral et al., *Statistical similarities between earthquakes and fracture experiments*, International Symposium on Complex Nonlinear Systems, Samarkand, October 2013.
- A. Corral et al., *Statistical Similarity between the Compression of a Porous Material and Earthquakes*, American Geophysical Union Fall Meeting, San Francisco, December 2013.
- A. Corral, *Criticality and Self-Organization: from the Ground to the Air*, Departament de Física Aplicada, UPC, Terrassa, Barcelona, April 2013.
- A. Corral, *Branching processes, self-organization, and the statistics of natural hazards*, Col.loqui IMUB, Barcelona, June 2013.

#### Seminars

- A. Corral, *Branching processes, criticality and self-organization in natural hazards*, Centre de Recerca Matemàtica, Barcelona, June 2012.

## □ Other activities

- Reviewer of the journals Europhysics Letters, Physical Review E, Physical Review Letters, Proceedings of the National Academy of the USA, and Scientific Reports.

**Tim Myers**



During 2013 much of my research activity was focussed on the application of mathematics to

nanotechnology. With Francesc Font I investigated a fundamental problem concerning the formulation of the one-phase Stefan problem. We also developed models for the melting of nanoparticles, which hopefully in the future will be combined with experiments in the Catalan Institute of Nanotechnology. However perhaps the most ground-breaking work came in collaboration with my other PhD student Michelle MacDevette.

The work for Michelle's thesis involved modelling nanofluids. In a paper submitted at the end of 2013 we showed that a standard model which has been used by hundreds of researchers to demonstrate the improved heat transfer properties of nanofluids in fact leads to the opposite conclusion. We were also able to demonstrate why so many research groups produced incorrect results. In fact, much of our theoretical work appears to indicate nanofluids are not the miracle fluids they have been promoted as. This result is now also appearing in an increasing number of experimental papers in the literature.

On the teaching side I have once again been active at the Universitat Politècnica de Catalunya,

taking part in the course *Models Matemàtics de la Tecnologia*. Michelle MacDevette submitted her PhD in December. Francesc Font expects to submit in July 2014. My supervision of research assistant Helena Ribera ended in July, and she took up a Master's position at the University of Bristol. A new post-doc, Vincent Cregan, joined the group to work on solar energy applications of nanofluids. Both Cregan and Ribera were funded through my Marie Curie grant.

In the meantime I have continued as a council member of the European Consortium for Mathematics in Industry and on the editorial board of Applied Mathematical Modelling.

## □ Publications

### Articles

- M. M. MacDevette, T. G. Myers and B. R. Wetton, *Boundary layer analysis and heat transfer of a nanofluid*, Microfluidics and Nanofluidics **Jan**, 12 pages (2014).
- F. Font and T. G. Myers, *Spherically symmetric nanoparticle melting with a variable phase change temperature*, J. Nanoparticle Research **15**, 2086 (2013).
- L. J. Cummings, J. Low and T. G. Myers, *Influence of electric field gradient on a stretched nematic sheet*, Euro. J. Appl. Math. **Oct**, online (2013).
- T. G. Myers, M. M. MacDevette and H. Ribera, *A time dependent model to determine the thermal conductivity of a nanofluid*, J. Nanoparticle Research **15**, 1775 (2013).
- T. G. Myers and J. Low, *Modelling the solidification of a power-law fluid flowing through a narrow pipe*, Int. J. Thermal Sci. **70**, 127–131 (2013).
- F. Font, S. L. Mitchell and T. G. Myers, *One-dimensional solidification of supercooled melts*, Int. J. Heat Mass Trans. **62**, 411–421 (2013).
- T. G. Myers and S. L. Mitchell, *A mathematical analysis of the motion of an in-flight soccer ball*, Sports Engineering **16**, 29–41 (2013).

### Preprints

- M. M. MacDevette, T. G. Myers and H. Ribera, *Heat balance integral method applied to spherical and cylindrical Stefan problems*, submitted to Appl. Math. Comput.
- T. G. Myers, V. Ribas Ripoll, A. Sáez de Tejada, S. L. Mitchell and M. J. McGuinness, *Modelling the cardiovascular system for automatic interpretation of the blood pressure curve*, submitted to Applied Mathematical Modelling.
- T. G. Myers, M. M. MacDevette and F. Font, *Continuum mathematics at the nanoscale*, to appear in J. Math. Ind.
- T. G. Myers, M. MacDevette and B. Wetton, *Boundary layer analysis and heat transfer of a nanofluid*, CRM Preprint 1178.

- T. G. Myers, M. MacDevette and H. Ribera, *A time dependent model to determine the thermal conductivity of a nanofluid*, CRM Preprint 1177.
- T. G. Myers and F. Font, *Spherically symmetric nanoparticle melting with a variable phase change temperature*, CRM Preprint 1176.
- T. G. Myers and S. L. Mitchell, *A mathematical analysis of the motion of an in-flight soccer ball*, CRM Preprint 1154.
- T. G. Myers and J. Low, *Modelling the solidification of a power-law fluid flowing through a narrow pipe*, CRM Preprint 1153.
- T. G. Myers, M. MacDevette and F. Font, *Continuum mathematics at the nanoscale*, CRM Preprint 1152.
- T. G. Myers, M. MacDevette and H. Ribera, *A simple yet effective model for thermal conductivity of nanofluids*, CRM Preprint 1149.

### **Conference proceedings**

- T. G. Myers, F. Font, M. M. MacDevette, *Mathematical modelling of nanoscale phenomena*, *NSTI-Nanotech 2013*, [www.nsti.org](http://www.nsti.org), Vol. 2 National Science and Technology Institute 2013 (ISBN 978-1-4822-0584-8).

### **□ Research projects**

- *Industrial applications of moving boundary problems*, CRM. From 2010 to 2014, PIRG06-GA-2009-256417. Principal investigator: Tim G. Myers.
- *Problemas de frontera móvil en presencia de capas líquidas*, MTM2010-17162, CRM. From 2011 to 2014. Principal investigator: Tim G. Myers.
- *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, UAB.

### **□ Activity in research training**

#### **Supervision of research students**

##### **Undergraduate project supervision**

- Helena Ribera Ponsa, Research Assistant, graduate of Universitat de Barcelona: *Modelling the effective conductivity of a nanofluid*, October 2012 - July 2013 (funded with Marie Curie Grant).

##### **PhD supervision**

- Michelle M. MacDevette (CRM), PhD project: *Mathematical modelling of the convective transport and thermal properties of nanofluids*, started Feb. 2011 (completed February 2014).
- Francesc Font Martinez (CRM), PhD project: *Beyond the classical Stefan problem*, started September 2010.

##### **Postdoc supervision**

- Maria Teresa Cao (CRM), Post-doc project: *Microwave defrosting of food*, Sept. 2012–May 2013.
- Vassil Tzanov: Post-doc visit, June 2013.

## □ Teaching activity

- Assitant Professor at Universitat Politècnica de Catalunya. I teach for the Facultat de Matemàtiques i Estadística, Departament de Matemàtica Aplicada I, on the undergraduate course “Models Matemàtics de la Tecnologia”, Degree in Mathematics.

## □ Scientific activities

### Organisation

- Council member of the *European Consortium for Mathematics in Industry*, see <http://www.ecmi-indmath.org/>.

### Participation

#### Communications in conferences

- T. G. Myers, *Mathematical modelling of nanoscale phenomena*, Nanotech 2013, Washington, June.

#### Seminars

- *Heat transfer in nanofluids*. Seminar at the Department of Mechanical Engineering, University of Leeds, Nov. 2013.
- *An introduction to perturbation methods applied to industrial mathematics*. Seminar at Departament de Matemàtica Aplicada, Universitat Politècnica de Catalunya, Oct. 2013.
- *Mathematical modelling of nanoscale phenomena*. Seminar at Vrije Universiteit, Amsterdam, July 2013.
- *Mathematics at the Nanoscale*. Seminar at Transfers, Interfaces and Processes, Université Libre de Bruxelles, July 2013.
- *Beyond the classical Stefan problem*. Seminar at the Department of Mathematics, New Jersey Inst. of Technology, June 2013.
- *Approximate mathematical methods for Industrial problems*. Seminar at Repsol, June 2013.
- *Mathematical modelling of phase change*. Seminar at Facultat de Física, Universitat de Barcelona, March 2013.
- *Beyond the classical Stefan problem*. Seminar at the Department of Mathematics, University of Limerick, Feb. 2013.
- *Footballs, phase change and nanotubes: practical applications of mathematics*. Seminar at the CRM, Feb. 2013.

#### Research stays

- July (4 weeks), Department of Mathematics, Vrije Universiteit, Amsterdam.
- June (4 days) Dept of Maths, New Jersey Institute of Technology, US.

## □ Other activities

#### Research stays

- Member of Editorial board, Applied Mathematical Modelling.
- Member of Editorial Board, Mathematics in Industry Case Studies.
- Council member, European Consortium for Mathematics in Industry.

- External examiner, University of Limerick applied mathematics undergraduate courses, 2011-2014.
- Referee for Applied Mathematics and Computing; Applied Mathematical Modelling; European J. Appl. Maths; Journal of Fluid Mechanics; Korean Mathematics Journal; Maths in Industry Case Studies; Meccanica.



**Andrei Korobeinikov**

During 2013, I continued my research in Mathematical Medicine and Biology, working in the following research directions: (i) The global analysis of mathematical models originated in Medicine and Biology, and the persistence and stability of biological systems. In particular, I was interested in ecological systems and host-microparasite systems; the latter include the models for the spread of a pathogen within a population, virus dynamics models and models of immune response. To a large extend, this research was a further development of my earlier advance in application of the Direct Lyapunov method to the problems in Mathematical Biology. Working with collaborators, I manage to establish global properties for a variety of models in host-parasite dynamics. (ii) The second direction of my research, and the one which I am currently most interested in, was mathematical modelling of pathogen evolution. Pathogen evolution is probably the most significant single factor responsible for the emergence of novel pathogens and for a rise of drug resistance; collapse of immune system and the development of AIDS is also probably a result of viral evolution within an infected host. (iii) The third direction of my research in 2013 was the optimal control

by biological processes. In particularly, I work on the optimal controls for antiretroviral therapy (HIV treatment) and the optimal controls for the biological treatment of waste water. In collaboration with Prof. E. Grigorieva and Prof. E. Khilov, we developed a mathematical technique which enabled us to analyze the controls with singularities (so-called "bang-bang controls") and reduce a problem of optimal control to a problem of the finite-dimensional optimization (the mathematical methods for the latter problems are well developed).

I also work on a number of industrial problems, which, apart from the mentioned problem of the optimal control for waste water biotreatment, include optimization of energy use in industrial processes.

In 2013 I established collaborations with a number of research groups, in Spain and abroad, working in experimental biology. In particular, these are the Dynamical Systems Biology Lab, Laboratory of Molecular Virology and the Infection Biology Group of the Universitat Pompeu Fabra (Barcelona); the Evolutionary Systems Virology Group, Instituto de Biología Molecular y Celular de Plantas; the Departament de Biología Marina i Oceanografía, Institut de Ciències del Mar-CMIMA, CSIC, Barcelona, and a few other groups. I hope that these new collaborations will be as fruitful as my existing collaborations are.

## □ Publications

### Articles

- E. V. Grigorieva, E. N. Khailov and A. Korobeinikov, *Optimal control for a SIR infectious disease model*, Journal of Coupled Systems and Multiscale Dynamics **1**, 324–331 (2013).

- E. V. Grigorieva, E. N. Khailov and A. Korobeinikov, *An optimal control problem in HIV treatment*, Discret Contin. Din. S. Suplement, 311–322 (2013).
- A. Korobeinikov, J. McCarthy, E. Mooney, K. Semkov and J. Varghese, *Mathematical modelling of internal heat recovery in flash tank heat exchanger cascades*, Mathematics-in-Industry Case Studies Journal 5, 43–58 (2013).
- E. V. Grigorieva, E. N. Khailov and A. Korobeinikov, *Parametrization of the attainable set for a nonlinear control model of a biochemical process*, Math. Biosci. Eng. 10, 1067–1094 (2013).
- T. Zhelev, K. Semkov, E. Mooney, T. Majozi and A. Korobeinikov, *Industrial heat utilisation through water management*, Heat Transfer Engineering 34, 1191–1201 (2013).
- E. V. Grigorieva, N. V. Bondarenko, E. N. Khailov and A. Korobeinikov, *Analysis of optimal control problems for the process of wastewater biological treatment*, Revista de Matemática: Teoría y Aplicaciones 20, 103–118 (2013).
- C. Vargas-De-León and A. Korobeinikov, *Global stability of a population dynamics model with inhibition and negative feedback*, Math. Med. Biol. 30, 65–72 (2013).
- S. M. O'Regan, T. C. Kelly, A. Korobeinikov, M. J. A. O'Callaghan and A. V. Pokrovskii, *Chaos in a seasonally perturbed SIR model: avian influenza in a seabird colony as a paradigm*, J. Math. Biol. 67, 293–327 (2013).
- A. V. Melnik and A. Korobeinikov, *Lyapunov functions and global stability for SIR and SEIR models with age-dependent susceptibility*, Math. Biosci. Eng. 10, 369–378 (2013).
- A. Korobeinikov and C. Dempsey, *A continuous phenotype space model of RNA virus evolution within a host*, Math. Biosci. Eng. 11, in print (2013).
- E. V. Grigorieva, E. N. Khailov, N. V. Bondarenko and A. Korobeinikov, *Modeling and optimal control for antiretroviral therapy*, to appear in Journal of Biological Systems.

## Preprints

- C. Vargas-De-León, L. Esteva and A. Korobeinikov, *Age-dependency in host-vector models: a global analysis*, submitted to *Applicable Analysis*, (2013).
- A. Korobeinikov and V. Sobolev *The phenomenon of apparent disappearance in the marine bacteriophage dynamics*, CRM Preprint Series 1156, (2013). <http://www.crm.cat/en/Publications/Publications/2013/Pr1156.pdf>.
- L. Shaikhet and A. Korobeinikov *Stability of a stochastic model for HIV-1 dynamics within a host*, submitted to *Appl. Math. Comp.*, (2013).
- A. Korobeinikov, J. McCarthy, E. Mooney and K. Semkov *Mathematical modelling of heat exchange in flash tank heat exchanger cascades*, CRM Preprint Series 1143, (2013). <http://www.crm.cat/en/Publications/Publications/2013/Pr1143.pdf>.
- A. Korobeinikov and A. V. Melnik *Global properties for SIR and SEIR age-structured models*, CRM Preprint Series 1134, (2013). <http://www.crm.cat/en/Publications/Publications/2013/Pr1134.pdf>.

**Books or chapters** • D. Okuonghae and A. Korobeinikov *Dynamics of tuberculosis in a developing country: Nigeria as a case study*, in Dynamic Models of Infectious Diseases; vol. 2: Non Vector-Borne Diseases 59–79 V. Sree Hari Rao and R. Durvasula. Springer, 2013. ISBN 978-1-4614-9224-5 online; 978-1-4614-9223-8 print. Doi:10.1007/978-1-4614-9224-5-3.

## □ Scientific activities

### Organisation

- Principal organizer, *Workshop on Emergence, Spread and Control of Infectious Diseases*, CRM, June 10 to 11, 2013.

## □ Other activities

- Member of Editorial board, Mathematical Biosciences and Engineering (MBE).
- Member of Editorial board, Journal of Nonlinear Systems and Applications (JNSA).
- Member of Editorial board, International Journal of Biology and Biomedical Engineering (IJBBE).
- Member of Editorial board, International Journal of Mathematics and Computers in Simulation (IJMCS).
- Member of Editorial board, International Journal of Pure Mathematics (IJPM).
- Member of Editorial board, Infectious Diseases: Research and Treatment.
- Member of Editorial board, Journal of Mathematics and Statistics.
- Member of Editorial board, Conference Papers in Mathematics.
- Member of Editorial board, Abstract and Applied Analysis.
- Member of Editorial board, Research and Communications in Biological Sciences.
- A member of scientific committee, MURPHYS.

**Luis Ortiz**



My field of research is Computational Finance. This subject lies in the intersection of numerics and stochastics. I am mainly interested in the efficient application of numerical techniques to risk measurement and pricing problems by means of the wavelets theory. State-of-the-art techniques rely on PDE methods and Fourier expansions.

