CENTRE DE RECERCA MATEMÀTICA

MEMÒRIA D'ACTIVITATS 2016

REPORT OF ACTIVITIES 2016

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Presentació

L'any 2016 el CRM ha tingut bones i males notícies. En la categoria de les bones notícies, el centre ha passat l'avaluació CERCA amb molts bons resultats. L'avaluació valora molt positivament l'activitat desenvolupada pel centre en relació als recursos disponibles però també ha posat de manifest algunes mancances i debilitats que ja s'han començat a corregir.

Per altra banda, degut a l'acomiadament de la responsable dels programes de recerca internacionals del CRM ha calgut reestructurar completament l'equip que, ara, gestiona de manera integrada tan els programes de recerca internacionals com les altres (nombroses) activitats que organitza el centre. Si be aquesta reestructuració ha estat molt positiva pel centre el procés ha provocat, òbviament, algunes conseqüències negatives que han afectat especialment la bona marxa del programa Large Cardinals and Strong Logics. El ≪Simons visiting program≫ i el suport del Clay Mathematical Institute han estat un any més una gran ajuda en l'organització dels programes de recerca internacionals del CRM. Pel que fa a la recerca, sens dubte, un dels projectes més importants del CRM és el programa formatiu en Recerca Matemàtica Col.laborativa finançat per la Fundació de l'Obra Social de la Caixa (la primera crida d'aquest programa va fer-se a finals del 2013 i ja està completament desplegat). Les tasques dels alumnes doctorals del programa són ara en fase intermedia i s'espera que els resultats del programa es comencin a materialitzar intensivament a finals de l'any vinent, que és el moment esperat de finalització d'un gran nombre de tesis doctorals.

El centre ha reobert el programa Research In Pairs, que era una de les activitats clàssiques del CRM en stand-by degut a la crisi dels darrers anys destinant-hi una partida pressupostaria. Les accions dins d'aquest programa que involucrin investigadors de la Universitat de Barcelona compten amb la col·laboració i el cofinançament de l'IMUB (Institut de Matemàtiques de la Universitat de Barcelona) com s'estableix a la renovació de l'any 2016 del conveni de col·laboració entre les dues institucions.

En relació al contracte-programa del centre amb la Generalitat de Catalunya hem continuat amb una implementació de base anual, degut a la crisi. El contracte per l'any 2016 va ser acordat i signat juntament amb els seus respectius indicadors a començaments d'any.

Els resultats de la recerca pel que fa a publicacions, impacte, visibilitat internacional, formació, etc. són prou bons, com el lector podrà contrastar en aquesta memòria. Així mateix, tots els investigadors del CRM tenen projectes competitius vius dins de les convocatòries de plans estatals encara que l'import assignat a aquests projectes és baix. Tal com el nostre pla estratègic destaca, l'assignatura pendent dels grups del CRM és la mateixa que la de gairebé tots els grups en Matemàtiques, i no és altra que la presència en els programes europeus i el H2020 molt particularment.

Durant 2016 s'ha endegat la renovació prevista del Comitè Científic i Assesor. Els nous membres són: Albert Cohen (Université Pierre et Marie Curie 4), Robert MacKay (University of

Warwick), Peregrina Quintela (Universidad Santiago de Compostela) i Eva Miranda (Universitat Politècnica de Catalunya), que substitueixen a Wolfgang Dahmen (RWTH Aachen), Charles Fefferman (Princeton University), Consuelo Martínez (Universidad de Oviedo) i Joan Porti (Universitat Autònoma de Barcelona).

Es prou clar que en el context actual el centre ha d'establir i enfortir sinergies de recerca amb altres centres CERCA apart de les accions de col·laboració amb l'empresa i la indústria. S'han iniciat accions en aquesta direcció que s'espera que donin fruit en breu. Comença a ser evident que per a avançar en aquesta línia cal enfortir decididament les infraestructures i unitats de transferència de tecnologia al centre.

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

Lluís Alsedà, Director

Presentation

In 2016 the CRM has had good and bad experiences. On the side of the good news, the center has passed the evaluation or CERCA with good results. The evaluation regards positively the activity developed by the center when compared to the resources available, but also exposed some weaknesses and shortcomings that are already being corrected.

On another note, due to the dismissal of the person in charge of the CRM's international research programs, it was needed a complete restructuring of the team that now manages, in an integrated manner, both the international research programs and the rest of the (numerous) activities organized by the center. Even though this restructuring has been very positive for the center, the process has obviously led to some negative consequences that have particularly affected the good progress of the Large Cardinals and Strong Logics program. The ¡¡Simons visiting program¿¿ and the support of the Clay Mathematical Institute have been a great help again this year in organizing the CRM's international research programs. In terms of research activity, certainly, one of the most important projects of the CRM is the training program in Collaborative Mathematical Research for the Fundació de l'Obra Social de la Caixa (the first call for this program was made in 2013 and is now fully deployed). The work of the doctoral students of the program is now in the intermediate phase and the results of the program are expected to come into fruition at the end of next year, which is the expected time of completion for most of the doctoral thesis.

The center has reopened the Research in Pairs program, one of the most central activities of the CRM, which was left in stand-by due to the crisis suffered during the last few years, channeling a budget line to that effect. The actions within this program that involve researchers from the Universitat de Barcelona have the collaboration and co-funding from the IMUB (Institut de Matemàtiques de la Universitat de Barcelona), as established in the renewal in 2016 of the collaboration agreement between both institutions.

With respect to the contract-program between the center and the Generalitat de Catalunya we have carried on with an implementation or the annual basis, due to the crisis. The contract for the year 2016 was agreed upon and signed, together with the relevant indicators, at the beginning of the year.

The research results in the form of publications, impact, international visibility, training, etc. are quite good, as the reader will be able to observe in this report. Also, all the researchers at the CRM have competitive projects active within national plan calls, even though the amount assigned to these projects is low. As our strategic plan points out, the pending task for the CRM groups is the same as for almost all groups in Mathematics, and it is no other than the presence in European programs and, above all, the H2020.

During the year 2016 the planned renewal of the Scientific Advisory Board has been set in motion. The new members are: Albert Cohen (Université Pierre et Marie Curie 4), Robert

MacKay (University of Warwick), Peregrina Quintela (Universidad Santiago de Compostela) and Eva Miranda (Universitat Politécnica de Catalunya), replacing Wolfgang Dahmen (RWTH Aachen), Charles Fefferman (Princeton University), Consuelo Martínez (Universidad de Oviedo) and Joan Porti (Universitat Autònoma de Barcelona).

It is quite clear that, in the current context, the center has to establish and strengthen research synergies with other CERCA centers, apart from the collaborative actions with the private sector and the industry. Some actions have been set up in that regard and it is expected to see results before long. It is starting to be noticeable that, in order to move forward with this line of action, an improvement in infrastructures and the technology transference unit is needed at the center.

In this report you will find complete information above all of the above, information that appears on the center's website (www.crm.cat) with more detail in some aspects.

Lluís Alsedà, Director

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1

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 2014-2019:

- 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 stablished 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 a transversal centre 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 core concepts, quoted in the strategic plan within the contract-program with the Generalitat de Catalunya for the period 2014-2019:

- *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 addressing the weaknesses of the mathematical research activity in Catalonia as a whole, encouraging emergent areas and creating its own research groups in these areas.*

1.2. Estructura jurídica

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

L'acord del Govern de la Generalitat de 9 de juliol de 2002 (DOGC núm. 3693, de 6 d'agost de 2002) aprovà la constitució del Consorci Centre de Recerca Matemàtica, integrat per la Generalitat de Catalunya i l'IEC. El Consorci és una entitat pública amb personalitat jurídica pròpia. El desembre de 2013, la Universitat Autònoma de Barcelona es va incorporar al Consorci.

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

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

1.3. Consell de Direcció

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

- El president, que és el conseller d'Economia i Coneixement, o persona en qui delegui.
- El vicepresident, que és el president de l'IEC, o persona en qui delegui.
- Tres vocals en representació de la Generalitat de Catalunya.

1.2. Legal Status

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 opened its own premises at the UAB's Science Faculty, thanks to the 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 th, 2002 (DOGC No. 3693, August 6 th, 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 December 2013 the Universitat Autònoma de Barcelona joined the Consortium.

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 ERCOM, a committee of the European Mathematical Society (EMS), and the European Post-Doctoral Institute (EPDI).

1.3. Governing Board

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

- *The president, who is the Minister of Economy and Knowledge, or his delegate.*
- *The vice president, who is the president of the IEC, or his delegate.*
- *Three representatives from the Generalitat of 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.

El Consell de Direcció es va reunir el dia 21 de juliol de 2016. En aquesta reunió, la Generalitat de Catalunya va estar representada per Francesc Subirada com a director general de recerca.
L'IEC hi va estar representat Joandoménec Ros, que va presidir el Consell, Joaquim Agulló i per Joan Girbau. Francisco Javier Lafuente, vicerector de Projectes Estratègics i de Planificació de la UAB, hi va assistir a la sessió en representació del rector de la UAB. Hi van assistir també el director del CRM, Lluís Alsedà, i la gerent, Àngels Huertos. Com a representant del CERCA va assistir el senyor Lluís Rovira. Va actuar com a secretari Josep Maria Alcoberro. El Consell es va tornar a reunir en sessió extraordinària el 15 de novembre de 2016.

- *Two representatives from the IEC.*
- *One representative from the UAB.*
- *The Director of CRM, who participates with a voice but not a vote.*

The Governing Board met on July 21 st, 2016. In that meeting, the Generalitat de Catalunya was represented by Francesc Subirada, in his capacity of Director General de Recerca, who assumed the position of Chairman of the Board.

The IEC was represented by Joandomènec Ros, by Joaquim Agulló and by Joan Girbau. Francisco Javier Lafuente, the vice-rector of Strategic Projects and Planning of the UAB, assisted to the meeting on behalf of the rector of the UAB. The CRM director, Lluís Alsedà, and the general manager, Àngels Huertos, also assisted to the meeting. CERCA was represented by Lluís Rovira. Josep Maria Alcoberro acted as Secretary. The Board met in extraordinary session on November 15 th, 2016

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 17 de juny de 2016. 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:

1.4 Scientific Advisory Board

The Scientific Advisory Board (SAB) consists of prestigious personalities within 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 Juny 17 th, 2016. Throughout the year, on-line meetings were held.

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

Stephen O'Brien, University of Limerick
Helen Byrne, University of Oxford

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

1.5. El pla estratègic del CRM 2014–2019

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, emanat del primer pla estratègic del centre. Aquest contracte-programa es va prorrogar durant el 2014, mentre s'elaborava el nou pla estratègic.

El pla estratègic del CRM per al període 2014-2019, aprovat pel Consell de Direcció a la reunió de l'11 de juliol de 2014, conté un apartat introductori sobre "Missió i visió del CRM", seguit d'una secció "El CRM al final del pla estratègic 2008-2013" en la qual es fa un retrat de la situació actual del centre. Seguidament s'aborda pròpiament el nou pla, el qual té per objectiu servir de full de ruta del centre en sintonia amb la seva missió estatutària. El nou pla es proposa desenvolupar determinades polítiques orientades a diferents àmbits i assolir uns objectius concrets, agrupats com segueix.

1.5.1. Recerca

El CRM com a pol atractor d'investigadors a Catalunya:

- Objectiu 1: atraure al CRM dos investigadors ICREA consolidats addicionals en els propers sis anys. El CRM farà una prospecció cada any i presentarà les corresponents expressions d'interès.

1.5. The CRM strategic plan 2014–2019

The first contract-program between the CRM with the Catalan Government was signed on June 18 th, 2003. It remained in force until 2006 and was extended over 2007. On February 14 th, 2009, a new contract-program, stemmed from the first CRM's strategic plan, was signed for the period 2008–2013, and extended over the year 2014. Meanwhile, the new strategic plan was designed.

The CRM strategic plan for the period 2014–2019, approved by the Board of Governors on July 11 th, 2014, contains an introductory section on "Mission and vision of CRM", followed by a section on "The CRM at the end of the strategic plan 2008–2013" which is a portrait of the current state of the center. Next, the document addresses the new plan, which serves as a roadmap for the center, in line with its statutory mission. The new plan proposes the development of policies oriented to different areas and to achieve specific goals, grouped as follows.

1.5.1. Research

The CRM as an attracting pole for researchers in Catalonia:

- *Goal 1: attract to the CRM two additional consolidated ICREA researchers in the next six years. The CRM will make a market search every year and will present the corresponding expressions of interest.*

- Objectiu 2: atraure al CRM una mitjana de 1,5 investigadors júnior per any en els propers sis anys a través de beques *Marie Skłodowska-Curie* i contractes *Ramón y Cajal*.

El CRM i la recerca aplicada i col·laborativa en matemàtiques:

- Objectiu 3: aconseguir, al final del pla 2014-2019, una unitat de recerca consolidada en Matemàtica Aplicada Col·laborativa, consistent en tretze investigadors (IP's).

- Objectiu 4. crear una unitat mixta CRM-CRG en *Exploratory Data Analysis*.

La creació de sinergies entre els grups:

- Objectiu 5: millorar la cooperació entre els grups de recerca amb una acurada planificació a mitjà i llarg termini en la preparació de propostes a convocatòries competitives.

- Objectiu 6: promoure la codirecció de tesis de doctorat dins del CRM.

Les xarxes temàtiques i els investigadors col·laboradors del CRM:

- Objectiu 7: augmentar el nombre de col·laboradors del CRM d'altres institucions, en particular els que participen en les xarxes temàtiques del CRM.

- Objectiu 8: posar en marxa altres xarxes temàtiques en un futur proper; per exemple, en Biologia de Sistemes, o Epidemiologia Matemàtica.

El paper del CRM en la formació d'investigadors:

- Objectiu 9: arribar a una mitjana de dos estudiants de secundària per any que facin el seu treball de recerca al CRM.