However, the density functions that we encounter have discontinuities, are highly peaked or fat-tailed. When these situations arise, some families of wavelets can deal properly with the problem.

I 2013 finished my postdoctoral stay with Professor Oosterlee at CWI institute. During my stay, I had the opportunity to visit the Antwerp University in Belgium and INRIA in France. I disseminated my research in seminars and international conferences and published one paper and submitted another one. Finally, I obtained a tenure-track position at the CRM to set up a group in Finance. I also got an adjunct professor position at the Universitat Pompeu Fabra in Barcelona.

## □ Publications

### Articles

- L. Ortiz-Gracia, C. W. Oosterlee, *Robust pricing of european options with wavelets and the characteristic function*, SIAM Journal on Scientific Computing **35**, B1055–B1084 (2013).

### Preprints

- L. Ortiz-Gracia, C. W. Oosterlee, *Efficient VaR and expected shortfall computations for non-linear portfolios within the delta-gamma approach*, submitted to Applied Mathematics and Computation.

## □ Teaching activity

- Adjunct Professor. Matemàtiques I, Degree in Economics, Universitat Pompeu Fabra, first term 2013-2014.
- Adjunct Professor. Markets and Derivative Products, Degree in Economics, Universitat Pompeu Fabra, first term 2013-2014.
- Adjunct Professor. Computació Científica en Riscos, Master of Mathematics in Finance, Centre de Recerca Matemàtica–Universitat Autònoma de Barcelona, first term 2013-2014.

## □ Scientific activities

### Participation

#### Invited lectures in conferences

- L. Ortiz-Gracia. *Medición Eficiente del Riesgo de Concentración en Carteras de Crédito con las Ondículas de Haar*. Workshop at the Centre de Recerca Matemàtica, February 2013.

- L. Ortiz-Gracia. *Robust Pricing of European Options with Wavelets*. Invited talk at the Financial Engineering Summer School, Borsa de Barcelona, June 2013.

- L. Ortiz-Gracia. *Robust Pricing of European Options with Wavelets*. Invited talk at the XXIII Congreso de Ecuaciones Diferenciales y Aplicaciones/XIII Congreso de Matemática Aplicada, Castelló de la Plana, September 2013.

- L. Ortiz-Gracia. *Robust Pricing of European Options with Wavelets*. Invited talk at the International Conference on Scientific Computation and Differential Equations, Valladolid, September 2013.

#### Seminars

- L. Ortiz-Gracia. *Efficient Credit Risk Measurement at Portfolio Level with Haar Wavelets*. Seminar at the Université Marne-la-Vallée, Paris, March 2013.

- L. Ortiz-Gracia. *Robust Pricing of European Options with Wavelets*. Seminar at the CWI, Amsterdam, April 2013.

- L. Ortiz-Gracia. *Robust Pricing of European Options with Wavelets*. Seminar at the University of Antwerp, Antwerp, May 2013.

- Research stays**
- INRIA, Paris, March 2013, with Professor Antonino Zanette (1 week).
  - Universiteit Antwerpen, May 2013, with Professor Karel in't Hout (1 week).
- Courses attended**
- Summer School on Computational Aspects of Uncertainty Quantification. University of Leuven, May 30–May 31, 2013.
  - Financial Engineering Summer School. Centre de Recerca Matemàtica and AFI, June 18–June 21, 2013.

## □ Technology transfer

- The Wavelet Approximation method for Value-at-Risk and Expected Shortfall computations, has been implemented in Premia software systems (INRIA).

## □ Other activities

- Co-organizer (with Professor Joan del Castillo) of the *Jornada CRM-Empresa sobre Finances Quantitatives*. Industry-academia workshop at the Centre de Recerca Matemàtica, February 2013.
- Coordinator of the *Seminar Cycle on Quantitative Finance* at the Centre de Recerca Matemàtica, October 2013–present.
- Supervisor of the research project: *Option Pricing with Daubechies Wavelets* funded by the CWI institute. Student: Jef Duijndam, duration: 4 months.



**Alex Roxin**

In 2013 two doctoral students began their thesis work in the group of Computational Neuroscience: Marina Vegué and Bernat Rovira. Marina was awarded one of only 25 doctoral grants from La Caixa foundation that year, to work on models of network connectivity in cortical microcircuits. Bernat was taken on in the framework of a training grant (formerly FPI) associated with

the project “Codificación y consolidación de la memoria: un estudio computacional” (reference number BFU2012-33413). His thesis work involves developing biologically plausible attractor models for the encoding of memories.

In 2013 the PI continued his work on cortical connectivity and models of memory consolidation, as well as his ongoing collaboration with researchers at IDIBAPS including Albert Compte and Jaime de la Rocha. These collaborations included work on models of network activity underlying simple perceptual decision-making tasks as well as network models of oscillatory activity.

## □ Publications

- Articles**
- A. Roxin and S. Fusi, *Efficient partitioning of memory systems and its importance for memory consolidation*, PLoS Comp. Biol. **9**, e1003146 (2013).

## □ Research projects

- *Codificación y consolidación de la memoria: un estudio computacional*, MINECO grant BFU2012-33413. From January 2013 to December 2015. Principal investigator: Alex Roxin.

## □ Activity in research training

### Supervision of research students

- PhD supervision
- Marina Vegué, PhD student (UPC, La Caixa fellowship).
  - Bernat Rovira, PhD student (CRM, FPI fellowship, starting Jan 2014).

## □ Scientific activities

- Organisation**
- *2013 Barcelona Computational and Systems Neuroscience Conference.* Institut d'Estudis Catalans, Barcelona, June 16-17, 2013.

- European Science Foundation Exploratory Workshop *Noise in decision making: theory meets experiment.* Món Sant Benet, May 2013. (with A. Compte, G. Deco, J. de la Rocha and K. Wimmer)

### Participation

- Invited lectures in conferences
- A. Roxin. *Connectivity motifs and dynamics in cortical network models* Invited talk at the Interdisciplinary symposium on signals and systems for medical applications, Institut Henri Poincaré, Paris, June 2013.



**Sergey Tikhonov**

During 2013, I have been involved in several scientific activities. First, in August 2013, I organized the session on Approximation theory and Harmonic analysis at the 9th International ISAAC congress in Krakow, Poland. Second, in November, 4–8, our group organized the conference “Joint CRM–ISAAC Conference on Fourier Analysis and Approximation Theory” in CRM, Barcelona, which was a joint conference with the International Society for Analysis, its Applications, and Computation. Second, I have served as a supervisor for two PhD students: Petr Chunaev and Ainur Jumambaeva. Petr Chunaev studied Hardy's inequalities for sequences of monotonic type. Ainur Jumambaeva continues working on her PhD and investigates the Liouville derivatives. Third, I have

been an editor of several books to be published in the series Advanced Courses in Mathematics CRM Barcelona, Birkhauser. I have served as an editor of the following journals: Abstract and Applied Analysis, Bulletin of Mathematical Analysis and Applications, and The Scientific World Journal. Fourth, I have given several talks in different conferences in Albanya, Germany, Israel, Poland, Russia, Spain, including two Colloquium talks in CRM (May) and the Universität Trier, Germany (October). In September I was invited to the Hausdorff Center for Mathematics in Bonn to participate at the workshop on Discrepancy, Numerical Integration and Hyperbolic Cross Approximation.

My research activities include the following topics. I continue investigating, with Andrey Bondarenko, weighted Bernstein's inequalities. Jointly with Feng Dai I have finished the project on the fractional Bernstein inequality with weights. Together with Polina Glazyrina, I studied sharp Landau-type inequalities for algebraic

polynomials and sharp Ulyanov inequalities for the  $K$ -functionals. Jointly with Amiran Gogatishvili, Mirek Opic, and Walter Trebels I proved sharp Ulyanov's inequalities for moduli of smoothness in the Lorentz spaces. Together with Alexander Kolesnikov, I investigated regularity problems of

the Monge-Ampère equation in Besov's spaces. Moreover, together with Erlan Nursultanov, I continue the investigation of properties of the fractional integrals and convolutions in the Lorentz spaces.

## □ Publications

### Articles

- L. De Carli, D. Gorbachev and S. Tikhonov, *Pitt and Boas inequalities for Fourier and Hankel transforms*, Journal Math. Anal. Appl. **408** (2), 762–774 (2013).
- M. Dyachenko, E. Nursultanov and S. Tikhonov, *Global and local smoothness of the Hilbert transforms*, Proc. Steklov Inst. Math. **280** (1), 169–180 (2013).
- E. Nursultanov and S. Tikhonov, *A sharp Remez inequality for trigonometric polynomials*, Constructive Approximation **38** (1), 101–132 (2013).
- M. Potapov, B. Simonov and S. Tikhonov, *Mixed moduli of smoothness in  $L_p$ ,  $1 < p < \infty$ : A survey*, Surveys in Approximation Theory **8**, 1–57 (2013).

### Preprints

- F. Dai and S. Tikhonov, *Weighted fractional Bernstein's inequalities and their applications*, to appear in *J. d'Analyse Math.*.
- A. Kolesnikov and S. Tikhonov, *Regularity of the Monge-Ampère equation in Besov's spaces*, to appear in *Calculus of Variations and Partial Differential Equations*.

### Books or chapters

- S. Tikhonov and M. Zeltser, *Weak monotonicity concept and its applications. Fourier Analysis and Pseudo-Differential Operators*, in Fourier Analysis, Trends in Mathematics (2013).

## □ Research projects

- *Análisis Armónico, Teoría de Aproximación y Problemas Extremales*, Ministerio de Ciencia e Innovación, MTM2011-27637. From 2011 to 2013. Principal investigator: S. Tikhonov.
- *Grup de Teoria de Funcions de la UB/UAB*, Generalitat de Catalunya, Suport a grups de recerca de qualitat, tipus B, 2009SGR-1303. From 2009 to 2013. Principal investigator: C. Cascante.

## □ Activity in research training

### Supervision of research students

#### PhD supervision

- Petr Chunaev (doctorate student at the UAB).
- Ainur Jumabayeva (doctorate student at the UAB, partially supported by CRM).

#### Postdoc supervision

- Ramazan Akgün (CRM Post-Doc, supported by Tubitak).

## □ Scientific activities

### Organisation

- Organizer of the “Joint CRM–ISAAC Conference on Fourier Analysis and Approximation Theory”, CRM, November 4–8, 2013.
- Organizer of the Session “Approximation theory and Harmonic analysis” at the 9th International ISAAC congress (International Society for Analysis, Applications and Computations), Krakow, August 5–9, 2013.

### Participation

#### Invited lectures in conferences

- S. Tikhonov. *General monotonicity concept in its applications*. Invited talk at the Balkan conference of mathematical sciences, Elbasan, May 2013.
- S. Tikhonov. *Wiener type theorems on Fourier series with nonnegative coefficients*. Invited talk at the Integral Transforms and Spectral Theory in Analysis and Geometry, Complex Analysis and Dynamical Systems, Naharia, May 2013.
- S. Tikhonov. *Weighted Bernstein inequality*. Invited talk at Radial Basis Functions Day, Justus-Liebig-Universität Giessen, July 2013.
- S. Tikhonov. *Weighted inequalities for convolution and Riesz potential*. Invited talk at the Approximation theory and Harmonic analysis, 9th International ISAAC congress, Krakow, August 2013.
- S. Tikhonov. *Sharp local polynomial inequalities*. Invited talk at the Conference on Nonlinear Approximations and Applications, Steklov Mathematical Institute, Moscow, October 2013.

#### Colloquium talks

- S. Tikhonov. CRM, May 2013.
- S. Tikhonov. Universität Trier, October 2013.

#### Seminars

- S. Tikhonov. *Sharp Ulyanov inequalities*, Gumilyov Eurasian National University, Astana, February 2013.
- S. Tikhonov. *Measure of smoothness and Fourier transforms*, Istanbul Analysis Seminar, May 2013.
- S. Tikhonov. *Sharp Ulyanov inequalities between Lorentz spaces*, Seminar “Function spaces”, Mathematical Institute, Jena, November 2013.
- S. Tikhonov. *Certain polynomial inequalities*, Analysis Seminar, Delft University of Technology, December 2013.

#### Research stays

- February, 2013: Visiting Researcher, Gumilyov Eurasian National University, Astana (2 weeks).

## □ Other activities

- Humboldt Research Fellowship for Experienced Researchers (granted by the Alexander von Humboldt Foundation).

- Editor, books of the series Advanced Courses in Mathematics CRM Barcelona, Birkhäuser (Basel) Uribe, Alberto Fiorenza, Michael Ruzhansky and Jens Wirth *Variable Lebesgue Space and Hyperbolic Systems*, edited by Sergey Tikhonov. Advanced Courses in Mathematics CRM Barcelona, vol. 20, Birkhäuser, Basel, 2013. ISBN 978-3-0348-0839-2
- Feng Dai and Yuan Xu *Analysis on  $h$ -harmonics and Dunkl Transforms*, edited by Sergey Tikhonov. Advanced Courses in Mathematics CRM Barcelona, vol. to appear, Birkhäuser, Basel, 2014.
- Vladimir Temlyakov *Sparse Approximation with Bases*, edited by Sergey Tikhonov. Advanced Courses in Mathematics CRM Barcelona, vol. to appear, Birkhäuser, Basel, 2014.
- Member of editorial board, *Abstract and Applied Analysis*.
- Member of Editorial board, *Bulletin of Mathematical Analysis and Applications*.
- Member of Editorial board, *The Scientific World Journal*.
- Member of *International Society for Analysis, its Applications, and Computation*.

## **2.2.2. Professors Visitants**

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### **Laurent Meersseman**



I spent two years in the CRM from August 2011 to August 2013 as a Marie Curie fellow. My research themes are: complex geometry, foliation theory, deformation of structures and moduli spaces and stacks. The objects that I study and deform are compact complex manifolds and their generalizations, such as holomorphic foliations, foliations by complex leaves and CR structures, with emphasis on sasakian and Levi flat structures. My proposal was called “Complex manifolds, Foliations and Deformations”.

## **2.2.2. Visiting Professors**

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From the one hand, it consists of constructing local moduli spaces for some of these geometric structures, keeping in mind the Kuranishi's space of a compact complex manifold as a prototype. Finding a good definition of a local moduli space in this context is an important part of the problem. 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. From the other hand, I study higher dimensional Teichmüller spaces (that is, given a smooth compact manifold, the set of isomorphism classes of complex structures for isomorphism isotopic to the identity) from a global point of view as an analytic stack.

## □ Publications

### Articles

- L. Meersseman, *Variétés CR polarisées et G-polarisées*, Int. Math. Res. Notes **2013 (10)**, 1093 (2013).
- L. Meersseman, *Une définition d'espaces de modules locaux de structures CR*, C. R. Acad. Sci. Paris **352**, 143–145 (2014).
- L. Katzarkov, E. Lupercio, L. Meersseman and A. Verjovsky, *The definition of a non-commutative toric variety*, to appear in *Contemporary Math.*.

### Preprints

- L. Meersseman, *Kuranishi type moduli spaces for proper CR-submersions over the circle*, arxiv.org:1210.1244, submitted.
- L. Meersseman, *Global moduli space of complex astructures and groupoids*, arxiv.org:1311.4170, submitted.

## □ Research projects

- *Complex manifolds, foliations and deformations*, Marie Curie IEF DEFFOL 271141. From 01/09/2011 to 31/08/2013. Principal investigator: L. Meersseman.

## □ Scientific activities

### Participation

#### Invited lectures in conferences

- L. Meersseman *Polarized and G polarized CR manifolds* Invited talk at the conference “Geometría Compleja, Sistemas Dinámicos y Teoría de Números: Celebrando los 70 años de Alberto Verjovsky”. UNAM, Cuernavaca, January 7–11, 2013.

#### Courses delivered

- Polarized and G polarized CR manifolds, Higher School of Economics. Moscow, February 25–28, 2013.

#### Seminars

- L. Meersseman, *Variétés CR polarisées et G-polarisées*, Department of Mathematics, Université de Nice, January 31st, 2013.
- L. Meersseman, *Variétés CR polarisées et G-polarisées*, Department of Mathematics, Université de Rennes, February 14th, 2013.
- L. Meersseman, *Global Moduli space of complex structures and Analytic Groupoids*, Department of Mathematics, State University of Moscow, March 1st, 2013.
- L. Meersseman, *Variétés CR polarisées et G-polarisées*, Department of Mathematics, Université de Toulouse, March 15th, 2013.
- L. Meersseman, *Espace de modules global de structures complexes et groupoïdes analytiques*, Department of Mathematics, Université de Nancy, March 18th, 2013.