- *Goal 2: attract to the CRM 1,5 junior researchers per year on average in the next six years through Marie Skłodowska-Curie fellowships and Ramón y Cajal contracts.*

The CRM and the collaborative applied research in mathematics:

- *Goal 3: achieve, by the end of this 2014-2019 plan, a consolidated research unit in Collaborative Applied Mathematics, consisting of thirteen researchers (IP's).*

- *Goal 4. create a joint CRM-CRG unit on Exploratory Data Analysis.*

Creating sinergies among groups:

- *Goal 5: improve the cooperation among research groups by means of a thorough mid- and long-term planning in order to prepare proposals to apply to competitive calls.*

- *Goal 6: promote the co-supervision of PHD theses within the CRM.*

Thematic networks and the scientific collaborators of the CRM:

- *Goal 7: increase the number of CRM scientific collaborators coming from other institutions, in particular those participating in the CRM thematic networks.*

- *Goal 8: launch other thematic networks in the near future; for instance, in Systems Biology or Mathematical Epidemiology.*

The role of CRM in research training:

- *Goal 9: achieve an average of two college students per year to develop their research project at the CRM.*

- Objectiu 10: enfortir les activitats de difusió dirigides als joves (*Saló de l'Ensenyament*, *Fira de la Ciència*, entrevistes gravades, etc.) per comunicar els valors de la investigació matemàtica a la societat.

- Objectiu 11: designar els investigadors del CRM com a col·laboradors científics a les universitats. Els actuals acords amb universitats ho permeten. A més, el projecte BGSMath hi tindria un efecte molt positiu.

- Objectiu 12: millorar i potenciar el programa d'estades d'investigació al CRM d'estudiants de grau i màster, amb el propòsit d'arribar a una mitjana de 4 estades per any.

- Objectiu 13: crear i consolidar la Unitat de Formació Doctoral del CRM (UFD-CRM).

- Objectiu 14: aconseguir una taxa mitjana de dos tesis doctorals per any durant el pla 2014–2019.

- Objectiu 15: obtenir recursos per a places postdoctorals en els projectes competitius atrets pels investigadors del CRM.

- Objectiu 16: obtenir recursos del sector privat per a la formació doctoral i postdoctoral en el CRM.

1.5.2. Reforçament del sistema

El CRM i la BGSMath:

- Objectiu 17: completar el redisseny institucional del CRM impulsant la BGSMath.

El CRM com a centre ERCOM organitzador d'activitats:

- Objectiu 18: el CRM ha de trobar finançament estable per als seus programes de recerca temàtica fora del sector públic.

- *Goal 10: reinforce the diffusion activities addressed to young students (Saló de l'Ensenyament, Fira de la Ciència, recorded interviews, etc.) to spread the impact of mathematical research on society.*

- *Goal 11: appoint the CRM researchers as scientific collaborators of the local universities, as the current agreements with universities allow. In addition, the BGSMath project would have a very positive effect in this respect.*

- *Goal 12: improve and potentiate research internships of undergraduate and masters' students at CRM, up to 4 stays per year on average.*

- *Goal 13: create and consolidate the CRM Doctoral Training Unit (UFD-CRM).*

- *Goal 14: achieve two PhD thesis per year on average along the 2014–2019 plan.*

- *Goal 15: obtain funds for postdoctoral position through the competitive projects attracted by CRM researchers.*

- *Goal 16: obtain funds from the private sector for doctoral and postdoctoral training at CRM.*

1.5.2. System reinforcement

The CRM and the BGSMath:

- *Goal 17: complete the institutional redesign of the CRM by promoting the BGSMath.*

The CRM as an ERCOM centre organiser of events:

- *Goal 18: find stable non-public funding for its thematic intensive research programmes.*

- Objectiu 19: el CRM ha d'obtenir un rendiment econòmic de l'organització d'esdeveniments científics en el centre; per exemple, un percentatge fix dels ingressos procedents dels drets d'inscripció.

- Objectiu 20: requerir als coordinadors dels programes de recerca i als visitants a llarg termini d'usar també una afiliació temporal al CRM quan signen documents originats durant la seva estada al centre.

El CRM com a centre promotor de la mobilitat dels investigadors:

- Objectiu 21: obtenir un finançament estable per als programes de visitants *DevMath* i *Lluís Santaló*.

1.5.3. Captació de recursos i transferència

Projectes de recerca:

- Objectiu 22: augmentar la participació del CRM en projectes de recerca finançats per la UE.

- Objectiu 23: aconseguir almenys un projecte de l'ERC durant els propers sis anys.

Transferència de coneixement i serveis a les empreses:

- Objectiu 24: aconseguir en transferència de coneixement una mitjana de dos contractes per any. El laboratori experimental hi podria tenir un paper important.

- Objectiu 25: posar en marxa una *start-up* en el camp de la Matemàtica Financera.

Explotació de les instal·lacions:

- Objectiu 26: aprofitar les instal·lacions del CRM per a obtenir ingressos addicionals.

- *Goal 19: obtain an economic yield from scientific events organised in the centre; for instance, a fixed percentage of the incomes from registration fees.*

- *Goal 20: require the coordinators of intensive research programmes and long-term visitors a temporary affiliation to the CRM when signing documents originated from their stay at the centre.*

The CRM as a centre promoting researchers' mobility:

- *Goal 21: obtain stable funding for the DevMath and Lluís Santaló visiting programmes.*

1.5.3. Fundraising and transference

Research projects:

- *Goal 22: increase the participation of the CRM in research projects funded by the EU.*

- *Goal 23: achieve, at least, one ERC contract in the next six years.*

Knowledge transfer to industry and services offered to private companies

- *Goal 24: obtain two contracts on knowledge transfer per year on average. The CRM experimental lab could play an important role in this regard.*

- *Goal 25: launch a start-up in the field of Financial Mathematics.*

Exploitation of the premises:

- *Goal 26: make the most of the CRM premises to get additional income.*

1.5.4. Publicacions i imatge

Activitat editorial:

- Objectiu 27: consolidar com una subcol·lecció dels *CRM Documents* els informes anuals dels programes de recerca temàtics i fer una nova sèrie amb els *extended abstracts* dels congressos i *workshops* celebrats al CRM.
- Objectiu 28: arribar a una taxa de publicació mitjana de dos números a l'any de la sèrie de *Advanced Courses CRM Barcelona*, editada per Birkhäuser, i reduir a sis mesos el retard entre el curs i l'edició.

Divulgació científica i imatge institucional:

- Objectiu 29: organitzar dues vegades l'any una jornada temàtica amb altres centres CERCA en les àrees de matemàtiques col·laboratives cultivades en el CRM.

1.5.5. Processos, administració i instal·lacions

- Objectiu 30: elaboració i implementació d'un pla d'igualtat del centre que comprengui tots els àmbits d'actuació del centre i en consideri tots els aspectes (diversitat, gènere, etc.).
- Objectiu 31: posar en marxa i executar la *HR Strategy for Researchers* (HRS4R).
- Objectiu 32: posar en marxa un servidor de càlcul intensiu.
- Objectiu 33: dissenyar i posar en marxa una intranet, que permeti millorar especialment la gestió econòmica dels projectes de recerca, la comptabilitat i la logística.

1.6. Col·laboració amb altres institucions

El CRM participa en iniciatives de diversa índole junt amb altres institucions acadèmiques.

1.5.4. Publications and image

Editorial activity:

- *Goal 27: consolidate as a subcollection of the CRM Documents the annual reports of the intensive research programmes and promote a new series around the extended abstracts of the conferences and workshops held at the CRM.*
- *Goal 28: achieve an average publication rate of two issues per year of the series Advanced Courses CRM Barcelona, edited by Birkhäuser, and reduce to six months the period between the courses and the edition.*

Scientific dissemination and institutional image:

- *Goal 29: organise, twice a year, a thematic day with other CERCA centres around the topics on collaborative mathematics cultivated in the CRM.*

1.5.5. Procedures, management and premises

- *Goal 30: ellaboration and implementation of an equality plan for the centre including all the action areas and considering all aspects (diversity, gendre, etc.).*
- *Goal 31: implement the HR Strategy for Researchers (HRS4R).*
- *Goal 32: set-up an intensive computing server.*
- *Goal 33: design and launch an intranet allowing to improve, specifically, the economic management of research projects, the accounting and the logistics.*

1.6. Institutional collaboration

The CRM participates in initiatives of various kinds with other academic institutions.

1.6.1. 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 es va crear 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 Matemàtica. L'Institut de Matemàtica de la Universitat de Barcelona també hi participa com a entitat de suport.

La BGSMath va estar guardonada l'any 2015 amb la distinció "María de Maeztu" pel Ministeri d'Economia i Competitivitat del Govern Espanyol com a part del seu Programa d'Excel·lència". Aquesta distinció va adreçada a centres de recerca espanyols destacats en totes les àrees de la ciència o les humanitats. Són beques adreçades a estades de doctorands i postdoctorals internacionals a Barcelona.

Els becaris finançats per la BGSMath que estan col·laborant amb els grups de recerca de les univesitats catalanes i el CRM són els següents:

1.6.1. 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. Another mission of the BGSMath is 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 Centre de Recerca Matemàtica. The Institut de Matemàtica de la Universitat de Barcelona also participates as a research support entity.

On 2015 BGSMath was awarded a "Maria de Maeztu" grant by the Spanish Ministry of Economy and Competitiveness under its "Excellence Program". The award is aimed at Spanish research centers that are leaders in all areas of science and the humanities. Grants provide funding for international PhD students and postdocs to complete stays in Barcelona.

The fellows financed by the BGSMath and in collaboration with the research groups of the catalan universities and the CRM are the following ones:

Nom	Cognom	Data d'inici	IP/Grup	Organisme
Federico	Cantaro	01/09/2016	Carles Casacuberta	UB
Enric	Costa	01/01/2016	Tomás Alarcón	CRM
Matteo	Cozzi	21/06/2016	Xavier Cabré	UPC
Gladston	Duarte	01/12/2016	Àngel Jorba	UB
Claudia	Fanelli	01/10/2016	Tim Myers	CRM
Francesc	Fité	01/09/2016	Víctor Rotger	UPC
Joan	Gimeno	15/01/2016	Àngel Jorba	UB
Carmelo	Puliatti	07/01/2016	Xavier Tolsa	UAB
Carlos	Sáez	01/01/2016	Carles Casacuberta	UB
Tomás	Sanz	01/09/2016	Xavier Cabré	UPC
Helmut	Schmidt	01/06/2016	Alex Roxin	CRM

http://www.bgsmath.cat/

1.6.2. ERCOM

ERCOM és l'acrònim del comitè European Research Centres on Mathematics de la Societat Matemàtica Europea (EMS), format pels directors científics de diversos centres 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 amb la possibilitat de nomenar-lo per un període de 2 anys més.

1.6.2. ERCOM

ERCOM is the acronym of the European Research Centres on Mathematics committee of the European Mathematical Society (EMS), composed by 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 with the possibility of re-appointment for another two-year period.

Des de la seva fundació, ERCOM ha estat presidit per: Ole Barndorff-Nielsen (MaPhySto) 1997–2002, Manuel Castellet (CRM) 2002–2005, Jan Karel Lenstra (CWI) 2006–2009, Gert-Martin Greuel (MFO) 2010–2013 i Ari Laptev (Institut Mittag-Keffler) 2014–.

La reunió anual d'ERCOM de 2016 tingué lloc els dies 15 i 16 d'abril, a St. Petersburg.

Per a més informació: www.ercom.org

Since its foundation, ERCOM has been chaired by Ole Barndorff-Nielsen (MaPhySto) 1997–2002, Manuel Castellet (CRM) 2002–2005, Jan Karel Lenstra (CWI) 2006–2009, Gert-Martin Greuel (MFO) 2010–2013, and Ari Laptev (Institut Mittag-Keffler) 2014–.

The annual meeting of ERCOM in 2016 was held on March 15 th and 16 th, in St. Petersburg.

Further information: www.ercom.org

1.6.3. EPDI

Des de desembre de 2000, el CRM és membre de l'EPDI (European Post-Doctoral Institute for the Mathematical Sciences), que agrupa deu prestigiosos instituts d'investigació europeus: Institut des Hautes Études Scientifiques, 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 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.

Per a més informació: www.ercom.org/EPDI.htm

1.6.3. EPDI

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 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.

Further information: www.ercom.org/EPDI.htm

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

1.6.4. ICREA

La Institució Catalana de Recerca i Estudis Avançats (ICREA) és una fundació impulsada per la Generalitat de Catalunya que, per mitjà d'un procés de selecció basat en el talent científic, contracta investigadors/es d'arreu del món per desenvolupar la seva tasca en universitats i centres de recerca de Catalunya. El CRM participa activament en totes les convocatòries de places d'ICREA presentant-hi candidatures d'investigadors en matemàtiques de reconegut prestigi. El centre compta de fa temps amb la presència de l'investigador ICREA Sergey Tikhonov i de l'investigador Tomás Alarcón que va obtenir una plaça ICREA senior a la convocatòria 2015.

1.6.4. ICREA

The Catalan Institution for Research and Advanced Studies (ICREA) is a foundation supported by the Catalan Government whose aim is to recruit top scientists for the Catalan R&D system. The CRM participates actively in all the ICREA calls by presenting renowned mathematical researchers as candidates for ICREA positions. ICREA researcher Sergey Tikhonov has been working at the CRM for some time and Tomas Alarcón, who obtained an ICREA senior position in the 2015 call.

*iCrea
INSTITUCIÓ CATALANA DE RECERCA I ESTUDIS AVANÇATS

http://www.icrea.cat/

1.7. 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 patrocinadors sensibles a la recerca en matemàtiques ha tingut alguns fruits al llarg de l'any 2016. El CRM 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.

1.7. Sponsorships

With the economic and financial situation in which the CRM is currently immersed, some of the projects undertaken in recent years 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 2016. The CRM is deeply grateful to the institutions listed below since their contribution can maintain and increase the quality of some of the activities consolidated in the center.

1.7.1. 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

1.7.1. "la Caixa" Foundation

"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

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. Vegeu

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. See

www.crm.cat/en/Research/Training/CollabMathResearch/Pages/Description.aspx

L'objectiu del programa és promoure la recerca matemàtica col·laborativa i interdisciplinària que estigui més ben representada en el sistema català de recerca, tant en universitats con en altres centres CERCA. En el marc d'aquest programa, s'entén per matemàtica col·laborativa "la recerca matemàtica situada en alguna interfície orientada al desenvolupament, anàlisi i simulació de models contextualitzats, amb interès més enllà de les matemàtiques, contrastada per la interacció amb experimentalistes".