#### Research stays

- February, 2013: Invited Researcher at Higher School of Economics, Moscow (1 week).

### **2.2.3. Investigadors Postdoctorals**

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#### **Maria Teresa Cao**



I joined the CRM group in Industrial Mathematics in September 2012, with a postdoctoral fellowship funded by the CRM, and left in April 2013. While in the CRM, I worked on two main themes: the numerical simulation of defrosting of food with microwaves and thin film flows. The defrosting problem is a follow on to a problem presented at the “IV Jornadas de Consulta Matemática para Empresas e Instituciones” held in Santiago de

### **2.2.3. Postdoctoral Researchers**

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Compostela in January 2012, that aims to optimize the intensity and frequency of microwaves in order to defrost food without cooking it. The numerical simulation has been performed considering a one-dimensional problem, and a finite differences code implemented in MATLAB. Some difficulties arose and we kept this problem open and continue to work on it. The thin flow problem I studied was aimed at analyzing the behaviour of the flow considering a depletion layer and matching this model with slip-length boundary conditions.

During my stay at the center I collaborated in the organization of the “CRM Applied Mathematical and Physics (CAMP)” seminars.

#### **Pilar Guerrero**



I have been a CRM postdoctoral fellow in the Computational and Mathematical Biology Group, under the supervision of Tomás Alarcón, from September 2011 to June 2013. We have been working on the formulation, analysis and stochastic simulation of models focused on multi-scale tumor growth. More specifically we have made a study of population dynamics involving issues such as competition for space and resources between normal and malignant cells in cancer, 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.

During my last six months at CRM I have collaborated in organizing the “CRM Applied Mathematical and Physics (CAMP)” seminars. I have participated in several conferences, by presenting two posters at the “Workshop on emergence, spread and control of infectious diseases”, at the CRM, and a lecture at the “Segundo Congreso de Jóvenes Investigadores RSME” in Sevilla.

#### **□ Publications**

##### **Articles**

- F. Spill, P. Guerrero, T. Alarcón, P.K. Maini and H.M. Byrne, *Mesoscopic and continuum modelling of angiogenesis*, to appear in *J. Math. Biol.*
- P. Guerrero, J. Montejo-Gámez and J. L. López, *A wavefunction description of quantum Fokker-Planck dissipation: Derivation, stationary solutions and numerical approximation of transient dynamics*, *J. Phys. A: Mathematical and Theoretical* **47**, 035303 (2014).

- J. Campos, P. Guerrero, O. Sánchez and J. Soler, *On the analysis of travelling waves to a nonlinear flux limited reaction-diffusion equation*, Ann. Inst. H. Poincaré Anal. Non Linéaire **30**, 141–155 (2013).

## □ Research projects

- *Mathematical modelling of biological populations with complex structure*, MICINN, MTM2011-29342. From 2012 to 2014. Principal investigator: Tomás Alarcón.

## □ Scientific activities

### Organisation

- Organiser of the CRM Applied Mathematical and Physics (CAMP) seminar.

### Participation

#### Communications in conferences

- P. Guerrero, *Stochastic multi-scale models of cell population*, Segundo Congreso de Jóvenes Investigadores RSM, Facultad de Matemáticas de la Universidad de Sevilla, September 16–20, 2013.
- P. Guerrero, *A nonlinear flux limited reaction-diffusion equation with application in biology: analysis of travelling waves*, Workshop on emergence, spread and control of infectious diseases, Centre Recerca Matemàtica, Barcelona, June 10–11, 2013.
- P. Guerrero, *Stochastic multi-scale models of cell population*, Workshop on emergence, spread and control of infectious diseases, Centre Recerca Matemàtica, Barcelona, June 10–11, 2013.



**Ivón Rodríguez**

I joined the CRM Lab on Microfluidics and Rheomics in August 2013. My main activity has been setting up the new lab and run the first experiments, as explained in Section 2.5.

### 2.2.4. Col.laboradors Científics

Durant l'any 2013, tres investigadors pertanyents a altres institucions han format part de la comunitat del CRM com a Col.laboradors Científics: Aurora Hernández-Machado i Claudia Trejo, de la Universitat de Barcelona, que participen en el Laboratori de Microreología de Biofluids del CRM (vegeu

### 2.2.4. Scientific Collaborators

*During the year 2013, three researchers belonging to external institutions have been joining the CRM community as Scientific Collaborators: Aurora Hernández-Machado and Claudia Trejo, from Universitat de Barcelona, who are part of the team of the CRM Lab for Microrheology of Biofluids (see*

Secció 2.3) i col.laboren amb els grups de Biologia Matemàtica i Computacional i Matemàtica Industrial; i Vicent Ribas, de l'empresa Sabirmedical, que col.labora amb el grup de Matemàtica Industrial.

*Section 2.3) and collaborate with the Mathematical and Computational Biology and the Industrial Mathematics groups; and Vicent Ribas, from the company Sabirmedical, who collaborates with the Industrial Mathematics groups.*

**Aurora Hernández-Machado**



Aurora Hernández-Machado is a Full Professor of Condensed Matter Physics at the Universitat

de Barcelona, who leads the group on *Dynamics of interfaces in nanotechnology, fluidics and biophysics*. Jointly with Tomás Alarcón, she is in charge of the CRM lab for Microrheology of Biofluids. The activity of her group can be followed from <http://www.nanobarnafluidics.com/>.

**Vincent Ribas**



The original terms of my scientific collaboration with the CRM covered the areas of Algebraic Models, Machine Learning and Artificial Intelligence in Industrial Mathematics, Mathematical Biology and Medicine (system modelling for diagnostics support). More particularly, I have collaborated with

the Industrial Mathematics group in the following topics: algebraic statistics applied to graphical models and inference functions; algebraic statistics applied to functional analysis for the derivation of a new kernel for inference that we have named the Quotient Basis Kernel; and, algebraic statistics for the definition of Deep Learning Architectures understood as the generalisation of Stochastic Factor Analysis Models. From an application point of view, I have also continued and strengthened a clinical collaboration with the Intensive Care Unit at Hospital Vall d'Hebron in Barcelona.

## □ Publications

### Articles

- V. Ribas Ripoll, A. Vellido, E. Romero and J.C. Ruiz-Rodríguez, *Sepsis mortality prediction with the Quotient Basis Kernel*, Artificial Intelligence in Medicine March 2014, S0933-3657 (2014).

### Conference proceedings

- V. Ribas Ripoll, E. Romero, J.C. Ruiz-Rodríguez and A. Vellido, *A quotient basis kernel for the prediction of mortality in severe sepsis patients*, ESANN 2009, Apr 2013, 379–384 Bruges, Belgium (2013).

## Claudia Trejo



Claudia Trejo participates also in the CRM lab for Microrheology of Biofluids. She belongs to the group on *Dynamics of interfaces in nanotechnology, fluidics and biophysics* from Universitat de Barcelona.

### 2.2.5. Visitants de llarga durada

#### Ramazan Akgün



My research area is Harmonic Analysis and Approximation Theory. I was visit, as postdoc researcher, the CRM group of Harmonic Analysis and Approximation Theory thanks to a Tübitak (the Scientific and technological research council of Turkey) research fellowship. In 2013 I have been studying:

#### □ Publications

##### Articles

- R. Akgün, *Improved converse theorems and fractional moduli of smoothness in Orlicz spaces*, Bull. Malays. Math. Sci. Soc. (2) **36** (1), 49–62 (2013).
- R. Akgün and V. Kokilashvili, *Some notes on trigonometric approximation of  $(\alpha, \psi)$ -differentiable functions in weighted variable exponent Lebesgue spaces*, Proceedings of A. Razmadze Math. Inst. **161**, 15–23 (2013).
- R. Akgün, *Some inequalities of trigonometric approximation in weighted Orlicz spaces*, to appear in *Math. Slovaca*.

##### Preprints

- R. Akgün, *Polynomial approximation in Bergman spaces*, submitted (2012).
- R. Akgün, *Jackson and inverse inequalities in rearrangement invariant Banach function spaces on Dini smooth domains*, submitted (2012).
- R. Akgün, *Realization and characterization of modulus of smoothness in weighted Lebesgue spaces*, submitted (2012).

### 2.2.5. Long-term visitors

1. Direct and Inverse inequalities of trigonometric approximation in weighted Orlicz spaces, generated by a quasiconvex Young function.
2. Fractional modulus of smoothness and main inequalities of trigonometric approximation in weighted variable exponent Lebesgue spaces.
3. Mixed modulus of smoothness and approximation in weighted lebesgue spaces on two dimensional torus, with Muckenhoupt weights.

## Salomón Rebollo-Perdomo



Salomón Rebollo-Perdomo is a researcher on dynamical systems and its applications who

collaborates with the UAB group on Dynamical Systems, [www.gsd.uab.cat](http://www.gsd.uab.cat). He has been visiting the CRM during the years 2012 and 2013. He has been working in reducing the difficulty of the study of zeros of Abelian integrals, one of the main problems related to the second part of the Hilbert's sixteen problem. He also works on the study of limit cycles of generalized Liénard equations.

### □ Publications

#### Articles

- J. Llibre and S. Rebollo-Perdomo, *Invariant Parallels, Invariant Meridians and Limit Cycles of Polynomial Vector Fields on Some 2-Dimensional Algebraic Tori in  $\mathbb{R}^3$* , Journal of Dynamics and Differential Equations **25**, 777–793 (2013).
- S. Rebollo-Perdomo, *Complete Abelian integrals for primitive polynomials of type  $\mathbb{C}^*$* , J. Math. Anal. Appl. **394**, 562–570 (2012).

#### Preprints

- S. Rebollo-Perdomo, *The number of medium amplitude limit cycles of some generalized Liénard systems*, CRM preprint no. 04/2013.

### 2.2.6. Estudiants de doctorat

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



Carles Barril  
(Math. Epidem.)



Roberto de la Cruz  
(Comp. & Math. Biol.)



Anna Deluca  
(Complex Syst.)



Francesc Font C.  
(Complex Syst.)



Francesc Font M.  
(Ind. Math.)



Michelle MacDevette  
(Ind. Math.)



Esther Ibáñez  
(Comp. & Math. Biol.)



Daniel Sánchez  
(Comp. & Math. Biol.)



Marina Vegué  
(Comp. Neurosc.)

També han estat vinculats temporalment o indirectament al CRM els estudiants Carles Barril, Petr Chunaev, Carles Llensa i Marina Vegué.

The PhD students Carles Barril, Petr Chunaev, Carles Llensa and Marina Vegué have also been linked to the CRM temporally or indirectly during 2013.

## □ Publications

### Articles

- **R. de la Cruz**, *Solución al problema 210*, La Gaceta de la Real Sociedad Matemática Española **16**, 512 (2013).
- **R. de la Cruz**, *Solución al problema 212*, La Gaceta de la Real Sociedad Matemática Española **16**, 703 (2013).
- **A. Deluca** and A. Corral, *Fitting and goodness-of-fit test of non-truncated and truncated power-law distribution*, Acta Geophys **21** (6), 1351–1394 (2013).
- F. A. Massucci, **F. Font-Clos**, A. De Martino and I. Pérez Castillo, *A novel methodology to estimate metabolic flux distributions in constraint-based models*, Metabolites **3** (3), 838–852 (2013).
- **F. Font-Clos**, G. Boleda and A. Corral, *A scaling law beyond Zipf's law and its relation to Heaps' law*, New J. Phys. **15**, 093033 (2013).
- **F. Font Martínez**, S. L. Mitchell and T. G. Myers, *One-dimensional solidification of supercooled melts*, International Journal of Heat and Mass Transfer **62**, 411–421 (2013).
- **F. Font Martínez** and T. G. Myers, *Spherically symmetric nanoparticle melting with a variable phase change temperature*, Journal of Nanoparticle Research **15**, 2086 (2013).
- T. G. Myers, **M. MacDevette** and **F. Font Martínez**, *Continuum mathematics at the nanoscale*, to appear in the *Journal of Mathematics in Industry*.

### Preprints

- J. Abelleira, I. Pérez-Elvira, J. Sánchez-Oneto, **R. de la Cruz**, J. Portela and E. Nebot, *Enhancement of methane production in mesophilic anaerobic digestion of secondary sewage sludge*, Avanced Thermal Hydrolysis Pretreatment preprint number: es-2013-050055, submitted to *Environmental Science & Technology*.
- **A. Deluca** and A. Corral, *Scale invariant events and dry spells for medium resolution local rain data*, submitted to *Nonlinear Processes in Geophysics*.
- **E. Ibáñez** and T. Alarcón, *The topology of robustness and evolvability in evolutionary systems with genotype-phenotype map*, submitted to *Journal of Theoretical Biology*.
- **E. Ibáñez** and M. Casanellas, *EM for phylogenetic topology reconstruction on non-homogeneous data*, submitted to *BMC Bioinformatics*.

## Conference proceedings

- **A. Deluca**, P. Puig and A. Corral, *Testing universality and goodness-of-fit test of power-law distribution*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- **A. Deluca**, N. R. Moloney and A. Corral, *Criticality on Rainfall: Statistical observational constrains for the onset of strong convection modelling*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- **F. Font-Clos** and A. Corral, *Stability of strength and weight distributions for time-evolving word co-occurrence networks*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- T. Myers, **F. Font Martínez** and **M. MacDevette**, *Mathematical modelling of nanoscale phenomena*, Nanotechnology 2013: Electronics, Devices, Fabrication, MEMS, Fluidics and Computation Washington (2013).
- **E. Ibáñez** and T. Alarcón, *Evolutionary dynamics of the genotype-phenotype map*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).
- **D. Sánchez-Taltavull** and T. Alarcón, *Stochastic models of cell populations with hierarchical structure*, in Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov, ISBN 978-3-319-08137-3. Birkhäuser, Basel (2013).

## □ Activity in research training

- PhD thesis defense: “Complexity in slowly-driven interaction-dominated threshold systems: the case of rainfall”, December 2013. (**A. Deluca**)

## □ Scientific activities

### Organisation

- **F. Font-Clos** has co-organized the first *ECCS Warm Up: School on Complex Networks*, an activity to which the CRM has given support both financially and logistically. The event took place on 13th–15th September 2013, coinciding with the *European Conference on Complex Systems 2013* (ECCS'13). Other sponsors were: *Ajuntament de Barcelona*, *BCN Lab*, *Facultat de Física (UB)*, *Universitat Politècnica de Catalunya*, *Complexitat.CAT* and *ECCS'13*.

## Participation

Communications in  
conferences

- **A. Deluca**, *Criticality on Rainfall: Statistical observational constrains for the onset of strong convection modelling*, Joint CRM-Imperial College Complex Systems Workshop, Centre de Recerca Matemàtica, May 2013.
- **A. Deluca** P. Puig, and A. Corral, *Testing universality and goodness-of-fit test of power-law distribution*, Joint CRM-Imperial College Complex Systems Workshop, Centre de Recerca Matemàtica, May 2013.
- **A. Deluca** P. Puig, A. Corral, *Statistical inference for complex systems: Power-law fitting and universality verification*, ECCS'13, Barcelona, September 2013.
- **A. Deluca** A. Corral and N. R. Moloney, *Statistical observational constraints for convective parametrizations and prediction of Rainfall extremes at fast and slow time scales*, ECCS'13, Barcelona, September 2013.
- **F. Font-Clos**, *A scaling law beyond Zipf's law*, Joint CRM-Imperial College Workshop in Complex Systems, Centre de Recerca Matemàtica, April 13, 2013.
- **F. Font-Clos**, *Scaling laws for language networks: uncovering robustness over time*, LangNetSci 2013, Copenhaguen, June 3, 2013.
- **F. Font-Clos**, *Scaling laws for language networks: Zipf's law and beyond*, Ignite Session at NetSci2013, Copenhaguen, June 7, 2013.
- **F. Font-Clos**, *Belief propagation on metabolic networks*, Summer school on Graphical models for the characterization of information flow in complex networks, Grenoble, July 9, 2013.
- **F. Font-Clos**, *Scaling laws for word-adjacency networks*, ECCS Warm-Up: School on Complex Networks, Barcelona, September 14, 2013.
- **F. Font-Clos**, *Stability of strength and weight distributions for time-evolving word co-occurrence networks*, ECCS'13, Barcelona, September 20, 2013.
- **F. Font Martínez**, *Phase change at the nanoscale*, SIAM Annual meeting 2013, San Diego, July 2013.
- **E. Ibáñez**, *Evolutionary dynamics of populations with genotype-phenotype map*, 1a Jornada d'Investigadors Predoctorals Interdisciplinària, Barcelona, February 2013.
- **E. Ibáñez**, *Evolutionary dynamics of populations with genotype-phenotype map*, Joint CRM-Imperial College School and Workshop in Complex Systems. Centre de Recerca Matemàtica, April 2013.
- **E. Ibáñez**, *Evolutionary dynamics of populations with genotype-phenotype map*, XXXIII Dynamics Days Europe, Madrid, June 2013.
- **E. Ibáñez**, *Evolutionary dynamics of populations with genotype-phenotype map*, Biomat 2013, Evolution and cooperation in social sciences and biomedicine, Granada, June 2013.
- **E. Ibáñez**, *Evolutionary dynamics of populations with genotype-phenotype map*, ECCS'13Barcelona, September 2013.
- **E. Ibáñez**, *Topology of robustness and evolvability in evolutionary systems with genotype-phenotype map*, 12th CRG Symposium, BCN2 - Biological Control Networks, CRG, Barcelona, October 2013.

- **D. Sánchez-Taltavull**, *Optimal transition paths of stochastic cell differentiation systems*, Jornada d'Investigadors Predoctorals Interdisciplinaria (JIP), Facultat de Matemàtiques, Universitat de Barcelona, February 7, 2012.
- **D. Sánchez-Taltavull**, *Stochastic models of cell populations with hierarchical structure*, Joint Centre de Recerca Matemàtica-Imperial College School and Workshop in Complex Systems, Centre de Recerca Matemàtica, April 8–13, 2013.
- **D. Sánchez-Taltavull**, *Stochastic models of cell populations with hierarchical structure*, Workshop on Emergence, Spread and Control of Infectious Diseases, Centre de Recerca Matemàtica, June 10–11, 2013.
- **D. Sánchez-Taltavull**, *Symmetric division model of cell differentiation systems*, ECCS'13, Barcelona, September 2013.

#### Seminars

- **A. Deluca**. *Statistical methods and observations for constraining Convective Parametrizations*, Group seminar Nonlinear Dynamics and Time Series Analysis, Max Planck Institute for the Physics of Complex Systems, Dresden, December 2013.
- **F. Font Martínez**. *Mathematical modelling of special solid-liquid phase transitions*, CAMP Seminar, CRM, November 2013.
- **F. Font Martínez**. *Nanoparticle melting with density change*, SIM Talk, University of Limerick, April 2013.
- **E. Ibáñez**. *Evolutionary dynamics of populations with genotype-phenotype map*, CAMP Seminar, CRM, April 2013.
- **E. Ibáñez**. *Introduction to graphs and evolutionary dynamics of populations with genotype-phenotype map*, Seminari SIMBa, Facultat de Matemàtiques de la Universitat de Barcelona, May 2013.
- **D. Sánchez-Taltavull**. *Stochastic modelling in Mathematical Biology*, Seminari SIMBa, Facultat de Matemàtiques de la Universitat de Barcelona, March 2013.
- **D. Sánchez-Taltavull**. *Stochastic models of cell populations with hierarchical structure and latently cell activation and viral blip generation in HIV-1 patients*, CAMP Seminar, CRM, March 2013.

#### Research stays

- Visiting Researcher at Max Planck Institute for the Physics of Complex Systems, Dresden (12 weeks). (**A. Deluca**)
- Visiting Researcher at Department of Mathematics and Statistics, University of Limerick (3.5 months). (**F. Font Martínez**)

#### Courses attended

- Big Data Analysis. Universitat de Barcelona. April–May 2013. (**A. Deluca**)
- COST ES0905 Final Training School, basics of atmospheric convection parameterization. Brac Island, Split. September 29–October 9, 2013. (**A. Deluca**)

- ECCS Warm-Up: School on Complex Networks. Fàbrica Fabra i Coats, Barcelona. September 2013. (**F. Font-Clos, E. Ibáñez**)
- Summer school on graphical models for the characterisation of information flow in complex networks: Application in neuroimaging (GMIneuro). Grenoble. July 2013. (**F. Font-Clos**)
- Network Factory 2013. Höllviken. June 2013. (**F. Font-Clos**)
- Joint CRM-Imperial College School and Workshop in Complex Systems. Centre de Recerca Matemàtica. April 8–13, 2013. (**F. Font-Clos, E. Ibáñez, D. Sánchez-Taltavull**)
- XXXIII Dynamics Days Europe. Center for Biomedical Technology, Madrid. June 2013. (**E. Ibáñez**)
- Biomat 2013. Courses about Evolution and cooperation in social sciences and biomedicine. Universidad de Granada. June 2013. (**E. Ibáñez**)
- Jornades de consultoria estadística i software II. Centre de Recerca Matemàtica. October 2013. (**E. Ibáñez**)
- 12th CRG Symposium. BCN2 - Biological Control Networks. Centre de Regulació Genòmica. October 2013. (**E. Ibáñez**)
- A course on dynamical systems. Barcelona Graduate School of Mathematics course. Universitat Politècnica de Catalunya. September-December, 2013. (**D. Sánchez-Taltavull**)

## □ Other activities

- Member of the Core Group on Theoretical Studies of the Convection Parameterization Problem, Research Network founded by the European COST program, ES0905. (**A. Deluca**)
- Referee for Europhysics Letters. (**A. Deluca**)
- Organization assistance Joint CRM-Imperial College Complex Systems School and Workshop, Barcelona, May 2013. (**A. Deluca, F. Font-Clos**)
- Volume editors of *Research Perspectives CRM Barcelona*, vol. 2, within the Birkhäuser series “Trends in Mathematics”. (**A. Deluca, F. Font-Clos**)
- Referee for the Journal Applied Mathematical Modelling. (**F. Font Martínez**)
- *Évariste Galois 2013* award of the Societat Catalana de Matemàtiques for the Master’s Thesis *Expectation Maximization for phylogenetic trees*. (**E. Ibáñez**)
- Organizer of the CRM Applied Mathematical and Physics (CAMP) seminar, from May 2013. (**E. Ibáñez**)
- Member of the Societat Catalana de Matemàtiques. (**E. Ibáñez**)

### **2.3. Laboratori de Microreologia de Biofluids**

El Laboratori de Microreologia de Biofluids del CRM és una unitat d'investigació experimental. Aquesta unitat s'ha establert conjuntament pels grups de Biologia Matemàtica i Computacional i de Matemàtica Industrial per tal de proporcionar una instal.lació experimental que permeti avançar en la investigació d'aquests grups, proporcionant resultats experimentals rellevants per alguns dels seus projectes relacionats amb la dinàmica de la biofluids a micro-escala. L'objectiu científic d'aquesta unitat d'investigació és l'estudi, tant per mitjà de models matemàtics com per mitjà d'investigació experimental directa, de les propietats mecàniques de biofluids en situacions dinàmiques. Aquest laboratori s'ha endegat en col.laboració amb el grup de Dinàmica d'Interfícies en Nanotecnologia, Fluídica i Biofísica de la Facultat de Física de la Universitat de Barcelona, dirigit per la Prof. Aurora Hernández-Machado, col.laboradora científica del CRM.

### **2.3. Lab for Microrheology of Biofluids**

*The CRM Lab for Microrheology of Biofluids is an experimental research unit based at CRM. This unit is established in collaboration with the Computational & Mathematical Biology Group and the Industrial Mathematics Group in order to provide an in-house experimental facility that allows to advance the mathematical research of those groups by providing experimental results relevant to some of their projects related to the dynamics of biofluids at the micro-scale. The scientific aim of this research unit is to study, both by means of mathematical models as well as by direct experimental investigation, the mechanical properties of biofluids in dynamical situations. This laboratory is ran by the Computational & Mathematical Biology Group and the Industrial Mathematics Group in collaboration with the Dynamics of Interfaces in Nanotechnology, Fluidics and Biophysics Group of the Faculty of Physics of the Universitat de Barcelona leaded by Prof. Aurora Hernández-Machado, scientific collaborator of CRM.*



## **2.4. Xarxes temàtiques**

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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 investigadors d'àrees més tradicionals o 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.

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 quals 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 Finances Quantitatives

i s'ha anat gestant la Xarxa de Biologia Computacional, que es posarà en marxa durant el 2014.

Les activitats d'aquestes xarxes poden veure's a

## **2.4. Thematic networks**

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*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 in Science and Technology are related to new mathematical applications, thus allowing the participation of mathematics in large-scale social projects.*

*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 Quantitative Finance*

*and the new Thematic Network on Computational Biology will start its activity in 2014.*

*The activities of these networks can be checked at*

[www.crm.cat/en/Research/Networks/Pages/default.aspx](http://www.crm.cat/en/Research/Networks/Pages/default.aspx)

## **2.5. Investigadors visitants**

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Diversos investigadors fan estades temporals al CRM durant el curs acadèmic, la majoria dels quals són participants invitats als programes de recerca 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 de quatre tipus diferents:

- Estades de recerca al CRM.
- Estades de recerca en col.laboració.
- Places “Lluís Santaló” per a visitants d’Amèrica llatina.
- El programa “Dev-Math” per a investigadors de països en vies de desenvolupament.

El llistat de visitants de 2013 es detalla a continuació. Aquest llistat no inclou el personal investigador propi del CRM ni els visitants que hagin fet estades inferiors a vuit dies.

Antonio Ache	<i>Princeton University</i>
Guglielmo Albanese	<i>Università degli studi di Milano</i>
Spyros Alexakis	<i>University of Toronto</i>
Janine Bachrachas	<i>McGill University</i>
Romero Barbieri	<i>Universitat Politècnica de Catalunya</i>
Ayanbayev Birzhan	<i>L.N. Gumilyov Eurasian National University</i>
Xia Bo	<i>Université Paris-Sud</i>
Marián Boguñá	<i>Universitat de Barcelona</i>
Alexei Bolsinov	<i>University Loughborough Leicestershire</i>
Roger Casals	<i>ICMAT/CSIC Madrid</i>
Jeffrey Case	<i>Princeton University</i>
Alice Chang	<i>Princeton University</i>
Sagun Chanillo	<i>The State University of New Jersey</i>
Jih-Hsin Cheng	<i>Institute of Mathematics - Academia Sinica</i>
Kim Christensen	<i>Imperial College London</i>
Matteo Cozzi	<i>Università degli studi di Milano</i>
Vincent Cregan	<i>University of Limerick</i>
Jörn Davidsen	<i>University of Calgary</i>
Azahara de la Torre	<i>Universitat Politècnica de Catalunya</i>
Alvaro del Pino	<i>ICMAT/CSIC Madrid</i>
Kostiantyn Drach	<i>Yanka Kupala State University of Grodno</i>
Nguyen Thac Dung	<i>National Tsing Hua University</i>
Chiara Esposito	<i>Mathematisches Forschungsinstitut Oberwolfach</i>
Jean-Pierre Françoise	<i>Université Pierre et Marie Curie</i>

## **2.5. List of visitors**

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*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 “Dev-Math” program for researchers from developing countries.*

*The list of 2013 visitors is the following. This list does not include CRM staff researchers nor visitors whose stay was shorter than eight days.*

Pedro Frejlich	<i>University Utrecht</i>
Yuxim Ge	<i>Université Paris Est Créteil</i>
Heiko Gimperlein	<i>Leibniz Universität Hannover</i>
Maria del Mar González	<i>Universitat Politècnica de Catalunya</i>
Rod Gover	<i>University of Auckland</i>
Robin Graham	<i>University of Washington</i>
Colin Guillarmou	<i>École Normale Supérieure</i>
Iskandarova Gulistan	<i>L.N. Gumilyov Eurasian National University</i>
Matthew Gursky	<i>University of Notre Dame</i>
Mark Hamilton	<i>Mount Allison</i>
Kengo Hirachi	<i>The University of Tokyo</i>
Xue Hu	<i>The Chinese Academy of Sciences</i>
Andreas Juhl	<i>Humboldt Universität zu Berlin</i>
Ainur Jumabayeva	<i>L.N. Gumilyov Eurasian National University</i>
Anna Kiesenhofer	<i>Universitat Politècnica de Catalunya</i>
Seongtag Kim	<i>Inha University</i>
Alexander Kolesnikov	<i>University of Eastern Finland</i>
Iurii Kolomoitsev	<i>IAMM of NAS of Ukraine</i>
Lou Kondic	<i>New Jersey Institute of Technology</i>
Boris Kruglikov	<i>University of Tromso</i>
Robert Kusner	<i>University of Massachusetts at Amherst</i>
Santiago López de Medrano	<i>UNAM (Lluís Santaló)</i>
Jean-Pierre Marco	<i>Université Pierre et Marie Curie</i>
Ali Maalaoui	<i>Rutgers University</i>
Niels Martin	<i>Princeton University</i>
Francisco Martín	<i>Universidad de Granada</i>
Luca Martinazzi	<i>Rutgers University</i>
Alfonso Martínez	<i>Universitat Pompeu Fabra</i>
David Martínez	<i>Instituto Superior Técnico</i>
Yoshihiko Matsumoto	<i>The University of Tokyo</i>
Vladimir Matveev	<i>Friedrich-Schiller Universität Jena</i>
Stephen McKeown	<i>University of Washington</i>
William Meeks III	<i>University of Massachusetts at Amherst</i>
Mateusz Michalek	<i>Université Joseph Fourier</i>
Eva Miranda	<i>Universitat Politècnica de Catalunya</i>
Andrey Mironov	<i>Sobolev Institute of Mathematics</i>
Nicholas R. Moloney	<i>London Mathematical Laboratory</i>
Ilaria Mondello	<i>Université de Nantes</i>
Philippe Monnier	<i>Université Paul Sabatier</i>
Juan José Morales	<i>Universidad Politécnica de Madrid</i>
Patrick Munroe	<i>McGill University</i>
Christian Murray	<i>University of Cape Town</i>
Klaus Niederkruger	<i>Université Paul Sabatier</i>
E. D. Nursultanov	<i>L.N. Gumilyov Eurasian National University</i>
Dragos Oprea	<i>University of California at San Diego</i>
Jesús Pérez García	<i>Universidad de Granada</i>
Joaquín Pérez Muñoz	<i>Universidad de Granada</i>

Kamana Porwal	<i>Indian Institute of Science Bangalore</i>
Francisco Presas	<i>Instituto de Ciencias Matemáticas</i>
Jie Qing	<i>University of California at Santa Cruz</i>
Roland Rabanal	<i>Pontificia Universidad Católica del Perú (Lluís Santaló)</i>
Salomón Rebollo-Perdomo	<i>Universitat Autònoma de Barcelona</i>
Nick Reichert	<i>Princeton University</i>
Helena Ribera	<i>PricewaterhouseCoopers</i>
Manuel Ritoré	<i>Universidad de Granada</i>
Stefan Rosemann	<i>Friedrich-Schiller Universität Jena</i>
María Amelia Salazar	<i>IMPA</i>
Manel Sanchón	<i>Universitat de Barcelona</i>
Yasha Savelyev	<i>Centro de Investigaciones Ener. Medio y Tecno.</i>
Konrad Schöbel	<i>Friedrich-Schiller Universität Jena</i>
Nora Seeliger	<i>Max Planck Institute for Mathematics</i>
M. Ángeles Serrano	<i>Universitat de Barcelona</i>
Elena Shchepakina	<i>Samara State Aerospace University</i>
Jedrzej Sniatycki	<i>University of Calgary</i>
Vladimir Sobolev	<i>Samara State Aerospace University</i>
Jose Luis Teruel	<i>Universidad de Granada</i>
Claudia Trejo	<i>Universitat de Barcelona</i>
Dmitry Treschev	<i>Steklov Mathematical Institute</i>
Vassil Tzanov	<i>Bristol University</i>
Andreas Vollmer	<i>Friedrich-Schiller Universität Jena</i>
Jonathan Weitsman	<i>Northeastern University</i>
David Wiygul	<i>Brown University</i>
Paul Yang	<i>Princeton University</i>
Ray Yang	<i>Courant Institute of Mathematical Sciences</i>
Wang Yi	<i>Stanford University</i>
Jingyang Zhong	<i>University of California at Santa Cruz</i>

La plaça “Lluís Santaló”, totalment finançada per l’Institut d’Estudis Catalans, va ser ocupada enguany pel Prof. Santiago López de Medrano i pel Dr. Roland Rabanal, mentre que les estades del programa Dev-Math es van concedir a:

*The “Lluís Santaló” visiting position, totally financed by the Institut d’Estudis Catalans, was held by Prof. Santiago López de Medrano and Dr. Roland Rabanal. The researchers and host scientists who benefited from the DevMath CRM program were:*

- Kamana Porwal, Blanca Ayuso (CRM).
- Damian Maingi, Rosa M. Miró (UB).
- Nguyen Thac Dung, M. del Mar González (UPC).
- Maria Amelia Salazar, Eva Miranda (UPC).
- Hamid Rahjoooy, Joan Elias (UB).