The aim of the program is to encourage interdisciplinary and collaborative mathematical research in the better represented interfaces in the Catalan research system, both in universities and in other centers CERCA. In the framework of this program, collaborative research is meant "mathematical research located in an interface which purpose is the development, analysis and simulation of contextualized models, with interest beyond mathematics, contrasted by interacting with experimentalists".

El finançament d'aquest programa per part de la Fundació "la Caixa" està permetent al CRM d'oferir un nombre important de contractes doctorals i postdoctorals al llarg de cinc anys a partir de gener de 2014. Cada contracte dura 3 anys i té assignat un projecte de formació en un tema específic escollit entre un investigador en matemàtiques que actua de director i un codirector d'una altra disciplina. Durant el 2016 es van concedir les següents beques o contractes (investigadors, temes, supervisor al CRM, supervisors externs):

The funding of this program by "la Caixa" allows the CRM to offer a number of doctoral and postdoctoral contracts over a period of five years starting January 2014. They consist of 3-year long contracts linked to a training project on a specific topic defined jointly by a researcher in mathematics as director and a co-director from another discipline. The following fellowships were awarded during 2016 (researcher, topic, CRM supervisor, external supervisors):

Contractes postdoctorals / *Postdoctoral contracts*:

- Juan Calvo, *Modelling the Growth of Kidney Cancer: A Hibrid Multiscale-Image Analysis Approach*. Tomás Alarcón (CRM), Simone Balocco (CVC), Anna Messeguer, Joan Morote (Vall d'Hebron). (Until 2016.)

Beques predoctorals / *Predoctoral grants*:

- Víctor Navas, *Statistics, Models, and Prediction of Synthetic Earthquakes*. Álvaro Corral (CRM), Eduard Vives i Santa-Eulalia (IMUB).

A la reunió de la comissió de seguiment de 23 de novembre de 2016 es va decidir, durant 2017, iniciar els treballs per a definir la continuïtat del programa a partir de 2018.

On the monitoring committee meeting held on November $23^{rd}, 2016$, it was decided that during the year 2017 the work to define the continuity of the program beyond 2018 would begin.

Obra Social "la Caixa"

http://obrasocial.lacaixa.es/laCaixaFoundation/home_en.html

1.7.2. Clay Mathematics Institute

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 investigadors rellevants sèniors com joves postdocs en el marc dels Programes Intensius de Recerca. Durant el 2016, l'ajut del CMI ha permès finançar dos tipus d'accions: la millora de les condicions econòmiques de 5 investigadors sènior i la participació de 12 estudiants doctorals i investigadors postdoctorals interessats en participar en esdeveniments científics dels programes de recerca.

A principis de l'any 2015, el CMI confirma la seva participació en l'organització de Programes de Recerca del CRM pel curs 2015–2016 i 2016–2017.

1.7.2. Clay Mathematics Institute

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 senior outstanding researchers and young postdocs in the CRM Intensive Research Programs. During 2016, the CMI support has been allocated in two directions: to enhance the economical conditions of five senior researchers and to support the participation of 12 doctoral students and post-doctoral researchers interested in participating in the scientific events organized during intensive research programmes.

In early 2015, the CMI confirmed its participation in the organization of CRM research programs for the 2015–2016 and 2016–2017 academic year.

CMI

http://www.claymath.org/

1.7.3. 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 el curs 2014–2015, el CRM va acollir els primers investigadors dins del *Simons Visiting Program* i ha continuat col·laborant durant els cursos 2015–2016 i 2016–2017.

1.7.3. 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 2014–2015, the CRM hosted the first researchers under the Simons Visiting Program, and this collaboration has continued in the 2015–2016 and 2016–2017 academic years.

SIMONS FOUNDATION

https://www.simonsfoundation.org/

1.8. Transferència de coneixement

1.8.1 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.

Al 2015 s'ha presentat, conjuntament amb la Universitat de Barcelona (UB), la sol·licitud de patent EP15382248.1 amb títol "Method, apparatus and micro-rheometer for measuring rheological properties of Newtonian and non-Newtonian fluids". A la segona meitat de 2016 s'ha presentat la sol·licitud de PCT No. PCT/EP2016/060835 "*Method, apparatus and micro-rheometer for measuring rheological properties of newtonian and non-newtonian fluids*" conjuntament amb la Universitat de

1.8. Knowledge transfer

1.8.1. Knowledge Transfer Team

The CRM Knowledge Transfer Team was set up in 2012 aiming at applying the knowledge derived from the research developed in the centre, giving priority to those pulling for innovation or those more related to the mathematical basis of the CRM research groups. This is a competitive advantage since it allows to work with cutting-edge tools and face any need of mathematical modelling, optimisation or operational research among others.

In 2015, the patent application EP15382248.1, entitled "Method apparatus and micro rheometer for measuring rheological properties of Newtonian and non-Newtonian fluids", was presented jointly with the Universitat de Barcelona (UB). In the second half of 2016, the application for the PCT /EP2016/060835 '"Method apparatus and micro-rheometer for measuring rheological properties of Newtonian and non-Newtonian fluids" has been submitted jointly with the Universitat de Barcelona (UB), after the pertinent patent

Barcelona (UB), després de la sol·licitud de patent corresponent amb data 14 de maig de 2015. Conjuntament amb la Fundació Bosch i Gimpera (UB) s'ha treballat per trobar aplicacions del viscòmetre amb experts en malalties tropicals tant de l'ISGlobal com de l'IGTP.

Respecte a la transferència de coneixement seguim ampliant els contactes i els camps ens els qual creiem que podem aportar valor col·laborant amb empreses. Seguim explorant la via del doctorat industrial i alhora la dels serveis.

Respecte a la transferència de coneixement no patentable, hem seguit treballant amb les empreses amb qui vam elaborar projectes citats en la memòria anterior:

- Creació d'un programa per optimitzar serveis en el cas d'una multinacional.
- Millora d'un procés intern per Hohner.
- Col·laboració amb un banc (fins principi de 2016).

En tots dos casos s'ha seguit millorant el producte, ampliant funcionalitats i, en el cas de Hohner, es segueix amb èxit el doctorat industrial (DI2014) concedit a Néstor Costa.

Es manté la col·laboració amb la Xarxa Math-in.

1.8.2. Red Española Matemática-Industria

Un dels objectius del projecte i-MATH, que va acabar l'any 2011, va ser la creació en una plataforma de transferència de tecnologia per a promoure la interacció entre els grups de matemàtiques de les universitats i la industria. Això va portar a la formació de la *Red Española Matemática-Industria (math-in)*.

El CRM va signar un acord de col·laboració amb math-in al maig de 2012, amb l'objectiu

application, on May 14th, 2015. Together with the Fundació Bosch i Gimpera (UB), work has been done to find applications for the viscometer, with experts in tropical illnesses from the ISGlobal as well as from the IGTP.

With regard to the knowledge transfer, we continue to expand the contacts and the fields where we believe we can valuably contribute to companies. We continue exploring the path of the industrial doctorate and at the same time the services route.

As for non-patentable knowledge, we have continued to work with the companies with which we developed projects mentioned in the previous report:

- Creation of a program to optimize services in the case of a multinational.
- Improvement of an internal process for Hohner.
- Collaboration with a bank (until the beginning of 2016).

In both cases, further improvements have been made to products and functionalities have been extended. In the case of the Hohner, Néstor Costa continues to make good progress on his industrial doctorate (DI2014).

We continue to work with the math-in network.

1.8.2. Red Española Matemática-Industria

One of the goals of the i-MATH project, which ended in 2011, was the setting up a Technology Transfer platform to promote interaction between university mathematics groups and industry. This led to the formation of the Red Española Matemática-Industria (math-in).

The CRM signed a collaboration agreement with math-in in May 2012, with the goal of involving

d'involucrar als investigadors del CRM en la transferència de tecnologia, mitjançant l'intercanvi d'informació, coordinant propostes de subvencions, oferint recolzament en l'organització de congressos i establint vincles amb empreses i centres de recerca.

CRM researchers in technology transfer, through the exchange of information, co-ordinating grant proposals, support in conference organisation and establishing links with companies and research centres.

La creació de la "Red math-in" ha estat una de les prioritats del Pla de Transferència de Tecnologia del projecte i-MATH i pretén ser l'evolució de la plataforma de Mathematica CONSULTING. La idea és que es converteixi en un foro per a la comunicació i l'intercanvi d'informació i experiències per a promoure la transferència dels resultats de recerca produïts en el camp de les matemàtiques.

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/

1.8.3. Doctorat Industrial

El CRM ha aportat propostes de Doctorat Industrial des de la creació d'aquest pla per part de la Generalitat de Catalunya. Afortunadament, en aquesta segona convocatòria s'ha pogut iniciar un dels projectes proposats, junt amb l'empresa Hohner Automáticos S.L. L'estudiant que realitzarà el seu doctorat en aquest projecte és Néstor Costa Jimeno.

1.8.3. Industrial Doctorate

The CRM has provided proposals for Industrial Doctorates since the set up of this plan by the Generalitat de Catalunya. Fortunately, in this second call, one of the proposed projects has been initiated, together with the company Hohner Automáticos S.L. The student who will carry out his PhD thesis in this project is Néstor Costa Jimeno.

http://doctoratsindustrials.gencat.cat/
http://doctoratsindustrials.gencat.cat/files/file/attachment/1367/P_DI_2014_038_HOHNER.pdf

1.9. Estructura i administració

1.9.1. Equip de direcció

El director del CRM és nomenat pel Consell de Direcció, a proposta del president, per a un període de quatre anys. L'actual director és Lluís Alsedà, que va ser nomenat a la reunió del Consell de Direcció del CRM de l'1 de desembre de 2015 per al període de 2016 a 2019.

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

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

1.9.2. Gerència

Des d'octubre del 2014 ocupa el càrrec de gerent:

1.9.3. Equip d'administració

L'equip d'administració del CRM durant el 2016 ha estat format per les persones següents:

1.9. Structure and administration

1.9.1. Team of Directors

The Governing Board elects a Director, proposed by the Chairman, to serve for a period of four years. The current Director is Lluís Alsedà, who was elected for the period from 2016 to 2019 in the meeting of the Governing Board on December 1st, 2015

The director, the assistant director, represented by the principal investigator Tomás Alarcón, 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.

1.9.2. General Management

Since October 2014, the CRM's general manager is

Maria Àngels Huertos mahuertos@crm.cat telèfon 93 586 8424

1.9.3. Management team

The following people made up the management team in 2016:

Ana García-Donas	agarcia@crm.cat	Tel: 93 581 4727
Núria Hernández	nhernandez@crm.cat	Tel: 93 586 8192
Raquel Hernández	rhernandez@crm.cat	Tel: 93 581 2953
Jordi Mullor	jmullor@crm.cat	Tel: 93 586 8496
Guillem Pérez	gperez@crm.cat	Tel: 93 586 8423
Neus Portet (until July 2016)		

Consol Roca	croca@crm.cat	Tel: 93 581 2201
Alba Tomàs	atomas@crm.cat	Tel: 93 581 4086
Mari Paz Valero	mpvalero@crm.cat	
Pau Varela	pvarela@crm.cat	Tel: 93 581 1081

1.10. Equipament

Els espais que actualment ocupa el CRM estan situats en una ala de l'edifici de la Facultat de Ciències de la UAB, amb una superfície total de 2.125 m^2, després de la darrera ampliació finalitzada l'octubre de 2010, amb el finançament de la Generalitat i del fons FEDER. Permeten la ubicació de 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 persones.

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

Durant l'any 2016, 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 aules i sales de reunions, recursos per a establir videoconferència, sistemes digitals de control d'aules, un panell tàctil de presentació del CRM i una infrastructura de retransmissió

1.10. Equipment

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

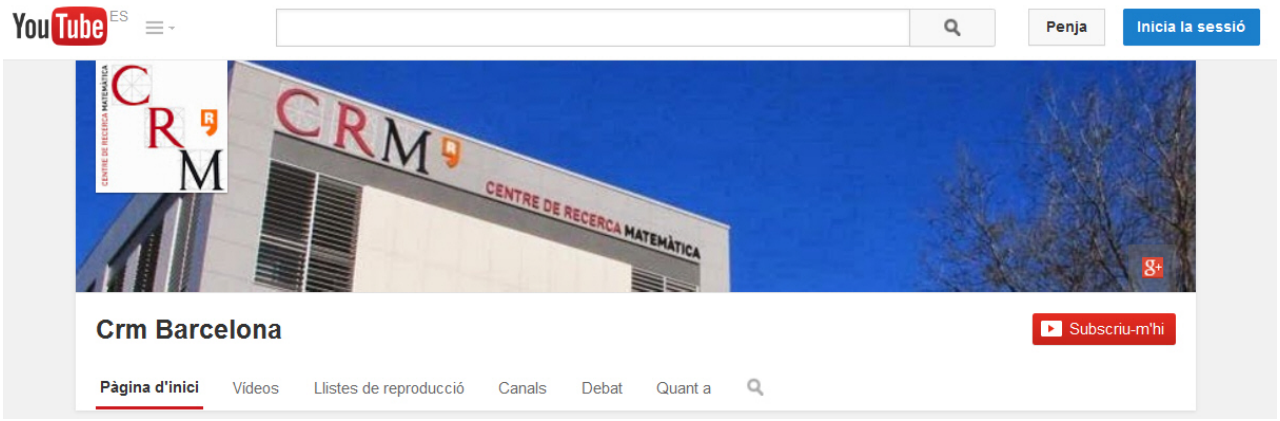
To host visiting researchers, the CRM uses the facilities provided by Vila Universitària at Bellaterra.