En total, el CRM ha hostatjat 224 mesos d'estada d'investigadors al llarg de l'any.

*Summing up, the CRM has hosted 224 months of stays of researchers during 2013.*

## **2.6. La formació en recerca al CRM**

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Hi ha tres vessants de formació al CRM: per a estudiants de grau i màster, doctoral i postdoctoral. Aquest darrer nivell ha estat tractat a les Seccions 2.1 i 2.2 d'aquesta memòria. A continuació expliquem l'activitat referent als dos primers estadis durant el 2013.

### **2.6.1. Formació doctoral**

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El CRM atorga beques doctorals destinades a la realització de tesis doctorals en les especialitats específiques 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; en l'apartat 2.2.6 hi ha informació més detallada d'aquells estudiants predoctorals que han estat contractats pel CRM durant aquest any.

Anna Deluca presented her PhD thesis dissertation, supervised by Álvaro Corral on September 2009.  
Funded by CRM.

Carles Barril is working on his PhD thesis, supervised by Àngel Calsina (UAB) since September 2013.  
Funded by CRM.

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

Roberto de la Cruz is working on his PhD thesis, supervised by Tomás Alarcón since February 2013.  
Funded by CRM.

Francesc Font Clos is working on his PhD thesis, supervised by Álvaro Corral since December 2011.  
Funded by FI-AGAUR.

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

Esther Ibáñez is working on her PhD thesis, supervised by Tomás Alarcón since January 2011. Funded by CRM.

Carles Llensa is working on his PhD thesis, supervised by Andrei Korobeinikov from January 2013 to August 2013. Funded by CRM.

Daniel Sánchez is working on his PhD thesis, supervised by Tomás Alarcón Since January 2011.  
Funded by CRM.

## **2.6. Research Training at CRM**

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*There are three training levels at CRM: undergraduate and masters, doctoral and postdoctoral. The latter has been exposed in Sections 2.1 and 2.2 of this report. Next, we explain the activity in the first two stages during 2013.*

### **2.6.1. Doctoral Training**

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*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. More information on predoctoral students that have been contracted by CRM during 2013 can be found in Section 2.2.6.*

Marina Vegué is working on his PhD thesis, supervised by Alexander Roxin since September 2013.  
Funded by La Caixa.

A més de la tasca de direcció de tesi, durant el 2013 també es va tutoritzar un treball final de grau:

Manuel Carbonell Nuñez, *Power laws: From linguistics to music*, supervised by Álvaro Corral, CRM.

## 2.6.2. Curs de màster

El Màster de Matemàtiques per als Instruments Financers es va impartir per quinzena vegada el 2013 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'Economia de l'Empresa, i d'Economia i d'Història Econòmica de la UAB, i el Departament d'Econometria, Estadística i Economia Espanyola 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 valuació 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 2013 han acabat el màster 15 alumnes.

*Apart from the PhD supervision tasks, the next Bachelor's Degree Thesis was also supervised during 2013:*

## 2.6.2. Master's Course

*The CRM master's course on Financial Mathematics was held for the fifteenth time in 2013 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 Department of Econometrics, Statistics and Spanish Economy 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 2013 a total of 15 students completed the master's course.*



#### **2.6.4. Estades d'iniciació a la recerca**

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El CRM va endegar el 2012 una convocatòria d'estades de recerca amb l'objectiu d'atraure l'interès dels joves cap a la recerca en matemàtiques. En el marc del programa, el CRM acull, en estades de 2 mesos, estudiants de grau o màster per tal de desenvolupar una etapa formativa en algun grup de recerca del CRM. Durant el 2013, els següents estudiants van participar en aquest programa:

- Miquel Raïch (Biologia matemàtica i computacional/*Computational & Mathematical Biology*).
- Helena Ribera (Matemàtica Industrial/*Industrial Mathematics*).
- Rosalba García (Sistemes Complexos/*Complex Systems*)

#### **2.6.4. Internship for initiation to research**

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*The CRM launched in 2012 a call for research stays aiming at attracting the interest of young people towards mathematical research. The CRM hosts, for a 2-month stay, undergraduate or master students willing to experience a training period in some of the CRM research groups. During 2013, the following students visited the CRM within this program:*





## Organització d'activitats científiques

### *Organization of Scientific Events*

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*.

#### **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.

Els programes de recerca del CRM duren, normalment, entre dos i cinc mesos. S'estructuren en dos vessants: els investigadors visitants i les activitats programades. Cada programa

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

- 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 organises Dissemination Activities and Research Seminars.*

#### **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.*

*Research Programmes can run for periods from two to five months. They are based on two aspects: visiting researchers and activities organised within. Every programme has a scientific committee, which*

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, 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 2013. La informació general sobre els programes de recerca es pot trobar a

*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, 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 internationally two years in advance and are evaluated by the Scientific Advisory Board. The CRM Research Programmes that took place in 2013 are described below. General information of Research Programmes can be found at*

[www.crm.cat/en/Activities/Pages/ResearchProgrammes.aspx](http://www.crm.cat/en/Activities/Pages/ResearchProgrammes.aspx)

### **3.1.1. CRM Research Programme on Conformal Geometry and Geometric PDE's**

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*May to July 2013*

Scientific Coordinators	Sun-Yung Alice Chang Maria del Mar González Robin Graham Francisco Martín Paul Yang	Princeton University Universitat Politècnica de Catalunya University of Washington Universidad de Granada Princeton University
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#### **Summary**

The particular interest of Geometric Analysis seems to lie in a combination of its relation to the physical world and the way it lies at the intersection of so many branches of Mathematics (Riemannian/Conformal/Complex/Algebraic Geometry, Calculus of Variations, and PDE's), or even Physics.

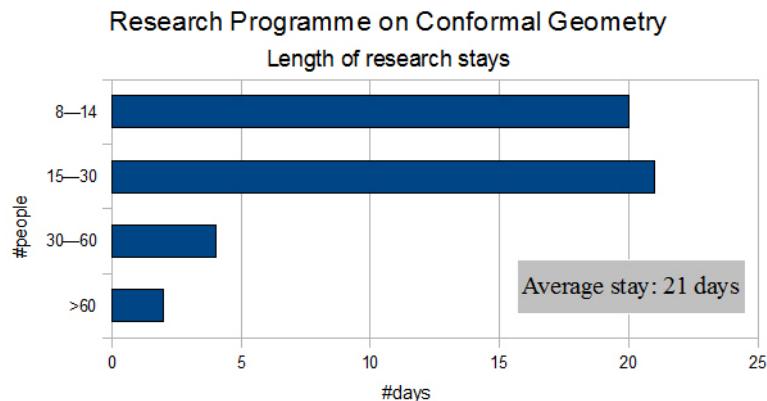
Conformal geometry is the study of the set of angle-preserving (conformal) transformations on a space. While in two dimensions, this is precisely the geometry of Riemann surfaces, in dimensions three and above the answer opens up many new different subjects, leading to the very wide field that is conformal geometry (Yamabe-type problems, non-local or non-linear conformally covariant operators, Poincaré-Einstein metrics and its relation to the AdS/CFT correspondence in Physics, and many more).

On the other hand, in CR geometry there are formal similarities with conformal geometry. The analysis of these operators is closely connected with the geometry of the pseudoconvex manifolds which they may bound, hence of interest in several complex variables. Another classical topic in Geometric Analysis is the study of variational problems related to the area functional. In this sense, the global theory of minimal and constant mean curvature surfaces in homogeneous three-manifolds, and more generally in Riemannian and sub-Riemannian manifolds, represents today a tremendously active field of new discoveries and challenges. Applications of minimal surfaces to other subjects include low dimensional topology, general relativity and materials science. Closely related to this topic appears the isoperimetric problem that connects Geometric Analysis with Geometric Measure Theory.

While all these seem to be almost unrelated topics, it is precisely the interaction between them that nurtures the development of such a fundamental branch of mathematics that is Geometrical analysis.

All program information can be found at:

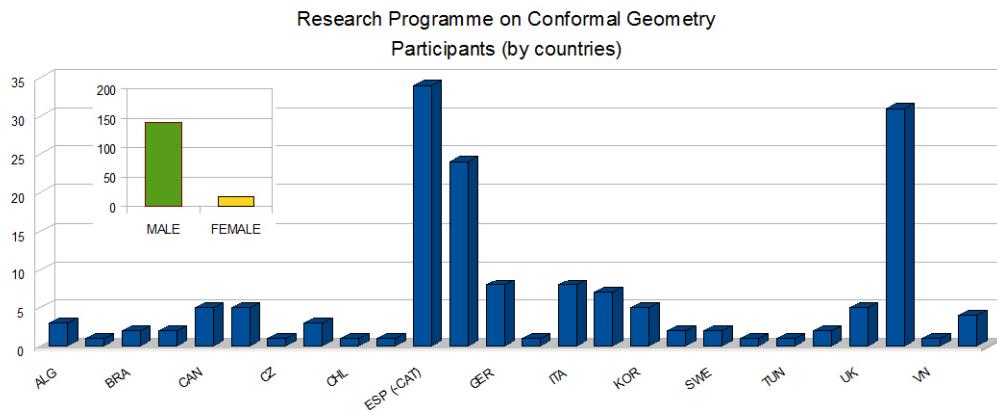
<http://www.crm.cat/en/Activities/Pages/ActivityDescriptions/Conformal-Geometry-and-Geometric-PDE%27s.aspx>



#### Visiting Researchers

Antonio Ache (Princeton University), Guglielmo Albanese (Università degli studi di Milano), Spyros Alexakis (University of Toronto), Janine Bachrachas (McGill University), Xia Bo (Université Paris-Sud), Jeffrey Case (Princeton University), Alice Chang (Princeton University), Sagun Chanillo (The State University of New Jersey), Jih-Hsin Cheng (Institute of Mathematics - Academia Sinica), Matteo Cozzi (Università degli studi di Milano), Azahara de la Torre (Universitat Politècnica de Catalunya), Kostiantyn Drach (Yanka Kupala State University of Grodno), Nguyen Thac Dung (National Tsing Hua University), Yuxim Ge (Université Paris Est Créteil), Heiko Gimperlein (Leibniz Universität Hannover), Maria del Mar González (Universitat Politècnica de Catalunya), Rod Gover (University of Auckland), Robin Graham (University of Washington), Colin Guillarmou (École Normale Supérieure), Matthew Gursky (University of Notre Dame),

Kengo Hirachi (The University of Tokyo), Xue Hu (The Chinese Academy of Sciences), Andreas Juhl (Humboldt Universität zu Berlin), Seongtag Kim (Inha University), Robert Kusner (University of Massachusetts at Amherst), Ali Maalaoui (Rutgers University), Niels Martin (Princeton University), Francisco Martín (Universidad de Granada), Luca Martinazzi (Rutgers University), Yoshihiko Matsumoto (The University of Tokyo), Stephen McKeown (University of Washington), William Meeks III (University of Massachusetts at Amherst), Ilaria Mondello (Université de Nantes), Patrick Munroe (McGill University), Christian Murray (University of Cape Town), Jesús Pérez García (Universidad de Granada), Joaquín Pérez Muñoz (Universidad de Granada), Jie Qing (University of California at Santa Cruz), Nick Reichert (Princeton University), Manuel Ritoré (Universidad de Granada), Jose Luis Teruel (Universidad de Granada), David Wiygul (Brown University), Paul Yang (Princeton University), Ray Yang (Courant Institute of Mathematical Sciences), Wang Yi (Stanford University), Jingyang Zhong (University of California at Santa Cruz).



## Activities

- **Weekly Seminar**

**Speakers**

Olivier Biquard, Université Paris 6

*Conformally invariant equations from Poincaré-Einstein metrics.*

June 14, 2013.

Sagun Chanillo, The State University of New Jersey

*Some non-linear wave equations arising from conformal geometry.*

June 14, 2013.

Rod Gover, University of Auckland

*Compactification and Einstein metrics.*

July 9, 2013.

Nguyen Thac Dung, National Taiwan University

*On the almost Schur lemma.*

June 21, 2013.

Ray Yang, Courant Institute of Mathematical Sciences  
*The method of moving planes for integral equations and the fractional Laplacian.*  
July 9, 2013.

• **Conference on Variational problems and Geometric PDE's**

*June 17 to 21, 2013*

*Participants: 90*

Speakers

Kazuo Akutagawa (Tokyo Institute of Technology), Antonio Alarcón (Universidad de Granada), Jacob Bernstein (University of Cambridge), Alice Chang (Princeton University), Pascal Collin (CNRS-Toulouse), Baris Coskunuzer (Koc University Turkey), Philippe Delanoe (CNRS-UNS), Ali Fardoun (LMBA, Brest), Alberto Farina (Université de Picardie Jules Verne), Laurent Hauswirth (Université Paris-Est Marne-la-Vallée), Sebastian Heller (Universität Tübingen), David Hoffman (Stanford University), Nicos Kapouleas (Brown University), Martin Kilian (University College Cork), Ernst Kuwert (University of Freiburg), Martin Lin (University of British Columbia), Levi de Lima (Universidad Federal de Ceará), Rafe Mazzeo (Stanford University), William H. Meeks (UMass Amherst), Andrea Mondino (Scuola Normale Superiore Pisa), André Neves (Imperial College), Franz Pedit (UMass Amherst), Magdalena Rodríguez (Universidad de Granada), Harold Rosenberg (IMPA), Andreas Savas-Halilaj (Universität Hannover), Vladimir Tkachev (Linköping University), Martin Traizet (Université Tours), Brian White (Stanford University), Michael Wolf (Rice University), Paul Yang (Princeton University).

• **Advanced Course on Topics in Conformal Geometry and Geometry Analysis**

*June 25 to 28, 2013*

*Participants: 35*

Lecturers

Alice Chang (Princeton University)

*Q-curvature and applications to problems in conformal geometry.*

Charles Fefferman (Princeton University)

*Local conformal invariants.*

William Meeks (University of Massachusetts at Amherst)

*Global theory of minimal surfaces.*



- **Conference on Geometrical Analysis**

*July 1 to 5, 2013*

*Participants: 55*

**Speakers**

Andrea Malchiodi (International School for Advanced Studies, SISSA), Colin Guillarmou (École Normale Supérieure), Daniel Fox (Universidad Politécnica de Madrid), Dmitry Jakobson (McGill University), Emmanuel Hebey (Université Cergy Pontoise), Fang Wang (Princeton University), Gil Solanes (Universitat Autònoma de Barcelona), Jeffrey Case (Princeton University), Jie Qing (University of California at Santa Cruz), Jih-Hsin Cheng (Institute of Mathematics - Academia Sinica), Kengo Hirachi (The University of Tokyo), Manuel Fernández (Universidade de Santiago de Compostela), Manuel Ritoré (Universidad de Granada), Matthew Gursky (University of Notre Dame), Pablo Mira (Universidad Politécnica de Cartagena), Robert Kusner (University of Massachusetts at Amherst), Rod Gover (University of Auckland), Spyros Alexakis (University of Toronto Seongtag Kim Inha University, Korea), Wang Yi (Stanford University), Yuxim Ge (Université Paris Est Créteil).