During 2016, 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 meeting rooms, a tactile CRM presentation panel and the infrastructure for live broadcasting and streaming. Morevoer, the CRM has opened a broadcast channel where*

de gravacions, tant en directe com en diferit (*streaming*). A més a més,, el CRM compta amb el canal d'emissió on podreu trobar vídeos de conferències celebrades al centre:

you can find videos of lectures held in the center:

https://www.youtube.com/user/CRMatematica



1.11. Serveis externs

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

1.11. External services

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

2

La recerca al CRM

Research at CRM

2.1. Grups de recerca

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. Els següents grups de recerca del CRM actius durant el 2016 han estat:

2.1. Research Groups

As mentioned in Section 1.1, the scientific policy of the CRM has two main axes, the second one aiming at building its own research groups in underdeveloped areas in Catalonia. The active CRM research groups continued during 2016 have been:

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

A continuació s'exposen les línies de recerca de cada grup i les principals activitats dutes a termes durant el 2016.

Next, we focus on the research lines of each group and the main activities they have carried on during 2016.

Anàlisi Harmònica i Teoria de l'Aproximació
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 una àrea establerta de les matemàtiques en fase de creixement per la varietat de les seves aplicacions, no solament en matemàtiques (anàlisi numèrica, anàlisi en ondetes) sinó també en ciències de la computació, tractament del senyal, 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.

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) 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

- 2014SGR 289. *Grup de teoria de funcions de la UB/UAB*, *Generalitat de Catalunya*, 2014-pr. PI: C. Cascante.

Membres del grup
Research Team

- Sergey Tikhonov (team leader)
- Néstor Costa (PhD student)
- Alberto Debernardi (PhD student)
- Ainur Jumabayeva (PhD student)
- Askhat Mukanov (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

• 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 2016

During 2016 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.

N. Costa studied optimal decoding and related problems of harmonic analysis A. Debernardi continued working on his PhD dissertation focusing on convergence of Fourier transforms of general monotone functions. A. Jumabaeva studied the (L_p, L_q) inequalities for moduli of smoothness of the generalized Liouville derivatives. A. Mukanov investigated different types of convergence of trigonometric series. S. Tikhonov has been working on sharp Fourier inequalities, restriction inequalities, and on polynomial inequalities.

Biologia matemàtica i computacional
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

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,

tractament d'aquest tipus de fenòmen, els resultats per a sistemes biològics són més modestos. Aquesta circumstància es deu a què la unitat fonamental en sistemes vius (la cèl·lula) és molt més complexa que les corresponents unitats en sistemes inerts. Per tant, es necessiten tant models com mètodes nous per analitzar els 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.

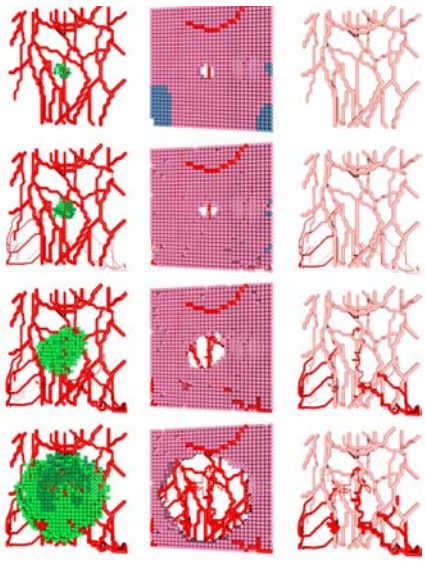
the success achieved so far in the Biological Sciences is rather more limited. This is partly due to the fact that the individual components of biological systems (e.g., cells) are much more complex than their counterparts in physical systems and, therefore, new methods and models are needed to analyse multi-scale processes in Biology. Such is the remit of the Computational & Mathematical Biology group at CRM: To propose new models relevant to experimental biologists and clinicians and develop the analytical and computational tools necessary for their analysis. We pay special attention to problems with clinical relevance, in particular those related to cancer.

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

- Modelatge multiescala del creixement del tumor i l'angiogènesi.
- Mètodes híbrids per als models multiescala.
- Modelació estocàstica de la reprogramació de cèl·lules somàtiques.
- Robustesa i capacitat d'evolució i la seva relació amb la resistència als medicaments.
- Models estocàstics en dinàmica de poblacions.
- Biofísica teòrica: biofísica de membranes i microfluídica.

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

- *Multiscale modelling of tumour growth and angiogenesis.*
- *Hybrid methods for multiscale models.*
- *Stochastic modelling of somatic cell reprogramming.*
- *Robustness and evolvability and their relation to drug resistance.*
- *Stochastic models in population dynamics.*
- *Theoretical biophysics: membrane biophysics and microfluidics.*



Projectes vigents
Current Projects

- *Mathematical models of biological population dynamics with complex structure*, 2011–2014. Extended for a further year until end 2016. PI: Tomás Alarcón.

Membres del grup
Research Team

• Tomás Alarcón	(ICREA Research Professor, team leader)
• Juan Calvo	(Postdoctoral researcher, "la Caixa"-CRM)
• Ivón Rodríguez-V.	(Postdoctoral researcher)
• Elisa Beltrán-Sáez	(PhD student, FPU grant)
• Enric Costa-Miracle	(PhD student, BGSMath FPI grant)
• Roberto de la Cruz	(PhD Student, FI grant)
• Núria Folguera-Blasco	(PhD Student, "la Caixa"-CRM)

Activitats relacionades
Related Activities

- Computational & Mathematical Biology Seminar

Col·laboradors
Collaborators

• Helen M. Byrne	University of Nottingham
• Pilar Guerrero	University College London
• 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
• Fabian Spill	MIT & Boston University
• Rui Travasso	Universidade de Coimbra

Group Activity in 2016

During 2016, the Computational & Mathematical Biology group has continued to develop its research activity around four basic axes: Stochastic multiscale modelling of tumour growth, hybrid methods for multiscale models, stochastic modelling of somatic cell

reprogramming, and mathematical and experimental microfluidics. We have further started and/or consolidated collaborations with both the mathematical and experimental communities. As a result, we have ongoing collaborations with researchers from the Department of Applied Mathematics and Analysis, School of Mathematics, University of Barcelona, the School of Physics, University of Barcelona, Catalan Institute Oncology-IDIBGI, Girona, the Centre for Computer Vision, Bellaterra, and the Vall d'Hebron Research Institute (VHIR).

Concerning training, during 2016, four PhD projects are ongoing: Elisa Beltrán-Sáez, who is working on robustness of cellular signaling systems and its relation to drug resistance, Enric Costa-Miracle, who is doing his PhD in mathematical modelling in microfluidics, Roberto de la Cruz, whose PhD is on stochastic multiscale models of tumour growth, and, Núria Folguera–Blasco, who is doing her PhD on models of reprogramming of somatic cells.

Finally, as research output, the group has published 7 papers in peer-reviewed journals during 2016. All of these were published in ISI journals of top quality.

Epidemiologia matemàtica

Àmbit de recerca

Durant 2016, el Grup d'Epidemiologia Matemàtica ha continuat treballant en modelització matemàtica de les malalties infecciones dels éssers humans, animals domèstics i salvatges i plantes. La modelització matemàtica de les malalties infeccioses és un àrea d'investigació en ràpida expansió i rellevant en la pràctica, i l'objectiu del grup de recerca en epidemiologia matemàtica és l'estudi de l'aparició i propagació de malalties infeccioses des d'un punt de vista matemàtic. L'èmfasi particular del grup en 2016 estava encaminat en direccions com ara l'evolució de patògens, l'aparició de nous agents patògens, la dinàmica de les malalties infeccioses en una població, el control de malalties infeccioses tant en una població com a nivell d'un sol hoste (teràpia), així com la dinàmica de microparàsits dins d'un hoste. També s'ocupa de la descripció matemàtica de la resposta immune, així com en el seu fracàs, com en el cas de la infecció por VIH.

Mathematical Epidemiology

Research Field

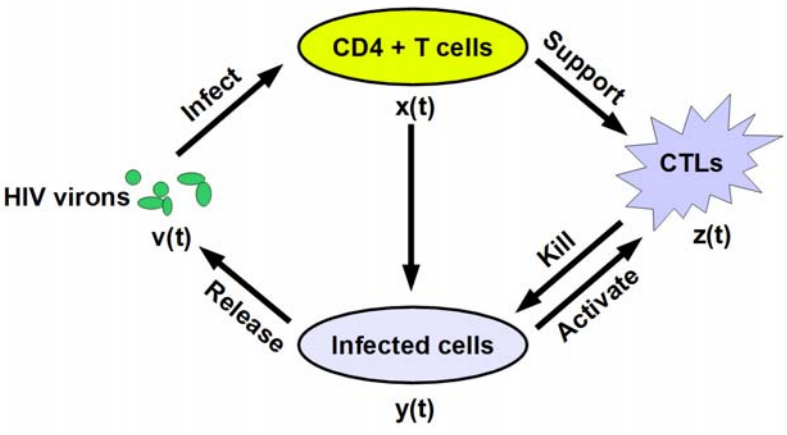
During 2016, the Group of Mathematical Epidemiology continue to work in general area of mathematical modelling of the humans, domestic and wild animals and plants. The mathematical modelling of infectious diseases is a rapidly expanding and a highly practically relevant area of research, and the aim of the Mathematical Epidemiology Research Group is to study the emergence and spread of infectious diseases from a mathematical point of view. The particular emphasis of the group in 2016 was in directions such as evolution of pathogens, the emergence of new pathogens, the dynamics of infectious diseases in a population, control of infectious diseases in a population and within a single host levels (therapy), 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.

El Grup d'Epidemiologia Matemàtica, treballant en contacte amb científics experimentals i amb el grup d'investigació en Biologia Matemàtica i Computacional, utilitza com a eines la modelització matemàtica i les tècniques matemàtiques de la teoria de sistemes dinàmics i per descriure i estudiar la dinàmica de les malalties infeccioses. Estem particularment interessats en la invasió de noves infeccions emergents, en l'estabilitat i persistència d'un agent patògen en una població amb un únic hoste, així com l'estabilitat de la resposta immune. El nostre particular interés és l'evolució viral i microbiana, que és probablement el factor responsable més important de l'aparició de noves infeccions i del desenvolupament de soques resistents als fàrmacs, i la prevenció d'un desenvolupament eficaç de medicaments i vacunes. Una de les direccions que actualment estem explorant de forma activa és l'aplicació de les eines i mètodes de la teoría del control òptima al control de malalties infeccioses.

The Mathematical Epidemiology group, working in close contact with experimental scientists and the Computational and 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, with a particular stress on the invasion of newly emerging infections, in the stability and persistence of a pathogen in a population and in a single host, as well as the stability of immune response. Our particular interest is 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 to the control of infectious diseases.

Apart d'aquestes indicacions de recerca que són tradicionals per al Grup, el 2016 iniciem la recerca en una nova direcció; és a dir, en col·laboració amb el Grup de Matemàtiques i Biologia Computacional vam iniciar una recerca en modelització matemàtica de l'evolució del càncer en un pacient. Els membres del grup han utilitzat en aquesta tasca les tècniques que es van desenvolupar anteriorment pel modelatge de malalties infeccioses.

Apart from these research directions which are traditional for the Group, in 2016 we start research in a new for us direction; namely, in close collaboration with the Group of Mathematical and Computational Biology we started research in mathematical modelling of cancer evolution within a patient. The Group members applied to this task the techniques that were earlier developed for infectious diseases modelling.



Membres del grup
Research Team
Research Team

- Andrei Korobeinikov (team leader)
- Anel Nurtay (PhD student)
- Silvia Pagliarini (MSc student)
- Ms Ana Cristina Buira (internship student)
- David Masip Bonet (internship student)
- Ms Sara Gomez Reverter (internship student)
- Vladimir Sobolev (medium-term visitor researcher)
- Elena Shchepakina (medium term visitor researcher)
- Paul A. Valle (visiting postdoctoral fellow, CANASYT, Mexico)

Col·laboradors
Collaborators

• Santiago F. Elena	Instituto de Biología Molecular y Celular de Plantas
• Lourdes Esteva	Universidad Nacional Autónoma de México
• Ellina Grigorieva	Texas Woman's University
• Tomas Kelly	University College Cork
• Evgenii Khailov	The Moscow State University
• Michael O'Callaghan	University College Cork
• Alexander Pimenov	Weierstrass Institute for Applied Analysis and Stochastics
• Dmitry Rachinskiy	The University of Texas at Dallas
• 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
• Cruz Vargas de León	Universidad Nacional Autónoma de México
• Graeme Wake	Massey University

Group Activity in 2016

Since 2014, 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 Biologia Evolutiva, UPF, Barcelona), and with participation of Vladimir Sobolev and Elena Shchepakina (Samara State Airspace University, Russia) and Graeme Wake (Massey University, New Zealand).

3. Optimal control of infectious diseases in a population; optimal therapy of a (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. Cancer evolution. In collaboration with Tomas Alarcon and Josep Sardanyes (CRM Group of Mathematical and Computational Biology).

Group organized and hosted the joint international multidisciplinary workshop MURPHYS-HSFS-2016 dedicated to mathematical theory and applications of the multiple scale systems, systems with hysteresis and trends in the dynamical systems theory.

In 2016 the group was visited by Prof. Sobolev and Prof. Shchepakina, who stay at the CRM for five weeks each, and by CANACYT fellow Dr. Paul A. Valle who stay for a three months.

Matemàtica Financera i Control de Riscos
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.

De particular interès per al nostre grup és el càlcul eficient de les mesures de risc àmpliament utilitzades en risc de crèdit i de mercat, com ara el Valor en Risc (VaR) i la *Expected Shortfall* (deute esperat); l'estimació acurada de les contribucions individuals de risc també és un tema rellevant.

Research Field

Computational Finance lies at the intersection of numerical analysis and stochastic calculus. 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 efficient computation of the risk measures widely used in credit and market risk such as the Value-at-Risk (VaR) and the Expected Shortfall. The accurate estimation of the individual risk contributions is an important issue as well.

Desenvolupem mètodes numèrics capaços de calcular aquestes mesures en un temps de CPU curt, el que permet la reavaluació de carteres molt grans freqüentment i evitar d'aquesta manera simulacions de Monte Carlo que consumeixen massa temps. També estem interessats en la valoració dels derivats de crèdit, com ara CDOs (obligacions de deute garantides), que s'utilitzen normalment per transferir el risc associat a una determinada cartera subjacent. Fins al moment, la maquinària per dur a terme aquest treball es basa principalment en ondícules de Haar.

We develop numerical methods capable to calculate these measures in a short CPU time, allowing to rebalance very large portfolios frequently and avoiding this way the time-consuming Monte Carlo simulations. We are also interested in the valuation of credit derivatives such as Collateralized Debt Obligations, which are typically used to transfer the risk associated to a certain underlying portfolio. So far, the machinery to carry out this work is mainly based on Haar wavelets.

Una altra línia important de recerca del nostre grup és la valoració d'opcions. La valoració robusta i eficient de les opcions és un camp recent i interessant en matemàtica aplicada i computació científica. L'equació en derivades parcials (EDP) de valoració d'opcions més coneguda és, sens dubte, l'equació de Black-Scholes, que valora una opció europea sota una dinàmica de preus dels actius que segueix un moviment brownià geomètric. Si es volen considerar dinàmiques més realistes d'actius, aleshores cal recórrer a altres EDPs de valoració d'opcions, o fins i tot equacions integro-diferencials parcials. La valoració d'opcions es fa sovint sota l'enfocament del valor esperat del *pay-off* descomptat, i la seva connexió amb la solució d'EDPs és el teorema de Feynman-Kac. En molts casos d'interès, no tenim la funció de densitat de probabilitat condicionada per als preus dels actius disponibles, però sí que tenim la seva transformada de Fourier. L'aplicació de Fourier i de tècniques basades en ondícules per recuperar una funció de densitat a partir de la seva transformada de Fourier és objecte del nostre interès.

Another important research line of our group is option pricing. The robust and efficient valuation of options is an interesting recent field in applied mathematics and scientific computing. The best known option pricing partial differential equation (PDE) is without any doubt the Black-Scholes equation, pricing a European option under geometric Brownian motion asset price dynamics. When considering more realistic asset dynamics, other option pricing PDEs, or even partial integro-differential equations, will be encountered. Option pricing is often done by the discounted expected pay-off approach, and its connection with the solution of the option pricing PDEs is the Feynman-Kac theorem. In many cases of interest, we do not have the conditional probability density function for the asset prices available, but we do have its Fourier transform. The application of Fourier and wavelets-based techniques to recover a density function from its Fourier transform is subject of our interest.

Projectes vigents
Current Projects

- CRM Research Group in Collaborative Mathematics, AGAUR. 2014–2016 PI: Álvaro Corral
- Ministerio de Economía y Competitividad (MINECO). *Stochastic Finance* 2014–2016. P.I: José Manuel Corcuera Valverde, Universitat de Barcelona.

Membres del grup
Research Team

- Luis Ortiz (team leader)
- Gemma Colldeforns (PhD student, "la Caixa" and AGAUR)
- Ricard Alemany (scientific collaborator)
- Juan Borrego (BSc student, UAB)
- Axel Masó (BSc student, UAB))

Activitats relacionades
Related Activities

- Quantitative Finance Seminar, thematic network CRM.

Col·laboradors
Collaborators

• Cornelis W. Oosterlee	Centrum voor Wiskunde en Informatica and Delft University
• Elisa Alòs	Universitat Pompeu Fabra
• Duy-Minh Dang	University of Queensland
• Argimiro Arratia	Universitat Politècnica de Catalunya

Group Activity in 2016

The group has incorporated two new members during 2016, Juan Borrego and Axel Masó from the UAB. Juan and Axel worked on the Value-at-Risk bounds in risk management. We also received the visit of Álvaro Leitao who is a PhD student at the CWI and TU Delft. We worked on the data-driven COS method during his three-weeks research stay.

The PhD student Gemma Colldeforns has been working on credit risk measurement with wavelets. She visited the CWI for four weeks and worked under the supervision of her PhD co-advisor C.W. Oosterlee. Luis Ortiz visited the CWI for three weeks to carry out a research project with C.W. Oosterlee on the data-driven COS method.

Matemàtica Industrial

Àmbit de recerca

La Matemàtica Industrial es pot definir com l'aplicació de les matemàtiques als problemes del món real. El camp sembla estar guanyant terreny a tot Europa, sobretot des de la publicació del llibre, "Històries d'èxit a Europa en Matemàtica Industrial", patrocinat per la Fundació Europea de la Ciència. Els grups existents, com ara el Consorci

Industrial Mathematics

Research Field

Industrial mathematics can be defined as the application of mathematics to real-world problems. The field appears to be gaining ground throughout Europe, particularly since the publication of the book, European Success Stories in Industrial Mathematics, sponsored by the European Science Foundation. Existing groups, such as the European

Europeu de Matemàtiques per la Indústria (ECMI) han augmentat amb la creació de la UE-math-In i el EU COST Network MI-Net.

D'acord amb la filosofia de la matemàtica industrial, el grup del CRM ha treballat en una àmplia varietat de problemes pràctics i ha participat en activitats nacionals i internacionals. Els camps principals d'investigació en el grup han cobert:

□ Nanomatemàtica. El nostre treball en aquest camp s'ha ampliat i ens ha portat a una col·laboració amb el Grup de nanopartícules inorgàniques de l'Institut Català de Nanotecnologia. Els nostres projectes abasten actualment canvis de fase a nanoescala (incloent nanopartícules i nanocables), el creixement de solucions de nanocristalls (amb ING), l'efecte Kirkendall, el flux de nanofluids per a la refrigeració i l'absorció directa de col·lectors solars. També tenim una col·laboració amb el departament de Física de la UAB sobre transferència de calor a escala nanomètrica o escales de temps extremadament curtes.

□ Canvis de fase. Les transicions de fase es produeixen en una multitud de situacions naturals i industrials, com ara en la formació de gel, la formació de metall des de l'estat de fusió, la fabricació de discs d'ordinador, les cobertures de xocolata i molts altres. A més del nostre treball sobre els canvis de fase a nanoescala els membres del grup de Matemàtica Industrial han treballat en la teoria bàsica de la formulació matemàtica dels models de canvi de fase, en reduccions rigoroses de models, fusió de contacte i formació de vapor en tubs de refrigeració.

□ Fluxos de capa prima. Els fluxos de capa prima poden incloure el moviment de lubricants, pintures, aigua corrent per una finestra, l'aire que suporta un disc dur d'ordinador en ràpida rotació o el moviment de la lava o una glacera. La modelació matemàtica dels fluxos de capa prima pot donar lloc a una rica varietat de comportaments i òbviament té moltes aplicacions pràctiques. Aquest treball implica fluids newtonians i no newtonians.

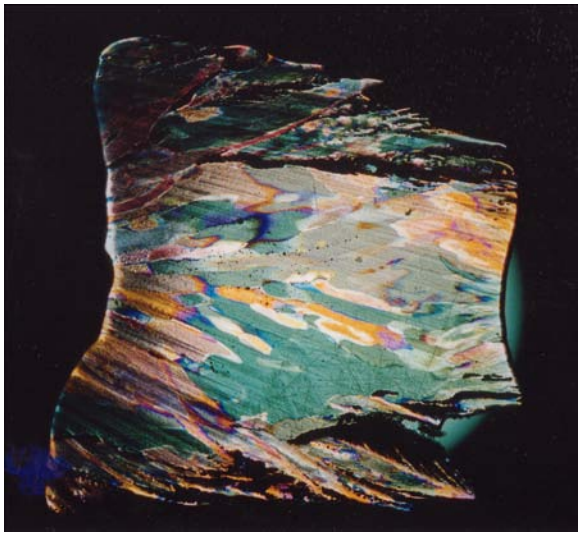
Consortium for Mathematics in Industry have been augmented by the creation of EU-math-In and the EU COST Network MI-Net.

In keeping with the industrial mathematics philosophy, the group at CRM has worked on a wide variety of practical problems as well as participating in national and international activities. The primary research fields in the group have covered:

□ *Nanomathematics. Our work in this field has expanded, leading to collaboration with the Inorganic Nanoparticles Group of the Institut Catalá de Nanotecnologia. Our projects currently cover phase change at the nanoscale (including nanoparticles and nanowires), growth from solution of nanocrystal (with ING), the Kirkendall effect, nanofluid flow for cooling and in Direct Absorption Solar Collectors. We also have a collaboration with the Physics department at UAB on heat transfer at the nanoscale or extremely short time-scale.*

□ *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. In addition to our work on phase change at the nanoscale IM group members have worked on the basic theory of the mathematical formulation of phase change models, rigorous reductions of the models, contact melting and vapour formation in cooling pipes.*

□ *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

- MTM2014-56218-C2-1-P. Dinámica de fluidos complejos y fronteras *móviles*. 2015–2017. P.I.: Tim Myers; Team Members: Vincent Cregan, Helena Ribera; Sub-Project 2: Susana Serna, Antonio Marquina.
- MARIE SK LODOWSKA-CURIE ACTIONS Individual Fellowship: Nanoheat, 140K to fund Post-doc Matt Hennessy.

Membres del grup
Research Team

• Tim Myers	(team leader)
• Vincent Cregan	("la Caixa" post-doc 04/2014-03/2017)
• Helena Ribera	("la Caixa" PhD, since 09/2014)
• Marc Calvo	("la Caixa" PhD, since 09/2015, previously Masters student in IM group)
• Claudia Fanelli	(BGSM PhD, since 09/2016)
• Vicent Ribas	(Scientific Collaborator)
• Gary O'Keeffe	(PhD student, University of Limerick, TM joint supervisor)
• Adrià González	(Final year graduate student, UPC)
• Maria de Araceli Morales	(Final year graduate student, UPC, supervisors VR, TM)
• Curial Gallart	(Final Year graduate, UAB)
• Pere Barber	(Final year graduate, UAB)
• Dani Salgado	(Final year graduate, UAB)
• Ariadne Moreno	(Final Year project, Batxillerat)

Activitats relacionades
Related Activities

• TM is currently the Short Term Scientific Mission Manage and a member of the Management Committee for the EU COST Action TD1409 Maths for Industry Network, MI-Net. He is the co-ordinator of the European Study Groups with Industry and the Spanish Representative on the council (and also a board member) for the European Consortium for Mathematics in Industry. He was a member of the scientific committee for the conferences NanoMath (Toulouse 2016), ECMI Conference (Santiago de Compostela 2016) and was the President of the organising committee for the 115th European Study Group with Industry (CRM 2016). He is currently a member of the scientific committee for the Workshop 'Industrial Maths in Action" to be held in Edinburgh in September 2017 and the IUTAM meeting Recent Advances in Moving Boundary Problems in Mechanics, Feb 2018.

In an attempt to cut down on editorial duties he resigned from Applied Mathematical Modelling, but remains on the board of Mathematics in Industry Case Studies and the RSME-Springer book series.

Col·laboradors
Collaborators

- Sarah Mitchell — University of Limerick
- Brian Wetton — University of British Columbia
- Gideon Fareo — University of the Witwatersrand
- Francesc Font — McMaster University
- Xavier Alvares — Universitat Autònoma de Barcelona

Group Activity in 2016

The group's research into nanotechnology has now led to various solid collaborations and fascinating research topics. Marc Calvo and the new post-doc Matt Hennessy are both working with a group in the physics department at UAB on heat flow at the nanoscale. A new PhD student, Claudia Fanelli is working on the problem of nanocrystal growth, in collaboration with the Inorganic Nanoparticles Group of ICN2.

In terms of conferences, TM was the main organiser of the 115th European Study with Industry, held at the CRM in January 2016 and a member of the scientific committee for the ECMI congress held in June in Santiago de Compostela. The ING presented their nanocrystal problem at the ESGI. All group members attended both meetings. Helena Ribera spent 3 months in Vancouver working with Brian Wetton on the Kirkendall effect, she also attended a Canadian Modelling week, where TM was an instructor. Marc Calvo spent 3 months at the University of Limerick working on numerical techniques for phase change with Sarah Mitchell. Marc, Helena and Claudia attended a modelling week in Edinburgh. TM was an invited expert at the South African Mathematics

in Industry Study Group, held in Johannesburg. He has also been active within the EU through his work on the ECMI council, where he is now on the board by virtue of his new role as the ESGI co-ordinator.

The group has also been active in outreach, participating in the talk series Bojos per les Matematiques (Mad for Maths) which involves giving a four hour presentation to talented final year school children. They also supervised a final year batxillerat student for her mathematics project. The students work was nominated for a Poincare award.

The successful Maria Curie proposal of TM and Matt Hennessy has now led to the addition of Matt within the group. He is playing a vital role in research, supervision and teaching.

Group members published 6 first quartile papers in 2016.

Neurociència Computacional

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 tipos 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 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 el paper de la connectivitat recurrent en la conformació de l'activitat espontània en models de microcircuits corticals. Aquest tema de recerca molt oportú en

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

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.

past decade, as well as improved measurements of the simultaneous activity of large numbers of neurons.

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

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 mechanisms involved in memory in the animal brain.

El Grup de Neurociència Computacional ha tingut sis investigadors a temps complert durant l'any 2016, incloent l'Investigador Principal, quatre estudiants de doctorat i un investigador post-doctoral. Els estudiants de doctorat han sigut: Marina Vegué (finançada per una beca de doctorat de la Fundació "la Caixa"), Bernat Rovira (finançat com a "investigador en formació", a través d'una subvenció per al projecte del Ministeri Espanyol d'Economia i Competitivitat), Genís Prat i Narani van Laarhoven (ambdós finançats a través d'un programa d'investigació en col·laboració amb la Fundació "la Caixa").

There were six full-time researchers in the Computational Neuroscience Group in 2016, including the PI, four PhD students and one post-doctoral researcher. The PhD students include: Marina Vegué (funded by a doctoral grant from the Caixa Foundation), Bernat Rovira (funded as a "researcher in training", through a project grant from the Spanish Ministry of Economics and Competitiveness), Genís Prat and Narani van Laarhoven (both funded through a collaborative research program of the Caixa Foundation).

Projectes vigents
Current Projects

- BFU2012-33413. *Memory encoding and consolidation: a computational study*, 2013–2016. PI: Alex Roxin.