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### **3.1.2. CRM Research Programme on Geometry and Dynamics of Integrable Systems**

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*September to November 2013*

**Scientific  
Coordinators**

Vladimir Matveev	Friedrich-Schiller-Universität Jena
Eva Miranda	Universitat Politècnica de Catalunya
Francisco Presas	Instituto de Ciencias Matemáticas, Madrid
Iskander Taimanov	Institute of Mathematics, Novosibirsk

**Summary**

This Research Programme focuses on the geometrical and the dynamical aspects in the study of integrable systems. We want to specially stress out the following topics in the study of integrable systems:

- 1- Connections of several aspects showing up in the geometry, topology and dynamics of integrable systems in symplectic manifolds such as singular aspects of integrable systems, symplectic topology of integrable integrability criteria and obstructions to integrability, connection with Geometric Quantization and integrable systems in contact and Poisson manifolds.
- 2- Study of geodesic flows, their integrability and non-integrability: methods and examples.
- 3- Study of relations with moduli spaces theory: integrable systems arising as symmetry reductions of Yang-Mills equations, integrable systems naturally arising as moduli spaces of bundles (Hitchin integrable system, etc.)
- 4- Applications to Mathematical Physics and classical differential geometry.

All program information can be found at:

<http://www.crm.cat/en/Activities/Pages/ActivityDescriptions/RP-Geometry-and-Dynamics-of-Integrable-Systems.aspx>

#### Visiting Researchers

Romero Barbieri Solha (Universitat Politècnica de Catalunya), Alexei Bolsinov (University Loughborough Leicestershire), Roger Casals (ICMAT/CSIC Madrid), Chiara Esposito (Mathematisches Forschungsinstitut Oberwolfach), Pedro Frejlich (Universiteit Utrecht), Anna Kiesenhofer (Universitat Politècnica de Catalunya), Jean-Pierre Marco (Université Pierre et Marie Curie), David Martínez Torres (Instituto Superior Técnico), Vladimir Matveev (Friedrich-Schiller Universität Jena), Eva Miranda (Universitat Politècnica de Catalunya), Andrey Mironov (Sobolev Institute of Mathematics), Philippe Monnier (Université Paul Sabatier), Klaus Niederkruger (Université Paul Sabatier), Alvaro del Pino (Universidad Autónoma de Madrid), Francisco Presas (Instituto de Ciencias Matemáticas), Stefan Rosemann (Friedrich-Schiller Universität Jena), Konrad Schöbel (Friedrich-Schiller Universität Jena), Iskander Taimanov (Institute of Mathematics), Vassil Tzanov (Bristol University), Andreas Vollmer (Friedrich-Schiller Universität Jena), Jonathan Weitsman (Northeastern University).

## Activities

- **Weekly Seminar**

#### Speakers

Florent Balacheff, Université Lille

*Systolic and contact geometry.*

November 14, 2013.

Adrien Boyer, Marseille Université

*Unitary representations on the Furstenberg boundary, and some aspect aspects of ergodic theory: the case of  $SL(2, R)$ .*

October 31, 2013.

David Martínez, Instituto Superior Técnico  
*An example of a Poisson manifold of strong compact type.*  
November 7, 2013.

Vladimir Matveev, Friedrich-Schiller Universität Jena  
*(Non)existence of integrals that are polynomial in momenta.*  
October 3, 2013.

Philippe Monnier, Université Paul Sabatier  
*Linearization of smooth Poisson structures.*  
October 24, 2013.

Volodya Roubtsov, Université Angers  
*Parameter-dependent Poisson-structures: from usual to double.*  
September 26, 2013.

M. Amelia Salazar, IMPA  
*Jacobi structures and Spencer operators.*  
October 31, 2013.

Jonathan Weitsman, Northeastern University  
*Semiclassical analysis, loop group characters, and the modular group action.*  
October 10, 2013.

• **Advanced Course on Geometry and Dynamics of Integrable Systems**

*September 9 to 14, 2013.*

*Participants:* 27

Lecturers  
Alexey Bolsinov (University Loughborough Leicestershire)  
*Singularities of bi-Hamiltonian systems and stability analysis*

Juan José Morales-Ruiz (Universidad Politécnica de Madrid)  
*Integrable Systems and Differential Galois Theory*

Nguyen Tien Zung (Université Paul Sabatier)  
*Geometry of integrable non-Hamiltonian systems*

• **Conference on Integrability, Topological obstructions to Integrability and Interplay with Geometry**

*September 16 to 20, 2013*

*Participants:* 33

Speakers  
Alain Albouy (CNRS), Alexey V. Borisov (Udmurt State University), Vincent Colin (Université de Nantes), Lucia Di Vizio (Université de Versailles - St. Quentin), Christian Duval (CNRS Marseille), Yuri Fedorov (Universitat Politècnica de Catalunya), Rui Loja Fernandes (University of Illinois at Urbana-Champaign), Valerij Vasilievich Kozlov (Russian Academy of Sciences), Alexander Kilin (Institute of Computer Science), Boris Kruglikov (Universitetet i Tromsø), Jean-Pierre Marco (Université Pierre et Marie Curie), Andrey

Mironov (Sobolev Institute of Mathematics), Klaus Niederkrüger (Université Paul Sabatier), Valentin Ovsienko (Université Claude Bernard, Lyon), Daniel Peralta (ICMAT), Konrad Schöbel (Friedrich-Schiller Universität Jena), Dmitry Treschev (Steklov Mathematical Institute), Jacques-Arthur Weil (Université de Limoges).



• **Qdays in Barcelona**

*October 16 to 18, 2013*

*Participants: 30*

**Speakers**

Pierre Bieliavsky (Université Catholique de Louvain), Sergei Gukov (California Institute of Technology), Simone Gutt (Université Libre de Bruxelles), Mark Hamilton (Mount Allison University), Peter Hochs (The University of Adelaide), Stéphane Korvers (Université Catholique de Louvain), Ryszard Nest (University of Copenhagen), Paul-Émile Paradan (Université de Montpellier), Martin Schlichenmaier (Université du Luxembourg), Jedrzej Sniatycki (University of Calgary), Jonathan Weitsman (Northeastern University).

• **Closing Conference (at ICMAT-Madrid) on Symplectic Aspects of Dynamical Systems**

*November 11 to 15, 2013*

*Participants:*

**Lecturers**

Alberto Abbondandolo (Rühr-Universität Bochum), Marta Batoréo (Instituto Nacional de Matemática Pura e Aplicada), Michael Bialy (Tel Aviv University), Paul Biran (ETH Zurich), Lev Buhovski (Tel Aviv University), Marc Chaperon (Institut de Mathématiques de Jussieu), Octav Cornea (Université de Montréal), Basak Gürel (University of Central Florida), Alberto Ibort (Universidad Carlos III de Madrid), Ely Kerman (University of Illinois at Urbana-Champaign), David Martínez (Universiteit Utrecht), Vladimir Matveev (Universität Jena), Will Merry (ETH Zürich), Klaus Niederkrüger (Université Paul Sabatier), Yaron Ostrover (Tel Aviv University), Leonid Polterovich (University of Chicago), Ana Rechtman (Université de Strasbourg), Sheila

Sandon (CNRS, Nantes), Iskander Taimanov (Novosibirsk State University), San Vu Ngoc (Université de Rennes), Chris Wendl (University College, London).

### **3.2. Congressos i Workshops**

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En aquest apartat es detallen els congressos i *workshops* que va organitzar el CRM durant l'any 2013 al marge dels programes de recerca.

### **3.2. Conferences and Workshops**

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*This section lists the congresses and workshops organised by CRM during 2013 not included in research programmes.*

#### **ESF Exploratory Workshop: Noise in decision making: theory meets experiment**

*May 28 to 31, 2013*

Participants: 32

Organisers                    Albert Compte (IDIBAPS), Gustavo Deco (UPF), Jaime de la Rocha (IDIBAPS), Alex Roxin (CRM), Klaus Wimmer (IDIBAPS).

Speakers                    Matthias Bethge (Universität Tübingen), Laura Busse (Universität Tübingen), Anne Churchland (Cold Spring Harbor Lab.), Albert Compte (IDIBAPS), Bruce Cumming (NIH, Bethesda), Gustavo Deco (Universitat Pompeu Fabra), Jaime de la Rocha (IDIBAPS), Sophie Denève (ENS, Paris), Georgia Gregoriou (University of Crete), Ralf Haefner (Central European University, Budapest), Christian Machens (Champalimaud Foundation, Lisbon), Zach Mainen (Champalimaud Foundation, Lisbon), Encarni Marcos (Universitat Pompeu Fabra), Rubén Moreno-Bote (Fundació Sant Joan de Déu, Barcelona), Hendrikje Nienborg (Universität Tübingen), Satu Palva (University of Helsinki), Néstor Parga (Universidad Autónoma de Madrid), Tatiana Pasternak (University of Rochester, NY), Alexandre Pouget (Université de Genève), Alfonso Renart (Champalimaud Foundation, Lisbon), Petra Ritter (Charité, Berlin), Douglas Ruff (Pittsburgh University), Michael Shadlen (Columbia University, New York), Catherine Tallon-Baudry (CNRS, Paris), Alex Thiele (University of Newcastle), Xiao-Jing Wang (New York University), Klaus Wimmer (IDIBAPS).

#### **On Slow-Fast Dynamics: Theory, Numerics, Application to Life and Earth Sciences**

*June 1 to 5, 2013*

Participants: 64

Organisers                    Peter De Maesschalck (Hasselt Universiteit), Mathieu Desroches (INRIA), Mark Kramer (Boston University), Martin Krupa (INRIA), Serafim Rodrigues (University of Plymouth), Alexandre Vidal (Université d'Evry), Haiping Zhu (University of York).

Scientific Committee	Eric Benoît (Université de La Rochelle), Freddy Dumortier (Hasselt Universiteit), Jean-Pierre Françoise (Université Pierre & Marie Curie, Paris 6), Boris Gutkin (École Normale Supérieure de Paris), Jean-Christophe Poggiale (Université de Marseille), Robert Roussarie (Université de Dijon).
Speakers	G. Bard Ermentrout (University of Pittsburgh), Freddy Dumortier (Hasselt Universiteit), Olivier Faugera (INRIA Sophia Antipolis), Jean-Pierre Françoise (Université Pierre & Marie Curie), John Guckenheimer (Cornell University), Antoni Guillamon (UPC), Yannis Kevrekidis (Princeton University), Martin Wechselberger (University of Sydney), Antonios Zagaris (University of Twente).

### **Emergence, Spread and Control of Infectious Diseases**

*June 10 to 11, 2013*

Participants: 26

Organiser	Andrei Korobeinikov
Speakers	Andrew Fowler (University of Limerick), Deirdre Hollingsworth (University of Warwick), Elena Lara (Institut de Ciències del Mar), Valery Perminov (Central Aerohydrodynamic Institut (TsAGI) and BioTeckFarm Ltd.), Josep Sardanyés (UPF), Dolors Vaqué (Institut de Ciències del Mar).

### **Barcelona Computational and Systems Neuroscience (BARCSYN) 2013**

*June 13 to 14, 2013*

Participants: 79

Organisers	Matthieu Louis (CRG), Rubén Moreno-Bote (FSJD), Alex Roxin (CRM), Klaus Wimmer (IDIBAPS).
Speakers	Ralph Andrzejak (UPF), Miguel Burgaleta (UPF), Maria Cano-Colino (IDIBAPS), Gonzalo de Polavieja (Cajal Institute), Lluís Fuentemilla (UB), Ivan Herreros (SPECS, UPF), Etienne Hugues (UPF), Gemma Huguet (UPC), Dani Jercog (IDIBAPS), Matthias Keil (UB), L. Luczak (Canadian Center for Behavioural Neurosciences, University of Lethbridge), Ernest Montbrió (UPF), Rubén Moreno-Bote (Fundació Sant Joan de Déu), Javier Orlandi (UB), August Romeo (UB), Alex Roxin (CRM), Nava Rubin (UPF), Marcel Ruiz-Mejias (IDIBAPS), Aljoscha Schulze (CRG), Belén Sancristóbal (UPF), Hans Supèr (UB).

## **Qualitative and Geometric Aspects of Elliptic PDE's**

*September 2 to 6, 2013*

Participants: 24

Organisers            Xavier Cabré (ICREA & Universitat Politècnica de Catalunya), Daniele Castorina (Università degli Studi di Roma “Tor Vergata”), Manel Sanchón (Universitat de Barcelona), Enrico Valdinoci (Università di Milano & Weierstrass Institute for Applied Analysis and Stochastics, Berlin).

Speakers            Manuel del Pino (Universidad de Chile), Alberto Farina (Université de Picardie Jules Verne, Amiens), Alessio Figalli (The University of Texas, Austin), François Hamel (IUF, Marseille), Nikola Kamburov (The University of Arizona, Tucson), Moritz Kassmann (Universität Bielefeld), Enno Lenzmann (University of Copenhagen), Chang-Shou Lin (National Taiwan University, Taipei), Carlo Mantegazza (Scuola Normale Superiore di Pisa), Robert McCann (University of Toronto, Bahen Centre), Frank Morgan (Williams College, Massachusetts), Nikolai Nadirashvili (CNRS et Université d'Aix-Marseille), Frank Pacard (École Polytechnique and Université Paris Est-Créteil), Ireneo Peral (Universidad Autónoma de Madrid), Joaquín Pérez (Universidad de Granada), Aldo Pratelli (Universität Erlangen-Nürnberg), Jean-Michel Roquejoffre (Université Paul Sabatier), Antonio Ros (Universidad de Granada), Bernardino Sciunzi (Università della Calabria, Cosenza), Gabriella Tarantello (Università Tor Vergata, Rome), Juan Luis Vázquez (Universidad Autónoma de Madrid), Jun-Cheng Wei (Chinese University of Hong Kong).

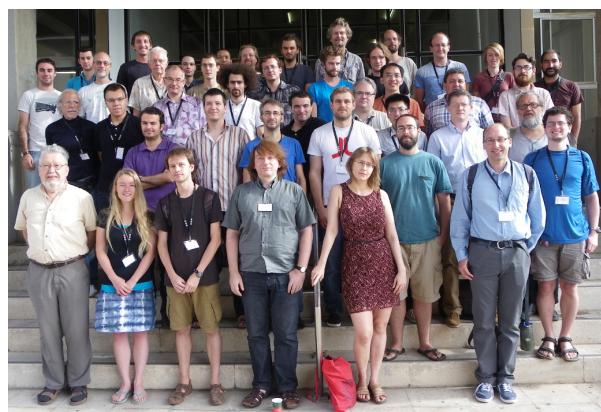
## **Type Theory, Homotopy Theory and Univalent Foundations**

*September 23 to 27, 2013*

Participants: 60

Organisers            Joachim Kock (UAB), Nicola Gambino (Università degli Studi di Palermo & University of Leeds).

Speakers            Richard Garner (Macquarie University), André Joyal (UQAM, Montréal), Peter LeFanu Lumsdaine (Institute for Advanced Study, Princeton), Thomas Streicher (Technische Universität Darmstadt).



## **Jornades de consultoria estadística i software II**

*October 23 to 25, 2013*

Participants: 90

Organisers	Llorenç Badiella (Servei d'Estadística Aplicada, UAB), Joaquim Berenguer (CRM), Àlvaro Corral (CRM), Joan del Castillo (UAB), Anna Espinal (Servei d'Estadística Aplicada, UAB).
Speakers	Pau Agulló (Kernel Analytics), Tània Arnau, Sergio Baena (Banc de Sabadell), Juan Ramón González (CREAL), Alex Sánchez-Pla (Bioinformatics and Big data); José Barrera (CREAL), X. Basagaña, David Conesa (Universitat de València), Daniel Cuadras (Fundació Sant Joan de Déu), Meritxell Falqués (Almirall SA), Eva Flo (Institut de Ciències del Mar, CSIC), Pilar Muñoz, Xavier Nuñez, Susana Pérez-Álvarez (Institut de Recerca de la Sida, IrsiCaixa), Santiago Pérez-Hoyos (Vall d'Hebron Institut de Recerca), Llorenç Quintó (Centre de Recerca en Salut Interna. de Barcelona), José Ríos, Sara Tous (Institut Català d'Oncologia), Joan Valls (Biostatistics and Clinical Trials), Jesús Aguilera (SAS Institute S.A.), Daniel Alcaide (BIOCLEVER 2005, S.L.), Míriam Amores (UAB), Llorenç Badiella (SEA, UAB), Marta Fernández, Vicente Lustres-Pérez, Héctor Perpiñán (Bayestats S.L.), Frederic Udina (Idescat), A. Vázquez (Business Analytics and other applications).

## **Joint CRM-ISAAC Conference on Fourier Analysis and Approximation Theory**

*November 4 to 8, 2013*

Participants: 44

Organisers	Michael Ruzhansky, (Imperial College, London), Sergey Tikhonov (ICREA & CRM, Barcelona).
Speakers	Yasuo Chiba (Tokyo University of Technology), Hiroyuki Chihara (Kagoshima University), Petr Chunaev (Vladimir State University), Piero D'Ancona (Università di Roma), Julio Delgado (Imperial College London), Evgenii Doubtsov (Steklov Mathematical Institute), Irene Drelichman (Universidad de Buenos Aires), Veronique Fischer (Imperial College London), Ushangi Goginava (Ivane Javakhishvili Tbilisi State University), Dmitry Gorbachev (Tula State University), Yurii Kolomoitsev (Inst. Applied Math. & Mech. Donetsk), Vjekoslav Kovač (University of Zagreb), Lev S. Maergoiz (Siberian Federal University), Tokio Matsuyama (Chuo University), Béla Nagy (University of Szeged), Nikolaos Pattakos (University of Birmingham), Mikhail Plotnikov (Vologda State Milk Industry Academy), Yauheni A. Rovba (Yanka Kupala State University of Grodno), Michael Ruzhansky (Imperial College London), René M. Schulz (Georg-August-Universität Göttingen), Simon Serovajsky (Al-Farabi Kazakh National University), K. K. Shakenov (Kazakh State University), Mitsuru Sugimoto (Nagoya University), Walter Trebels (Technische Universität Darmstadt), Paco Villarroya (Lund University),

# Joint CRM-ISAAC Conference on Fourier Analysis and Approximation Theory

November 4 to 8, 2013

Centre de Recerca Matemàtica, Bellaterra, Barcelona

## Topics

Fourier analysis  
Function spaces  
Pseudo-differential operators  
Microlocal analysis  
Time-frequency analysis  
Partial differential equations  
Approximation theory



## Organizers

Michael Ruzhansky (Imperial College, London)  
Sergey Tikhonov (ICREA and CRM, Barcelona)

## Further information on the activity

[www.crm.cat/2013/CIsaac](http://www.crm.cat/2013/CIsaac)



Fons Europeu de Desenvolupament Regional

"Una manera de fer Europa"

## 3.3. Cursos avançats

En aquest apartat es detallen els cursos avançats que va organitzar el CRM durant l'any 2013 al marge dels programes de recerca.

## 3.3. Advanced Courses

This section lists the advanced courses organised by CRM during 2013, not included in research programmes.

### Advanced Course on Flag Manifolds and Schubert Calculus

April 8 to 12, 2013

Participants: 15

Organiser Wolfgang Pitsch (Universitat Autònoma de Barcelona).

Lecturers Duan Haibao (Institute of Mathematics, Chinese Academy of Sciences)  
*Flag manifolds and Schubert calculus*

### Joint CRM Imperial College School and Workshop in Complex Systems

April 8 to 13, 2013

Participants: 92

Organisers Álvaro Corral (CRM), Tomás Alarcón (CRM).

Scientific Committee	Albert Díaz Guilera (Universitat de Barcelona), Kim Christensen (Imperial College London), Henrik J. Jensen (Imperial College London), M. Ángeles Serrano (Universitat de Barcelona).
Lecturers	<p>Marián Boguñá (Universitat de Barcelona)  <i>Percolation in complex networks</i></p> <p>Kim Christensen (Imperial College London)  <i>Critical phenomena and percolation theory</i></p> <p>Henrik J. Jensen (Imperial College London)  <i>Dynamics of complex systems (intermittency, stability, etc)</i></p> <p>Gunnar Pruessner (Imperial College London)  <i>Non-equilibrium phase transitions, field theory and self-organised criticality</i></p> <p>M. Ángeles Serrano, Universitat de Barcelona)  <i>Complex networks and Hidden metric spaces: internet, metabolic networks</i></p> <p>Antonio Turiel (CSIC)  <i>Multifractal formalism: From models for turbulent flows to applications in ocean remote sensing</i></p>

### **Advanced course on Compactifying moduli spaces**

May 27 to 31, 2013

Participants: 74

Organisers	Gilberto Bini (Università degli Studi di Milano), Martí Lahoz (Université Paris Sud 11), Emanuele Macrý (The Ohio State University), Paolo Stellari (Università degli Studi di Milano).
Scientific committee	Enrico Arbarello (Sapienza Università di Roma), Aaron Bertram (University of Utah), Bert van Geemen (Università degli Studi di Milano), Daniel Huybrechts (Universität Bonn), Joan Carles Naranjo (Universitat de Barcelona).
Lecturers	<p>Valery Alexeev (University of Georgia)  <i>Moduli of weighted hyperplane arrangements, with applications</i></p> <p>Paul Hacking (University of Massachusetts Amherst)  <i>Compact moduli spaces of surfaces and exceptional vector bundles</i></p> <p>Radu Laza (Stony Brook University)  <i>Perspectives on the construction and compactification of moduli spaces</i></p> <p>Manfred Lehn (Universität Mainz)  <i>Lectures on Moduli of rational curves of small degree</i></p> <p>Dragos Oprea (University of California at San Diego)  <i>The moduli space of stable quotients</i></p>

## **Financial Engineering Summer School (FESS2013)**

Juny 18 to 21, 2013

Participants: 63

Organiser                    Joan del Castillo (Universitat Autònoma de Barcelona), Paul MacManus (Analistas Financieros Internacionales).

Speaker                    Damiano Brigo (Imperial College London)  
*Consistent modeling of counterparty credit risk, collateral and funding costs*  
Jim Gatheral (Baruch College, New York)  
*The volatility surface: statics and dynamics*

Richard Martin (Longwood Credit Partners)

*Hedge fund trading strategies*

Alexander McNeil (Heriot-Watt University)

*Credit risk models and the changing regulatory environment*

Apart dels Cursos Avançats estàndard, el CRM també es va involucrar en la següent activitat:

*Besides the standard Advanced Courses, the CRM was also involved in the following activity:*

- *ECCS Warm-up: School on Complex Networks, September 13 to 15, 2013*

Organisers                    Francesc Font-Clos (CRM), Oleguer Sagarrà (UB), Michele Starnini (UPC), Jesús Gómez Gardeñes (Universidad de Zaragoza).

Lecturers                    Àlex Arenas (URV), Romualdo Pastor-Satorras (UPC & ICREA), Marta Sales-Pardo (URV).

Description                    Coinciding with the European Conference on Complex Systems, the school aimed to offer young researchers the opportunity to learn new methods, present their work and meet fellow researchers on complex networks ranging from the internet to the metabolic system, going through transport infrastructures and social systems. The CRM was one of the sponsors of the school, together with Ajuntament de Barcelona, BCN Lab, the *complexitat.cat* network, ECCS'13, the *Universitat de Barcelona* and the *Universitat Politècnica de Catalunya*.

### **3.4. Jornades temàtiques**

El CRM promou també trobades intensives de recerca sota la denominació de "jornades temàtiques". El 2013 es van celebrar les següents:

### **3.4. Thematic Days**

*The CRM also promotes intensive research meetings generically named "thematic days". In 2013 the following have been hosted:*

□ *Jornada CRM-Empresa sobre finances quantitatives*, February 22, 2013

Coordinators Luis Ortiz (CRM), Joan del Castillo (UAB), Joaquim Berenguer (CRM, Knowledge Transfer Team).

Speakers Elisa Alòs (UPF), Argimiro Arratia (UPC), Llorenç Badiella (Servei Estadística Aplicada, UAB), Sergio Baena (Banc Sabadell), Javier Calvo (Management Solutions), Ferran Carrascosa (AIS), Santiago Carrillo (Universidad Autónoma de Madrid), José Manuel Corcuera (UB), Rafael de Santiago (IESE Business School), Eduard Giménez (La Caixa), Chainarong Kesamoon (UAB), Javier Nore (Deloitte), Luis Ortiz (CRM), Jorge Segura (Universidad de Córdoba), Isabel Serra (UAB), Gerard Torrent (Tatine), Fernando Valles (PrinceWaterHouseCoopers), Josep Vives (UB).

□ *CRM Colloquium: Monotonicity, Smoothness, and Fourier Transforms*, March 20, 2013

Speakers Sergey Tikhonov (ICREA - CRM).

□ *Eighth Barcelona Weekend in Group Theory*, April 26 to 27, 2013

Coordinators Josep Burillo (UPC), Enric Ventura (UPC).

Speakers Ariadna Fossas (EPFL, Lausanne), Jon González (Euskal Herriko Unibertsatea), Delaram Kahrobaei (CUNY, New York), Ana Khukhro (Université de Neuchâtel), Francesco Matucci (Université Paris-Sud 11), Andrzej Zuk (Université Paris 7).

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### 3.5. Activitats divulgatives

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El CRM promou activitats de divulgació en l'àmbit de la matemàtica, a diferents nivells formatius. Durant el 2013 s'han organitzat xerrades científiques interdisciplinars, s'ha inaugurat una exposició que combina art fotogràfic amb l'espiritu de la matemàtica i s'ha difós la recerca entre estudiants preuniversitaris.

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### 3.6. Seminaris del CRM

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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.

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### 3.5. Dissemination Activities

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*The CRM promotes dissemination activities around mathematics, at different specialization levels. During 2013, 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.*

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### 3.6. CRM Seminars

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

## The CRM Applied Mathematical and Physics (CAMP) seminar

**Coordinators/ Coordinators:** Pilar Guerrero (CRM), Esther Ibáñez (CRM).

30/01/2013. Eduard Vives, UB, *Criticality during boiling crisis: Acoustic emission avalanches.*

20/02/2013. Nicholas R. Moloney, London Mathematical Laboratory, *An information-theoretic model for communication.*

06/03/2013. Daniel Sánchez Taltavull, CRM, *Stochastic models of cell populations with hierarchical structure and latently cell activation and viral blip generation in HIV-1 patients.*

19/03/2013. Julia Sánchez, BCAM-Basque Center for Applied Mathematics, Bilbao, *Numerical computation of stability boundaries for structured population models.*

20/03/2013. Alex Roxin, CRM, *The problem with computational neuroscience.*

03/04/2013. Esther Ibáñez Marcelo, CRM, *Evolutionary dynamics of populations with genotype-phenotype map.*

17/04/2013. Juan Calvo Yagüe, UPF, *Kinetic models in gravitation and the rotation curve of the Milky Way.*

24/04/2013. Jorge F. Mejias, Department of Physics and Centre for Neural Dynamics, Neurophysics Group, University of Ottawa, *Optimal heterogeneity for coding in spiking neural networks.*

09/05/2013. José Mazón, Universitat de València, *Algunos problemas de transporte de masas obtenidos como límites de  $p$ -Laplacianos. (Jointly organized with "Seminari d'equacions en derivades parcials i aplicacions").*

14/05/2013. Juan Luis Fernández Martínez, Universidad de Oviedo, *Inverse problems, uncertainty analysis and industrial applications.*

22/05/2013. Fabian Spill, Mathematical Institute, University of Oxford, *Mathematical models of vascular tumour growth.*

29/05/2013. Francesc Font Clos, CRM, *The striking robustness of time-evolving word co-occurrence networks.*

25/06/2013. Lou Kondic, New Jersey Institute of Technology, *Films, rings, and rivulets: Instabilities of liquid metals on nanoscale.*

26/06/2013. Eugenia Corvera-Poire, UNAM, *Vascular alterations. Screening, rerouting, robustness and critical sites for blood supply.*

12/09/2013. Jörn Dørsdal Davidsen, University of Calgary, *Inferring causal connections and functional networks.*

25/09/2013. Nico Stollenwerk, Universidade de Lisboa, *Fokker-Planck- and Hamilton-Jacobi-approximations in parameter estimation and model evaluation of complex epidemiological.*

15/12/2013. Vincent Cregan, CRM, *Application of asymptotic methods to industrial problems.*

29/12/2013. Carles Barril, CRM, *Social behavior and the spread of sexually transmitted diseases.*

05/11/2013. Vladimir Sobolev, Samara State Aerospace University, Russian Federation, *Canards in combustion problems*.

07/11/2013. Marina Vegué, CRM, *Study of the Wilson-Cowan equations, a neural network model*.

21/11/2013. Susanna Manrubia, Centro de Astrobiología, Instituto Nacional de Técnica Aeroespacial, Madrid, *Evolution on heterogeneous genotype networks causes phenotypic entrapment*.

28/11/2013. Francesc Font Martínez, CRM, *Mathematical modelling of special solid-liquid phase transitions*.

05/12/2013. Sarah Mitchell, Department of Mathematics & Statistics University of Limerick, *Asymptotic, numerical and approximate results for spherical Stefan problems*.

12/12/2013. Georgina Palau, UPF, *Using cardiac modelling for understanding cardiovascular diseases*.

### Computational Neuroscience Seminar

**Organitzador / Organiser:** Alex Roxin (Centre de Recerca Matemàtica).

16/09/2013. Brent Doiron, University of Pittsburgh, *Formation of neuronal assemblies and their maintenance during spontaneous cortical activity*.

17/12/2013. Belen de Sancristóbal Alonso, Centre de Regulació Genòmica (CRG), *Role of frequency mismatch in neuronal communication through coherence*.

### Seminar Cycle on Quantitative Finance

**Organitzadors / Organisers:** Joan del Castillo (UAB), José Manuel Corcuera (UB), Josep J. Masdemont, (UPC), Frederic Utzet (UAB), Josep Vives (UB).

07/03/2013. Francisco Manuel Mejías Ruiz, Banc de Sabadell, *Introducción Crédito Single Names*.

27/06/2013. Archil Gulisashvili, The Ohio University, *On the asymptotic behavior of sums of correlated lognormal variables with applications to finance and risk management*.

19/09/2013. Thorsten Rheinlaender, Technische Universität Wien, *Valuation of exotic options by duality*.

### Seminari d'EDPs i aplicacions

Joint seminar of the Universitat Autònoma de Barcelona, Universitat de Girona, Universitat Politècnica de Catalunya and Centre de Recerca Matemàtica. The CRM has participated in its organization through Blanca Ayuso. To see the complete activity, please visit <http://www-ma2.upc.es/~{}edps/>.





## Publicacions del CRM

### CRM Publications

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, Research Perspectives CRM Barcelona, CRM Documents, Quaderns, Preprints, Series on Popularization, treballs finals de màster i tesis doctorals.*

Per tal de coordinar aquesta activitat, es va crear, a finals de 2011, el **Comitè Editorial del CRM**. Durant l'any 2013, ha estat format per Carles Casacuberta (editor en cap del CRM fins a desembre de 2013), Enric Ventura (nou editor en cap des de juliol de 2013), Antoni Guillamon (en representació de l'Equip de Direcció) i Raquel Hernández (responsable d'edició). El Comitè Editorial es reuneix bimensualment.

A continuació, donem una breu descripció de cadascuna de les sèries i un llistat dels *preprints* que han aparegut al llarg de 2013.

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

*With the purpose of coordinating this activity, the CRM Editorial Board was created in November 2011. During 2013, it was formed by Carles Casacuberta (Editor-in-Chief of CRM until December 2013), Enric Ventura (new Editor-in-Chief of CRM from July 2013), Antoni Guillamon and Raquel Hernández (edition tasks). The Editorial Board meets every two months.*

*We give next an overview of the different series and a list of the preprints issued along the year 2013.*

#### 4.1. Advanced Courses in Mathematics CRM Barcelona

Els volums d'aquests sèries, publicada per l'editorial suís Birkhäuser, recullen el contingut d'alguns dels cursos avançats impartits al CRM, a partir de les notes prèvies lliurades als participants i

*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*

reelaborades pels mateixos autors. Es tracta de llibres de text, especialment adreçats a estudiants de doctorat avançats i a joves investigadors postdoctorals.

Des de juliol de 2013, Enric Ventura és l'editor responsable d'aquesta sèrie. Relleva en el càrrec a Carles Casacuberta, que ha exercit aquesta tasca des de setembre de 2008 fins a desembre de 2013. La sèrie va ser iniciada l'any 2001 per Manuel Castellet.