Membres del grup
Research Team

• Alex Roxin	(team leader)
• Panagiota Theodoni	(Postdoctoral researcher, FPI fellowship)
• Genís Prat	(PhD student, "la Caixa"-CRM, since 09/2014)
• Bernat Rovira	(PhD student, FPI fellowship)
• Narani van Laarhoven	(PhD student, "la Caixa"-CRM, since 11/2014)
• Marina Vegué	(PhD student, "la Caixa"-UPC)

Activitats relacionades
Related Activities

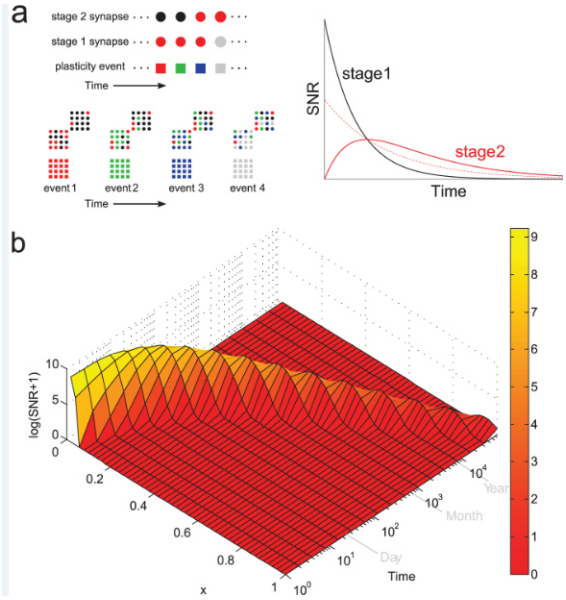
- Barcelona Computational Cognitive and Systems Neuroscience (BARCCSYN 2016) June 16^{th} to 17^{th}, 2016.

Col·laboradors
Collaborators

- Albert Compte IDIBAPS
- Ernest Montbrió UPF
- Jaime de la Rocha IDIBAPS
- Duane Nykamp University of Minnesota

Group Activity in 2016

We continued to work on three parallel topics: 1- cortical networks and network dynamics, 2- memory formation and consolidation, 3- perceptual decision making. Specifically, Marina Vegué has analyzed different candidate network structures to explain the connectivity statistics seen in in-vitro slice experiments. Bernat Rovira has explored the stability of random patterns stored in attractor neural networks as a function of their age. Panagiota Theodoni has developed a model of spatial learning in rodents via spike-timing dependent synaptic plasticity in a network of place cells. Genís Prat has studied an attractor model for the dynamics underlying two-choice forced alternative decision making (collaboration with Jaime de la Rocha). We have also been actively collaborating with the group of Ernest Montbrió at the University Pompeu Fabra on mean-field models of neuronal networks, and with the group of Albert Compte at the Institut d'Investigacions Biomèdiques August Pi i Sunyer on the role of oscillations in cognition. Marina Vegué spent a three-month stay in the group of Nicolas Brunel at the University of Chicago and Alex Roxin spent six months visiting Nancy Kopell at Boston University.



Sistemes Complexos

Complex Systems

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'hidrògen, el sistema solar o un gas ideal serien sistemes simples, malgrat que per descriure'ls necessitem conceptes profunds de la física i matemàtiques sofisticades. Tanmateix, si tot allò que és complex és un sistema complex, què aporta de nou el nou paradigma de la complexitat? Tots aquests sistemes d'àmbits tan diversos poden ser tractats des d'una única perspectiva? Una de les idees clau en els estudis de complexitat és que les estructures apareixen en aquest tipus de sistemes a tots els nivells, incloent nivells molt llunyans dels propis de la interacció entre els components i, a més, mostren regularitats estadístiques sorprenents.

En el grup de Sistemes Complexos del CRM ens concentrem en dues línies de recerca: la primera, desastres naturals i fenòmens meteorològics, resultat de l'activitat complexa de la Terra; i la segona, l'estructura de la informació en la comunicació entre humans, originada per l'activitat complexa de les zones cerebrals que les controlen i de les relacions socials entre els comunicadors. A la línia de desastres naturals investiguem els patrons d'ocurrència de terratrèmols, incendis forestals, huracans, pluja, etc., amb la idea que les seves propietats estadístiques amaguen claus per a la seva comprensió, modelització i previsió. 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

Research Field

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

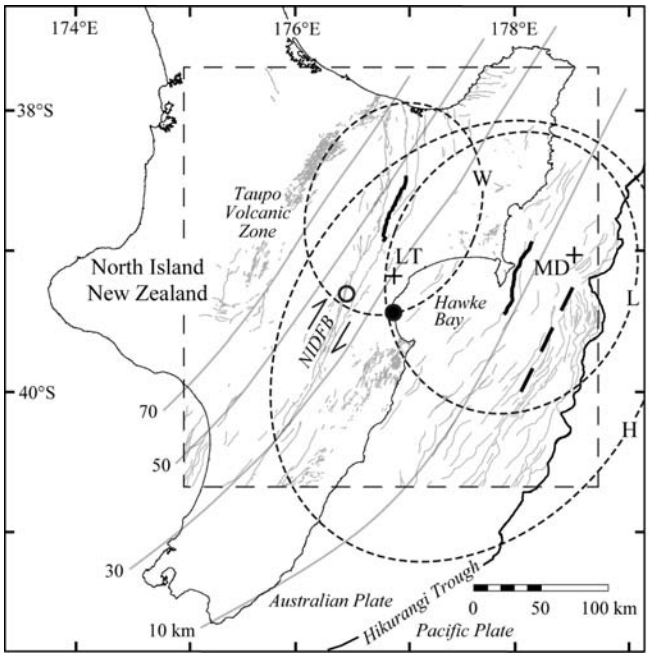
At the CRM Complex Systems Group, we focus on two major lines of research: one, natural disasters and meteorological phenomena, resulting from the complex activity of the Earth's system, and the other, the structure of information in human communication, produced by the areas of the brain responsible for this and the relationship between the 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

humà i, per què no?, esbrinar si les màquines les podrien reproduir.

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, 2013–16. PI: Álvaro Corral. Number of researchers: 4.
- 2014SGR1307 AGAUR. *CRM research group in Collaborative*, Mathematics 2014–2016. PI: Álvaro Corral. Number of researchers: 18
- FIS2015-71851-P. *Sistemas invariantes de escala: herramientas, evidencia empírica, modelos y limitaciones*, Ministerio de Economía y Competitividad, 2016–2018. PI: Álvaro Corral. Number of researchers: 2.



Membres del grup
Research Team

- Álvaro Corral (team leader)
- Isabel Serra (Postdoctoral res., "la Caixa"-CRM, since 09/2014)
- Víctor Navas (PhD student, "la Caixa"-CRM, since 01/2016)
- Irina Espejo (internship student)
- Eidr Ibiriuc Pera (internship student)

Activitats relacionades
Related Activities

- Reviewing Core Statistics, CRM November – December 2016.

Col·laboradors
Collaborators

• Josep Lluís Arcos	IIIA -CSIC
• Gemma Boleda	Universitat Pompeu Fabra
• Anna Deluca	Max Planck Institute for the Physics of Complex Systems
• Albert Díaz-Guilera	Universitat de Barcelona
• Ramon Ferrer i Cancho	Universitat Politècnica de Catalunya
• Basil Gomez	University of Hawai'i
• Nicholas R. Moloney	London Mathematical Laboratory
• Gunnar Pruessner	Imperial College London
• Francesc Sagués	Universitat de Barcelona
• Joan Serrà	Telefónica I+D
• M. Ángeles Serrano	Universitat de Barcelona
• Eduard Vives	Universitat de Barcelona

Group Activity in 2016

During 2016 we have witnessed the incorporation to the group of Víctor Navas-Portella as a predoctoral researcher. The main research of the group has focused on the theory of branching processes, quantitative linguistics, permutational tests for universality, analysis of fracture experiments, statistical seismology and the study of similarity-based time series motifs. Some papers about these research have been published in top journals. The group has continued also some consulting projects that started in previous years. Some guests that have contributed to the CRM CAMP Seminars are Ramon Ferrer-i-Cancho (UPC), Guillermo García-Pérez (UB) and Oleger Sagarra (Dribia).

2.2. Personal investigador / Research Staff

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 2.5).

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 2.5).

Tomás Alarcón

During 2016, the main activity has continued to focus around four basic axes: Stochastic multiscale modelling of tumour growth, hybrid methods for multiscale models, stochastic modelling of somatic cell reprogramming, and mathematical and experimental microfluidics. We have further started and/or consolidated collaborations with both the mathematical and experimental communities. As a result, we have ongoing collaborations with researchers from the Department of Applied Mathematics and Analysis, School of Mathematics, University of Barcelona, the School of Physics, University of Barcelona, Catalan Institute Oncology-IDIBGI, Girona, the Centre for Computer Vision, Bellaterra, and the Vall d'Hebron Research Institute (VHIR).

Concerning training, during 2016, four PhD projects are ongoing: Elisa Beltrán-Sáez, who is working on robustness of cellular signaling systems and its relation to drug resistance, Enric Costa-Miracle, who is doing his PhD in mathematical modelling in microfluidics, Roberto de la Cruz, whose PhD is on stochastic multiscale models of tumour growth, and, Núria Folguera-Blasco, who is doing her PhD on models of reprogramming of somatic cells.

As far as research output is concerned, I have published 10 papers in peer-reviewed journals during 2016. All of these were published in ISI journals of top quality.

In October 2015, I was appointed to an ICREA Research Professorship at the Centre de Recerca Matemàtica.

□ Publications

Articles

• T. Alarcón, J.A. Menéndez, N. Folguera, E. Cuyas, S. Fernández-Arroyo, J. Joven, *Accelerated geroncogenesis in hereditay breast-ovarian cancer syndrome*, ONCOTARGET **7**, 11959–11971 (2016).

• T. Alarcón, J. Castillo, Berenice García-Ponce, et al, *Growth rate and shape as possible control mechanisms for the selection of mode development in optimal biological branching processes*, European Physical Journal - Special Topics **225(13-14)**, 2581–2589 (2016).

• T. Alarcón, D. Sánchez-Taltavull, A. Vieiro, *Stochastic modelling of the eradication of the HIV-1 infection by stimulation of latently infected cells in patients under highly active anti-retroviral therapy*, Journal of Mathematical Biology **73(4)**, 919–946 (2016).

• T. Alarcón, E. Cuyàs, S. Fernández-Arroyo, R. Lupu, J. Joven, J.A. Menéndez, *Germline BRCA1 mutation reprograms breast epithelial cell metabolism towards mitochondrial-dependent biosynthesis: Evidence for metformin-based "starvation" strategies in BRCA1 carriers*, ONCOTARGET **7(33)**, 52974–52992 (2016).

• T. Alarcón, C. Trejo-Soto, E. Costa Miracle, I. Rodriguez Villarreal, J. Cid, A. Hernández-Machado, *Capillary Filling at the Microscale: Control of Fluid Front Using Geometry*, PLOS ONE **11(4)**, nr.:e0153559 (2016).

• T. Alarcón, E. Ibáñez, *Evolutionary escape on complex genotype-phenotype networks*, Journal of Theoretical Biology **394**, 18–31 (2016).

• T. Alarcón, J.A. Menéndez, B. Corominas-Faja, E. Cuyàs, M. García, A. Fernández, J. Joven, M. Fraga, *Oncometabolic Nuclear Reprogramming of Cancer Stemness*, Stem Cell Reports **6(3)**, 273–283 (2016).

• T. Alarcón, E. Ibáñez, *Surviving evolutionary escape on complex genotype-phenotype networks*, Journal of Mathematical Biology **72(3)**, 2016 (623–647).

• T. Alarcón, P. Guerrero, H. Byrne, P. Maini, Philip, *From invasion to latency: intracellular noise and cell motility as key controls of the competition between resource-limited cellular populations*, Journal of Mathematical Biology **72(42767)**, 2016 (123–156).

• T. Alarcón, J.A. Menéndez, *Nuclear reprogramming of cancer stem cells: Corrupting the epigenetic code of cell identity with oncometabolites*, Molecular & Cellular Oncology **3(6)**, 2016 (nr: UNSP e1160854).

Patents

• I. Rodríguez-Villarreal, T. Alarcón, J. Colomer, A. Hernández-Machado, P. Miribel. Method apparatus for measuring viscosity of Newtonian and Non-Newtonian fluids. Submitted. Patent application number: 15382248.1-1553, (2015).

□ Research projects

• *CRM research group in Collaborative Mathematics,* 2014SGR1307. From 2014 to 2016. Principal investigator: Álvaro Corral.

• *Kidney integration software: developing a new tool for diagnostic and decision making treatments for kidney tumour,* EUIN2013-51201. From 2014 to 2016. Principal investigator: Anna Messeguer, Vall d'Hebron Hospital Research Institute.

□ Activity in research training

Supervision of research students

PhD supervision

• Elisa Beltrán-Sáez. Funded by a FPU scholarship. Subject: *Evolutionary dynamics of systems with degeneracy*, since October 2014 – Present.

• Enric Costa-Miracle. Funded by a FPI scholarship associated to the Maria de Maeztu–BGSMath Unit. Subject: *Mathematical modelling in microfluidics*. November 2014 – Present. Co-supervised by Aurora Hernández-Machado (School of Physics, Universitat de Barcelona).

• Roberto de la Cruz. Funded by a scholarship of the Generalitat de Catalunya (FI-AGAUR). Subject: *Stochastic multi-scale modelling of tumour growth*. January 2013 – Present. Co-supervised by Pilar Guerrero (Dep. Mathematics, University College London, UK).

• Nuria Folguera-Blasco. Funded by Obra Social "la Caixa" through the CRM programme in Collaborative Mathematics. Subject: *Stochastic modelling of cellular reprogramming*. November 2014 – Present.

Postdoc supervision

• Juan Calvo. Funded by Obra Social "la Caixa" through the CRM programme in Collaborative Mathematics. Subject: *Hybrid multi-scale modelling of tumour growth*. April 2015 – Present.

• Ivón Rodríguez-Villareal. Funded by the Centre de Recerca Matemàtica. Subject: *Microrheology of biofluids*. Co-supervised by Aurora Hernández Machado (School of Physics, University of Barcelona). March 2013 – Present.

□ Teaching activity

• *Module on Asymptotic and Numerical Methods* (10 lectures) in the Advanced Stochastic Methods course with the MSc on Modelling in Science and Engineering, Universitat Autònoma de Barcelona, Course 2015–2016.

□ Scientific activities

Organisation

• Co-organiser (jointly with Ruben Perez-Carrasco, University College London, UK, Pilar Guerrero, University College London, UK, and Juan Calvo, Granada) of the mini-symposium "Dynamics of stochastic molecular systems" within the ECMTB 2016, Nottingham, July 2016.

• Co-organiser (jointly with Ruben Perez-Carrasco, University College London, UK, Pilar Guerrero, University College London, UK, and Juan Calvo, Granada) of the mini-symposium "Analysis of stochastic multi-scale and hybrid models" within the ECMTB 2016, Nottingham, July 2016

Participation

Invited lectures in conferences

• *Population and evolutionary dynamics of tumour growth*. Invited talk at the Workshop on "Mathematical Perspectives in Biology", ICMAT (Institute for Mathematical Sciences), Madrid, Spain, February 2016.

• *Optimal path theory of stochastic processes and its applications to robustness of gene regulatory circuits*. Joint UB-UPC seminar on dynamical systems, Barcelona, Spain, February 2016.

• *Gene regulatory systems under epigenetic regulation: robustness, noise-enabled bifurcations, and cellular reprogramming*. Seminar, Mathematical Biology & Ecology Seminar, Mathematical Institute, University of Oxford, Oxford, UK, April 2016.

• *Stochastic multi-scale modelling of cell populations: Numerical methods, mean-field approximation, and hybrid simulation methods*. Seminar at the Angiogenesis & Vascular Tumour Growth Working Group, Mathematical Institute, University of Oxford, UK, May 2016.

• *Stochastic modelling of somatic cell reprogramming*. Biomathematics seminar, Imperial College London, UK, June 2016.

• *Stochastic modelling of somatic cell reprogramming*. Seminar at the Institute for the Physics of Living Systems, University College London, UK, July 2016.

• *Oncometabolic nuclear reprogramming of cancer stemness*. Invited talk at the Conference "Bridging scales in models of cell to tissue behaviour: recent progress and future challenges", Society for Experimental Biology–Mathematical Institute, University of Oxford, UK, September 2016.

• *Plasticity and heterogeneity of epigenetic states: the roles of oncometabolic transformation and aging*. Seminar at the Basque Centre for Applied Mathematics (BCAM), Bilbao, Spain, November 2016.

Álvaro Corral

During 2016, the research activity of A. Corral has been dispersed accross several research lines, including: the theory of branching processes from the point of view of statistical physics, together with F. Font-Clos and R. García Millán; large-scale analysis of Zipf's law in texts, with F. Font-Clos and I. Moreno-Sánchez; statistics of avalanches in compression experiments, with V. Navas-Portella and E. Vives; ranking of similarity-based time series motifs, with J. Serrà, and I. Serra; and statistical tools for testing universality in critical exponents, with A. Deluca and P. Puig.

A. Corral has continued his work in the Scientific Committees of complexitat.cat and the GEFENOL Summer School.

□ Publications

Articles

• A. Corral, V. Navas, E. Vives, *Avalanches and force drops in displacement-driven compression of porous glasses*, Physical Review E **94(3)**, 2016 (nr: 033005).

• A. Corral, R. García-Millan, F. Font Clos, *Exact Derivation of a Finite-Size Scaling Law and Corrections to Scaling in the Geometric Galton-Watson Process*, PLOS ONE **11(9)**, 2016 (nr: e0161586).

• A. Corral, J. Serra, I. Serra, J. Lluis Arcos, *Ranking and significance of variable-length similarity-based time series motifs*, Expert systems with applications **55**, 2016 (452–460).

• A. Corral, P. Puig, A. Deluca, *Testing universality in critical exponents: The case of rainfall*, Physical Review E **93(4)**, 2016 (nr: 042301).

• A. Corral, I. Moreno, F. Font Clos, *Large-Scale Analysis of Zipf's Law in English Texts*, PLOS ONE **11(1)**, 2016 (nr: e0147073).

• A. Corral, I. Moreno, F. Font Clos, *Las leyes matemáticas emergentes en el uso del lenguaje*, Investigación y Ciencia **478**, 2016 (16–17).

□ Research projects

• *Scaling, complejidad y predictibilidad en fenómenos atmosféricos y formas de comunicación,* Ministerio de Economía y Competitividad, FIS2012-31324. From 2013 to 2016. Principal investigator: Álvaro Corral.

• *Sistemas invariantes de escala: herramientas, evidencia empírica, modelos y limitaciones,* Ministerio de Economía y Competitividad, FIS2015-71851-P. From 2016 to 2018. Principal investigator: Álvaro Corral.

• *Grup de Recerca en Matemàtica Col·laborativa del CRM,* Generalitat de Catalunya, SGR-01307. From 2014 to 2016. Principal investigator: Álvaro Corral.

□ Scientific activities

Participation

Communications in conferences

• A. Corral, *The strange properties and useful applications of power-law distributions*. XVII Encuentro Nacional de Estudiantes de Matemáticas (ENEM) Barcelona, July 2016

□ Other activities

• Referee of the journals Physical Review E (4 reviews), Proceedings of the National Academy of Sciences, Geophysical Journal International, Physica A (2), Journal of Statistical Physics.

Andrei Korobeinikov

During 2016, 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, and in particular of ecological systems and host-microparasite systems, including the spread of a pathogen within a population, virus dynamics models and models of immune response. To a large extend, these research were 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 number of models in host-parasite dynamics. (ii) The second direction of my research was mathematical modelling of biological evolution, and viral evolution in particular. 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. In this direction framework I also studied mechanisms of adaptation, such as memory, to biological system dynamics. (iii) The third direction of my research in 2016 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 spread of an infection in a population. 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).

Apart from the mentioned research directions, which are continuations of research that i started earlier, in 2016 I started, in collaboration with Tomas Alarcon and Josep Sardanyes, research in evolution of cancer. In this direction I applied the technique that was previously developed for microbial evolution, to cancer. I also initiated, in collaboration with Prof. E. Khailov and Prof. E. Grigorieva, research in optimal cancer therapy.

□ Publications

Articles

• A. Korobeinikov, E. Shchepakina and V. Sobolev, *Paradox of enrichment and system order reduction: bacteriophages dynamics as case study*, Math. Med. Biol. **33 (3)** (2016), 359–369, doi:10.1093/imammb/dqv025

• A.A. Archibasov, A. Korobeinikov and V.A. Sobolev, *Passage to the limits in a singularly perturbed partial integro-differential system*, Differential Equations **52 (9)** (2016), 111–1122, doi:10.1134/S0012266116090020.

• E.V. Grigorieva, E.N. Khailov and A. Korobeinikov,*Optimal control for a SIR epidemic model with nonlinear incidence rate*, Math. Model. Nat. Phenom. **11 (4)** (2016), 90–105, doi:10.1051/mmnp/201611407.

• L. Shaikhet and A. Korobeinikov, *Stability of a stochastic model for HIV-1 dynamics within a host*, Applicable Analysis **95 (6)** (2016), 1228–1238), doi:10.1080/00036811.2015.1058363.

• A. Korobeinikov, A. Archibasov, V. Sobolev, *Multi-scale problem in the model of RNA virus evolution*, J. Phys. Conf. Ser. **727** (2016), 012007, doi:10.1088/1742-6596/727/1/012007, `http://iopscience.iop.org/article/10.1088/1742-6596/727/1/012007`.

Conference proceedings

• A. Korobeinikov, A. Archibasov, V. Sobolev, *Multi-scale problem in the model of RNA virus evolution* in "J. Phys. Conf. Ser."727 (2016), 012007, doi:10.1088/1742-6596/727/1/012007.

□ Research projects

• *Ramón y Cajal Fellowship,* MICINN. From 2012 to 2017. Principal investigator: A. Korobeinikov.

• *Análisis de sistemas con dinámica compleja en las áreas de medicina matemática y física utilizando los métodos de localización de conjuntos compactos invariantes,* CONACYT (México), grant N 219614. From 2014 to 2017. Principal investigator: Konstantin Starkov.

• *Grup de recerca en matemàtica col·laborativa del CRM (CRM research group on collaborative mathematics),* AGAUR, Generalitat de Catalunya, grant 2014SGR1307. From 2014 to 2016. Principal investigator: Álvaro Corral.

• *Evolutionary and stochastic modelling and analisys of multi-scale dynamics in Bio-medicine,* MINECO. From 2016 to 2018. Principal investigator: Andrei Korobeinikov and Tomas Alarcon.

• Recerca Matemàtica Col·laborativa (Interdisciplinary Research in Mathematics), La Caixa Foundation project. CRM. From 2014 to 2018 Lluis Alsedà EUR 967,000

□ Activity in research training

• Silvia Pagliarini (MSc student, CRM/University of Turin, October 2016):

Bacteriophages evolution.

• David Masip Bonet (final year BSc honour project, CRM/UAB):

Cancer evolutionary escape.

• Aleksei Archibasov (PhD student, CRM & Samara State Aerospace University):

Model order reduction in mathematical models of viral evolution.

• Anel Nurtay (PhD student CRM & Universitat Autonoma de Barcelona):

Modelling of biological evolution: development of specialization in biological species.

• Dr Paul Valle (CANACYT Postdoctoral fellow, CRM & CITEDI, Mexico):

A project in cancer evolution.

□ Scientific activities

Scientific activities organised

• The joint international multidisciplinary workshop MURPHYS-HSFS-2016, CRM, 2016.

• BIO 2016: The 2016 International Conference on Biology and Biomedicine (Riga, Latvia, May 28–30, 2016) `http://www.inase.org/conferences/2016/riga/bio.htm`.

• BBE 2016: The 2016 International Conference on Biology and Biomedical Engineering, Vienna, Austria, January 15–17, 2016, `http://www.inase.org/conferences/2016/vienna/bbe.htm`.

• The 3rd International Conference on Mathematics and Computers in Science and Industry – MCSI 2016, Chania, Crete Island, Greece August 27–29, 2016 `http://www.mcsi-conf.org`.

• The 2016 International Conference on Pure Mathematics, Applied Mathematics and Computational Methods, Corfu Island, Greece, July 14–17, 2016, `http://www.inase.org/conferences/2016/corfu/pmamcm.htm`.

• The 4th International Conference on Complex Dynamical Systems in Life Sciences: Modeling and Analysis (4th ICCDS'2016), Agadir, Morocco, October 26–28, 2016. `http://www.cosylis.org/iccds2016/organizing1.html`.

• 115th European Study group with Industry: ESGI 2016, Centre de Recerca Matemàtica, January 25–29, 2016, `http://www.crm.cat/en/Activities/Curs$_$2015-2016/Pages/ESGI-2015.aspx`.

□ 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, Nonlinear Modeling and Control; `http://www.mukpublications.com/board-nmc.php`.
- Member of Editorial board, Abstract and Applied Analysis.
- Member of Editorial board, Research and Communications in Biological Sciences.

Tim Myers

My activities are currently split into three main sections: Research, Teaching and Supervision, and External Activities (which is obviously a very loose term).

My research is primarily focussed on the nanoscale. Together with my PhD students and post-docs I have worked on the rigorous formulation of nanoscale phase change, the Kirkendall effect, nanocrystal growth and nanoscale heat flow. The crystal growth and Kirkendall work is in collaboration with the Catalan Institute of Nanoscience and Nanotechnology. The heat flow with the Physics department at UAB. My work on nanofluid heat transfer culminated in a paper explaining why the results in thousands of publications by mathematicians contradict recent experimental evidence. It was not good news for the mathematicians, who then fought against publication. In the end I submitted to another Q1 journal and the paper was accepted within 2 hours of submission. The editor stated it was his first time in accepting without review, but felt the message was very important. I am still awaiting the mathematical backlash.

Currently I am supervising 3 PhDs at CRM and 1 in Ireland. I continue to teach at the Universitat Polit'ecnica de Catalunya, taking part in the course Models Matematics de la Tecnologia. I supervised undergraduate students in their final year projects, both from UAB and UPC as well as a final year batxillerat student, whose thesis was later nominated for a prize. I also visited Vancouver to act as a mentor at a mathematical modelling camp.

My external activities include being the Short Term Scientific Manager and member of the core Management Committee for the EU COST Action TD1409, Mathematics for Industry Network. I am also member of the council for the European Consortium for Mathematics in Industry and, by virtue of being the co-ordinator for all European Study Groups with Industry, I am a member of the ECMI board. I gave up my editorial duties with the Elsevier journal, Applied Mathematical Modelling but am still on the board of Mathematics in Industry Case Studies and the RSME Springer book series.

I have carried out too many reviews, for journals, for the Agencia Nacional de Evaluación y Prospectiva, Generalitat de Catalunya Tecnio programme and the King Abdul Aziz Highly Cited program.

□ Publications

Articles

- T.G. Myers, H. Ribera, *A mathematical model for nanoparticle melting with size-dependent latent heat and melt temperature*, Microfluidics and Nanofluidics **20(11)**, 147 (2016).
- T.G. Myers, *Mathematical modelling of phase change at the nanoscale*, International Communications in Heat and Mass Transfer **76**, 59–62 (2016).
- B.J. Florio, T.G. Myers, *The melting and solidification of nanowires*, Journal of Nanoparticle Research **18**, 168 (2016).
- T.G. Myers, M.M. MacDevette, *Nanofluids: An innovative phase change material for cold storage systems?*, International Journal of Heat and Mass Transfer **92**, 550–557 (2016).

□ Research projects

- *Dinámica de fluidos complejos y fronteras móviles*, MTM2014-56218-C2-1-P. From 2015 to 2017. Principal investigator: Tim G. Myers. Team Members: Vincent Cregan, Helena Ribera, Sub-Project 2: Susana Serna, Antonio Marquina.

□ Activity in research training

Supervision of research students

Undergraduate project supervision

- Marc Marugán, UAB, *Nanoscale heat transfer*, September 2015 – September 2016.
- Pere Barber, UAB, *Nucleation and growth of nanocrystals: General model and aproximations*, September 2016.
- Daniel Salgado, UAB, *Mathematical modelling of nanocrystal growth*, September 2016.
- Curial Gallart, UAB, *Sintesi i estructura de materials cristal.linds i amorfs*, December 2016.