L'any 2013 han aparegut tres volums d'aquesta sèrie:

- Semyon Alesker and Joseph Fu *Integral Geometry and Valuation Theory*, edited by Eduardo Gallego and Gil Solanes. Advanced Courses in Mathematics CRM Barcelona, vol. 22, Birkhäuser, Basel, 2014.
- Masayuki Asaoka, Aziz El-Kacimi Alaoui, Steven Hurder and Ken Richardson *Foliations: Dynamics, Geometry and Topology*, edited by Jesús Álvarez López and Marcel Nicolau. Advanced Courses in Mathematics CRM Barcelona, vol. 21, Birkhäuser, Basel, 2014.
- David Cruz-Uribe, Alberto Fiorenza, Michael Ruzhansky and Jens Wirth *Variable Lebesgue Space and Hyperbolic Systems*, edited by Sergey Tikhonov. Advanced Courses in Mathematics CRM Barcelona, vol. 20, Birkhäuser, Basel, 2013. ISBN 978-3-0348-0839-2

## 4.2. Research Perspectives CRM Barcelona

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L'any 2012, el Comitè Editorial del CRM va endegar en l'edició de resums ampliats de les comunicacions científiques dels congressos i *workshops* hostatjats pel centre. La intenció era la d'accelerar la difusió dels avenços en recerca, especialment dels resultats encara no publicats, consolidar el profit científic del esdeveniments del CRM i ajudar a actualitzar de manera fluïda l'estat de l'art en el camp de recerca corresponent. Quan el primer volum ja estava a punt d'imprimir-se (i esdevenir el volum dotzè de la sèrie *CRM Documents*), l'editorial Birkhäuser ens va oferir la possibilitat d'acollir aquests materials com a una nova subsèrie de la sèrie *Trends in Mathematics*. Estem contents de poder informar ara dels dos primers volums de la nova sèrie *Research Perspectives CRM Barcelona*:

*handed out to students and later reworked by the authors. These volumes are especially addressed to advanced doctoral and young post-doctoral students.*

*Since July 2013, Enric Ventura is the responsible editor of this series. He replaces Carles Casacuberta, who has assumed the task from September 2008 to December 2013. The series was initiated in 2001 by Manuel Castellet.*

*The following three volumes of this series were published in 2013:*

*In 2012, the CRM Editorial Board committed itself to edit extended conference abstracts, emanated from the conferences and workshops organized by the center. The aim was bringing the opportunity to quickly spreading recent research, including interesting new results not yet published, consolidating the scientific profit of CRM meetings and helping to fluently update the state of the art in each field. When the first volume was ready for printing (planned to be the CRM Document no. 12), the publishing company Birkhäuser offered the possibility to host them as a new subseries of the series *Trends in Mathematics*. Now, we are glad to report the first two volumes of the resulting new series *Research Perspectives CRM Barcelona*:*

- *Extended Abstracts Fall 2012. Automorphisms of Free Groups*, edited by J. González-Meneses, M. Lustig, E. Ventura. Research Perspectives CRM Barcelona, vol. 1, in *Trends in Mathematics* Birkhäuser, Basel, 2014. ISBN 978-3-319-05487-2.
- *Extended Abstracts Spring 2013. Complex systems; Emergence, Spread and Control of Infectious Diseases*, edited by Á. Corral, A. Deluca, F. Font-Clos, P. Guerrero, F. Masucci; A. Korobeinikov. Research Perspectives CRM Barcelona, vol. 2, in *Trends in Mathematics* Birkhäuser, Basel, 2014. ISBN 978-3-319-08137-3.

Els editors de la sèrie són Antoni Guillamon i Enric Ventura.

*The series editors are Antoni Guillamon and Enric Ventura.*

#### 4.3. Quaderns

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La sèrie *Quaderns* recull el contingut d'activitats especialitzades, principalment els apunts lliurats prèviament pel professorat de cursos avançats del CRM. Durant l'any 2013 s'han publicat els exemplars següents:

*Booklets in the Quaderns series contain specialized texts, mostly preliminary notes delivered by the teachers of the advanced courses. The following issues were printed in 2013:*

- Valery Alexeev, Paul Hacking, Radu Laza, Manfred Lehn, Dragos Oprea. *Advanced Course on Compactifying Moduli Spaces*, Vol. 65, May 2013.
- A. Chang, C. Fefferman, W. Meeks. *Advanced Course on Topics in Conformal Geometry and Geometry Analysis*, Vol. 66, June 2013.
- Alexey Bolsinov, Juan Jose Morales-Ruiz, Nguyen Tien Zung. *Advanced Course on Geometry and Dynamics of Integrable Systems*, Vol. 67, September 2013.

#### 4.4. Preprints

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La sèrie de prepublicacions del CRM s'ha incrementat amb els 48 títols següents durant l'any 2013:

*The CRM preprint series grew with the following 48 items in 2013:*

- Andrei Korobeinikov, A. V. Melnik. *Global properties for SIR and SEIR age-structured models*, preprint no. 01/2013
- Nir Lev, Sigrid Grepstad. *Multi-tiling and Riesz bases*, preprint no. 02/2013
- Kirill Kopotun, Dany Leviatan, I. A. Shevchuk. *Weighted D-T moduli revisited and applied*, preprint no. 03/2013.
- Salomón Rebollo Perdomo. *The number of medium amplitude limit cycles of some generalized Liénard systems*, preprint no. 04/2013.

- Álvaro Corral, E. Lippiello, M. Bottiglieri, C. Godano, L. de Arcangelis. *On the scaling behavior of the earthquake inter-time distribution: Influence of large shocks and time scales in the Omori law*, preprint no. 05/2013.
- Enric Ventura Capell, O. Kharlampovich. *A Whitehead algorithm for toral relatively hyperbolic groups*, preprint no. 06/2013.
- Enric Ventura Capell, Pedro Ventura Alves da Silva, X. Soler-Escrivà. *Finite automata for Schreier graphs of virtually free groups*, preprint no. 07/2013.
- Enric Ventura Capell, Pedro Ventura Alves da Silva, M. Ladra. *Bounding the gap between a free group (outer) automorphism and its inverse*, preprint no. 08/2013.
- Enric Ventura Capell, Jordi Delgado. *Algorithmic problems for free-abelian times free groups*, preprint no. 09/2013.
- Andrei Korobeinikov, J. McCarthy, E. Mooney, Krum Semkov. *Mathematical modelling of heat exchange in flash tank heat exchanger cascades*, preprint no. 10/2013.
- Luis Ortiz Gracia, Cornelis W. Oosterlee. *Robust pricing of European options with wavelets and the characteristic function*, preprint no. 10/2013.
- Sergey Tikhonov, Dmitry Gorbachev, Laura De Carli. *Pitt's and Boas' inequalities for Fourier and Hankel transforms*, preprint no. 12/2013.
- Goulnara N. Arzhantseva, Cornelia Drutu. *Geometry of infinitely presented small cancellation groups, Rapid Decay and quasi-homomorphism*, preprint no. 13/2013.
- J. T. Gill, S. Rohde. *A note on quasiconformal maps with Hölder-continuous dilation*, preprint no. 14/2013.
- Sergey Tikhonov, V. Kolesnikov. *Regularity of the Monge–Ampère equation in Besov's spaces*, preprint no. 15/2013.
- Timothy G. Myers, Michelle MacDevette, Helena Ribera. *A simple yet effective model for thermal conductivity of nanofluids*, preprint no. 16/2013.
- Alvaro Corral, Francesc Font Clos, Gemma Boleda. *A scaling law beyond Zipf's law and its relation with Heaps' law*, preprint no. 17/2013.
- Vicent J. Ribas Ripoll, Alfredo Vellido, Enrique Romero, Juan Carlos Ruiz-Rodríguez. *Sepsis mortality prediction with the quotient basis kernel*, preprint no. 18/2013.
- Timothy G. Myers, Michelle MacDevette, Francesc Font Martínez. *Continuum mathematics at the nanoscale*, preprint no. 19/2013.
- Timothy G. Myers, Jonathan Low. *Modelling the solidification of a power-law fluid flowing through a narrow pipe*, preprint no. 20/2013.
- Timothy G. Myers, Sarah Mitchell. *A mathematical analysis of the motion of an in-flight soccer ball*, preprint no. 21/2013.
- Damian M. Maingi. *Vector bundles of low rank on a multiprojective space*, preprint no. 22/2013.

- Andrei Korobeinikov, Vladimir Sobolev. *The phenomenon of apparent disappearance in the marine bacteriophage dynamics*, preprint no. 23/2013.
- Roland Rabanal Montoya. *On the limit cycles of a class of Kukles type differential systems*, preprint no. 24/2013.
- Nguyen Thac Dung. *Rigidity of immersed submanifolds in a hyperbolic space*, preprint no. 25/2013.
- Pilar Guerrero Contreras, Jesús Montejo Gámez, J. L. López. *A wavefunction description of stochastic-mechanics Fokker-Planck dissipation: derivation, stationary dynamics and numerical approximations*, preprint no. 26/2013.
- Yerlan Nursultanov, Viktor Burenkov, Diana Darbayeva. *Description of interpolation spaces for the pair of local Morrey-type spaces and their generalizations*, preprint no. 27/2013.
- Nazerke Tleukhanova, G.K. Mussabaeva. *On the Hardy and Littlewood inequality in Lorentz spaces  $L_{2,r}$* , preprint no. 28/2013.
- Roland Rabanal Montoya. *On the limit cycles of a class of Kukles type differential systems*, preprint no. 29/2013.
- Sergey Tikhonov, Erlan Nursultanov. *Weighted norm inequalities for convolution and Riesz potential*, preprint no. 30/2013.
- Sergey Tikhonov, Feng Dai. *Weighted fractional Bernstein's inequalities and their applications*, preprint no. 31/2013.
- V. Kolesnikov, D. A. Zaev. *Optimal transportation of processes with infinite Kantorovich distance. Independence and symmetry*, preprint no. 32/2013.
- Armando Martino, Yago Antolin Pichel, Josep Burillo. *Conjugacy in Houghton's Groups*, preprint no. 33/2013.
- Saul Schleimer, Matt Clay, Kasra Rafi. *Uniform hyperbolicity of the curve graph via surgery sequences*, preprint no. 34/2013.
- Ramazan Akgün. *A modulus of smoothness for some Banach function spaces*, preprint no. 35/2013.
- Luis Ortiz Gracia, Cornelis W. Oosterlee. *Efficient VaR and expected shortfall computations for non-linear portfolios within the delta-gamma approach*, preprint no. 36/2013.
- Ramazan Akgün. *Realization and characterization of modulus of smoothness in weighted Lebesgue spaces*, preprint no. 37/2013.
- Jaume Llibre Saló, Roland Rabanal Montoya. *Explicit focal basis for some planar rigid polynomial differential systems*, preprint no. 38/2013.
- Ramazan Akgün. *Some inequalities of trigonometric approximation in weighted Orlicz spaces*, preprint no. 39/2013.
- Andrei Korobeinikov, Cruz Vargas-de-León, Lourdes Esteva. *Age-dependency in host-vector models: a global analysis*, preprint no. 40/2013.

- Francesc Font Clos, Francesco A. Massucci, Isaac P. Castillo, Andrea de Martino. *A novel methodology to estimate metabolic flux distributions in constraint-based models*, preprint no. 41/2013.
- Santiago López de Medrano Sánchez, Vinicio Gómez Gutiérrez. *Topology of the intersections of quadrics II*, preprint no. 42/2013.
- Timothy G. Myers, Francesc Font Martínez. *Spherically symmetric nanoparticle melting with a variable phase change temperature*, preprint no. 43/2013.
- Timothy G. Myers, Michelle MacDevette, Helena Ribera. *A time dependent model to determine the thermal conductivity of a nanofluid*, preprint no. 44/2013.
- Timothy G. Myers, Michelle MacDevette, Brian Wetton. *Boundary layer analysis and heat transfer of a nanofluid*, preprint no. 45/2013.
- F. Font Martínez, Timothy G. Myers. *Spherically symmetric nanoparticle melting*, preprint no. 46/2013.
- A. Gogatishvili, B. Opic, S. Tikhonov, W. Trebels. *Ulyanov-type inequalities between Lorentz-Zygmund spaces*, preprint no. 47/2013.
- P. Frejlich, D. Martínez Torres, E. Miranda. *Symplectic topology of  $b$ -symplectic manifolds*, preprint no. 48/2013.

#### **4.5. Other publications**

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Les altres sèries editades pel CRM (tesis doctorals, treballs de recerca de màster i materials de divulgació) es troben en format elèctronic a la secció de Publicacions de la web del Centre. En aquesta memòria, podeu trobar els llistats de tesis doctorals i 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/](http://www.crm.cat/en/Publications/Pages/)

# Resum econòmic

## Financial Summary

NOTA: Les dades d'aquest resum són provisionals, pendent de tancament d'auditoria.

### 5.1 Ingressos

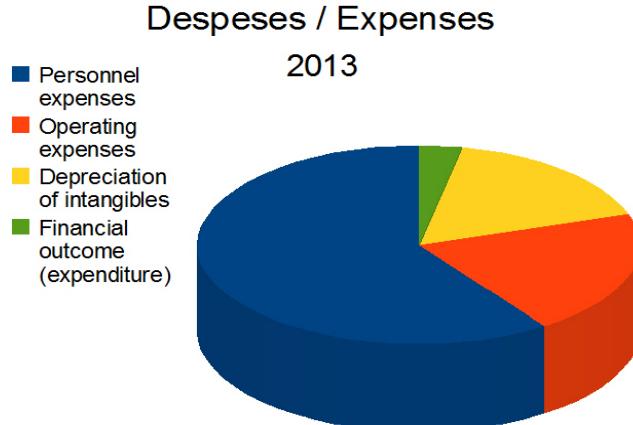
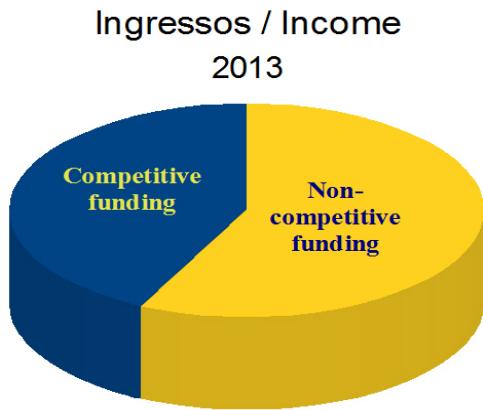
### 5.1. Income

Ingressos competitius <i>Competitive funding</i>	625.888,54 €
Ingressos no competitius <i>Non-competitive funding</i>	840.144,80 €
<b>TOTAL</b>	<b>1.466.033,34 €</b>

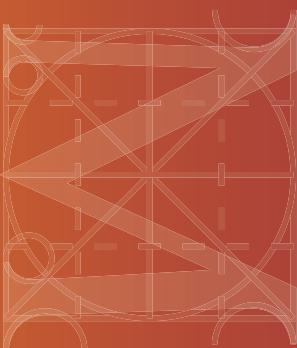
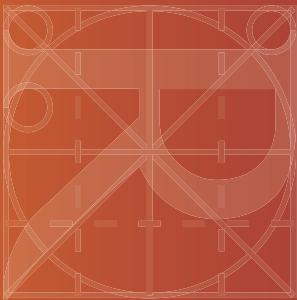
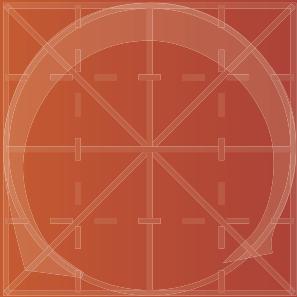
### 5.2 Despeses

### 5.2. Expenses

Despeses de personal <i>Personnel expenses</i>	923.896,18 €
Despeses d'explotació <i>Operating expenses</i>	315.609,15 €
Altres despeses <i>Other expenses</i>	2.833,86 €
Amortització immobilitzat <i>Depreciation of intangibles</i>	259.077,01 €
Resultat financer (despesa) <i>Financial outcome (expenditure)</i>	49.101,30 €
Resultat exercici <i>Annual profit</i>	-84.484,16 €
<b>TOTAL</b>	<b>1.466.033,34 €</b>



# CENTRE DE RECERCA MATEMÀTICA



CENTRE DE RECERCA MATEMÀTICA

CRM  
Campus de Bellaterra, Edifici C  
08193 Bellaterra  
Barcelona, Spain