PhD supervision

- Helena Ribera, PhD project: *Mathematical modelling of nanoparticle evolution*, September 2014 – .
- Marc Calvo, *Heat transfer and phase change at the nanoscale*, October 2015 – .
- Gary O'Keeffe, PhD project: *Mathematical modelling of nanofluid direct absorption solar cells*, September 2014 – .
- Claudia Fanelli, PHD project: *Diffusion processes and nanoparticle growth*, October 2016 – .

Postdoc supervision

- Vincent Cregan, "la Caixa" Post-doc, *Nanoparticle evolution*, September 14 – .

Teaching activity

• Adjunct 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, mathematics degree.

Scientific activities

Organisation

• Short Term Scientific Manager & member of Management committee EU COST Action, TD1409 Mathematics for industry network (MI-NET), see `http://www.cost.eu/COST_Actions/TDP/Actions/TD1409`.

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

• Scientific committee *Nanomath* 2016, Toulouse 2016, see `http://nanomath2016.sciencesconf.org/`.

• Scientific committee *European Consortium for Mathematics in Industry Conference*, Santiago de Compostela 2016.

• President for 115th *European Study Group with Industry*, Barcelona 2016.

• Organiser of *An introduction to* seminar series, Faculty of Math. & Stats., Universitat Politècnica de Catalunya, where experts in a field give an introductory lecture to a general audience.

Participation

Invited lectures in conferences

• T.G. Myers, *Can you trust mathematics at the nanoscale?*, Nanomath 2016, Toulouse, France, June 2016.

• T.G. Myers, Invited international expert, University of the Witwatersrand, Johannesburg, January 2016.

Other activities

• Member of Editorial Board, Book Series RSME Springer Briefs, `http://www.springer.com/series/13759`.

• Member of Editorial Board, Applied Mathematical Modelling.

• Member of Editorial Board, Mathematics in Industry Case Studies.

• PhD examiner, School of Mechanical Engineering, University of Leeds.

• Evaluator for Tecniospring Fellowships, Generalitat de Catalunya.

- Evaluator for King Abdul Aziz University, HiCi Distinguished Professor Visiting Programme.
- Evaluator for Agencia Nacional de Evaluación y Prospectiva.
- Evaluator for Belgian Research Foundation FWO.
- Research Stay: July (4 weeks), Department of Mathematics, Vrije Universiteit, Netherlands.
- Referee for Applied Mathematical Modelling; Cold Region Science and Technology; International Journal of Thermal Science; JIMA Journal of Applied Mathematics, etc.

Luis Ortiz

During 2016, my research activity has been focused on the development of new efficient numerical methods to price financial options as well as on the enhancement of risk measurement techniques. Within the option pricing framework, the starting point is the discounted expected pay-off pricing formula, and my methods belong to the class of numerical integration methods. The Fourier transform of the density that we encounter in these kinds of problems is typically known for most of the interesting processes in finance, and we recover the density by means of wavelets. Three projects were undertaken on this field, namely two-dimensional option pricing with Gemma Colldeforns-Papiol and Cornelis W. Oosterlee, computation of market risk measures with Gemma Colldeforns-Papiol and the data-driven COS method with Álvaro Leitao, Cornelis W. Oosterlee and Sander M. Bohte. Regarding the last, I carried out a three-weeks research stay at the CWI in the Netherlands.

I delivered several seminars at international level and supervised four master theses in the context of Quantitative Finance. My teaching activity within this year comprises a course on computational aspects of risk management for PhD students at the CWI and a course on computational risk management for master students at the CRM.

□ Publications

Articles

- L. Ortiz-Gracia, *Efficient wavelets-based valuation of synthetic CDO tranches*, Journal of Computational and Applied Mathematics 292 (2016), 562–575.
- L. Ortiz-Gracia, C.W. Oosterlee, *A highly efficient Shannon wavelet inverse Fourier technique for pricing European options*, SIAM Journal on Scientific Computing 38(1) (2016), B118-B143.

Preprints

- D.M. Dang and L. Ortiz-Gracia, *A dimension reduction Shannon-wavelet based method for option pricing*. **Submitted for publication**, (2016).

- G. Colldeforns-Papiol, L. Ortiz-Gracia, and C.W. Oosterlee, *Two-dimensional Shannon wavelet inverse Fourier technique for pricing European options*. **Submitted for publication**, (2016).

- G. Colldeforns-Papiol and L. Ortiz-Gracia, *Computation of market risk measures with stochastic liquidity horizon*. **Submitted for publication**, (2016).

Research projects

- *Grup de Recerca en Matemàtica Col·laborativa del CRM*, Generalitat de Catalunya, SGR-01307. From 2014 to 2016 P.I.: Álvaro Corral, Centre de Recerca Matemàtica.

- *Stochastic Finance*, Ministerio de Economía y Competitividad (MINECO). From 2014 to 2016. P.I.: José Manuel Corcuera Valverde, Universitat de Barcelona.

Activity in research training

Supervision of research students

PhD supervision

- Gemma Colldeforns (Universitat Autònoma de Barcelona), starting date October 1st, 2014, in co-direction with Cornelis W. Oosterlee. PhD project: *Wavelets-based methods to compute solutions of BSDEs arising in Finance*.

MSc supervision

- Prin Chongpakdeepong, Universitat Autònoma de Barcelona, February 2016 – June 2016. Project: *Applying Shannon wavelet inverse Fourier technique on Asian options pricing*.

- Oriol Madaula Esquirol, Universitat de Barcelona, February 2016 – June 2016. Project: *Superficie de volatilidad e interpolación de opciones del Ibex no cotizadas*.

- Pablo Cabrera (in co-direction with Miguel Santolino), Universitat de Barcelona, February 2016 – June 2016. Project: *Asignación de capitales, aproximación práctica*.

- Cristina Carmona Camacho, Universitat de Barcelona, February 2016 – June 2016. Project: *Medición del riesgo de una cartera de opciones*.

Teaching activity

- Graduate level: First term 2016–2017: *Computational Risk Management*, Master of Mathematics in Finance, Universitat Autònoma de Barcelona.

□ Scientific activities

Participation in scientific activities

Invited lectures in conferences

- L. Ortiz-Gracia. *A dimension reduction method for option pricing*. Czech, Slovenian, Austrian, Slovak and Catalan Mathematical Societies joint meeting, Barcelona, Spain. September 20^{th} to 23^{rd}, 2016.

Courses delivered

- L. Ortiz-Gracia. *Computational aspects of risk management*. Course for PhD students at the CWI, Amsterdam, the Netherlands, October 2016.
- L. Ortiz-Gracia. *Computational arspects of risk management*. Introductory course on Financial Mathematics for undergraduate students in Mathematics, Physics and Economics, Centre de Recerca Matemàtica, Spain, September 2016.

Communications in conferences

- L. Ortiz-Gracia. *A Fourier-wavelet based dimension reduction method for option pricing*. The 19th European Conference on Mathematics for Industry (ECMI 2016), Santiago de Compostela, Spain, June 13^{th} to 17^{th}, 2016.

Seminars

- L. Ortiz-Gracia. *A dimension reduction method for option pricing*. MAC Seminar at CWI, Amsterdam, the Netherlands, September 27^{th}, 2016.
- L. Ortiz-Gracia. *Tendències Actuals de les Matemàtiques (Finances)*. Talk for undergraduate students in Mathematics, Universitat Autònoma de Barcelona, Spain, April 19^{th}, 2016.

Research stays

- CWI, Amsterdam, the Netherlands, October 2016 (3 weeks).

Alex Roxin

My research group has been focused on four main problems:

1. The first is to understand the detailed statistical structure of cortical networks and the second is to investigate the neuronal basis of memory consolidation. Regarding the first, it is known from electrophysiological experiments recording from several neurons simultaneously in cortical tissue, that the patterns of connectivity are inconsistent with the underlying network being random in the Erdös-Renyi sense. That is, the probability of connection between any two neurons, called the sparseness, is not a sucient statistic to describe the types of connectivity patterns seen in real data. Therefore we have been

exploring other possible types of networks which can come closer to matching the data. Some candidate models are: clustered networks, spatially in homogeneous networks and networks with a large degree of heterogeneity in the number of incoming and outgoing connections. One major technical obstacle is the fact that the experimental data comes from very small sample sizes, 12 neurons at most. We have developed a statistical measure which allows us to infer the global pattern of connectivity using only local measures. Using this measure we show that real data is compatible which a spatially structured network with additional non-spatial clustering, which is hierarchical in nature. This work has been carried out by my PhD student Marina Vegué.

2. Our work on memory consolidation has involved two different yet related projects. The first is to encode patterns of activity in a neuronal network by ensuring that they are attracting fixed points of the dynamics. This follows the classical work of John Hop field and others. In our case, we are attempting to modify the network models to make them more biologically plausible, e.g., by separating neurons into excitatory and inhibitory classes. We have also gone beyond the classical calculation of memory capacity to consider the basins of attraction of the stable fixed points, a crucial property for recall, or for re-activition during memory consolidation. The second is more closely related with electrophysiological data from rodents involved in spatial navigation and exploration. It is well established that in the hippocampus of the rodent, some neurons, so-called place cells, are active when the animal traverses a particular spatial location in a given environment. We consider a network of place cells which learn to encode the memory of a given environment via realistic spike-timing dependent synaptic plasticity rules. Specifically, place cells which encode for nearby locations become strongly coupled, while neurons which encode for far-away locations are weakly coupled and interact mainly via inhibitory interneurons. This learning process leads to the spontaneous emergence of sequential place-cell activation when sensory input is removed, modeling awake quiescence or sleep. We have looked for the signature of this emergence in data from awake exploring rats and have verified an increase in cross-correlation in the activity of cells with neighboring place fields seen in the model. The work on these two projects is being carried out by my PhD student Bernat Rovira and postdoc Panagiota Theodoni.

3. In collaboration with the group of Jaime de la Rocha at IDIBAPS, Genís Prat has been studying the role of stimulus fluctuations in perceptual decision-making tasks. Specifically, he has discovered that increasing the level of stimulus noise in attractor models can in some cases improve performance; this happens when an incorrect decision is first made and then fluctuations generate a change-of-mind. He has testing this finding by running psychophysics experiments with human subjects while recording their brain signals using magnetoencephalography. We are currently analyzing this data.

4. In collaboration with Ernest Montbrió at the Universitat Pompeu Fabra we have been developing an exact mean-field model for networks of so-called quadratic integrate-and-fire neurons. Unlike standard, heuristic mean-field models for neuronal tissue, these exact equations correctly capture not only changes in the network firing rate, but also in the degree of spike synchrony. We have studied how oscillatory signals can drive synchrony to switch neuronal networks between distinct states, allowing for a simple command signal for the loading and clearing of memories. This work has been done in collaboration with the post-doctoral researcher Helmut Schmidt.

Publications

Articles

- A. Roxin, A. Compte, *Oscillations in the bistable regime of neuronal networks*. Phys. Rev. E **94** (2016), 012410.
- A. Roxin, G. Prat-Ortega, K. Wimmer, J. de la Rocha, *Attractor models of perceptual decisions making exhibit stochastic resonance*. Artificial Neural Networks and Machine Learning - ICANN 2016, PT I **9886** 555 2016

Research projects

- *Network Dynamics,* SGR Grup Emergent 2014SGR 1265. From 2014 to 2017. Principal investigator: Albert Compte.

Activity in research training

- Helmut Schmidt, Post-doctoral researcher (BGSMath-CRM).
- Panagiota Theodoni, Post-doctoral researcher (CRM).
- Bernat Rovira, PhD student (UPF-CRM).
- Genís Prat, PhD student (CRM-IDIBAPS).
- Marina Vegué, PhD student (CRM).

Scientific activities

Participation in scientific activities

Invited lectures in conferences

- A. Roxin, *A model of plasticity-dependent network activity in rodent hippocampus during exploration of novel environments*. Institut fuer Neuroinformatik, Zurich, Switzerland, December 2016.
- A. Roxin, *Les Matemàtiques de la Memòria*. Talk for students of ESO and Batxillerat at the CaixaForum, Lleida, December 1st 2016 (in Catalan).
- A. Roxin, *Les Matemàtiques de la Memòria*. Talk for students of ESO and Batxillerat a the CaixaForum, Girona, November 8th 2016 (in Catalan).
- A. Roxin, *A computational model of spatial learning in rodent hippocampus*. Dynamical systems and data analysis in neuroscience workshop: Bridging the Gap. MBI Ohio State University, Columbus Ohio, October 2016.
- A. Roxin, *A model of spatial learning in rodent hippocampus*. 2nd International Conference on Mathematical Neuroscience. Antibes, Juan les Pins, France May 2016.

• A. Roxin, *Exact meanfield models for QIF neurons*. Workshop on "Population models and meanfield approaches to in vivo brain activity states", Paris, February 2016.

Sergey Tikhonov

During 2016, my research activities include the following topics. I continue investigating, with Vladimir Temlyakov, Remez and Nikolskii polynomial inequalities. The case of the hyperbolic cross polynomials was of special interest to us. Jointly with Dmitry Gorbachev and Eli Liflyand, I have finished the project on the weighted inequalities for Fourier transforms. Together with Amiran Gogatishvili, Mirek Opic, and Walter Trebels we have been investigating sharp Ulyanov-type inequalities between different function spaces.

Jointly with Yury Kolomoitsev, I studied sharp (L_p, L_q) inequalities for smoothness characteristics in the case of $0 < p < q$. Moreover, together with Laura De Carli, Dmitriy Gorbachev, and Erlan Nursultanov, I continue the investigation of properties of the Fourier integrals in the weighted Lebesgue and Lorentz spaces.

Together with Mikhail Dyachenko and Erlan Nursultanov we proved new Hardy–Littlewood and Pitt's inequalities for Hausdorff operators and studied smoothness and asymptotic properties of functions with general monotone Fourier coefficients.

Jointly with Dmitry Gorbachev and Valery Ivanov, I have studied several classical approximation results for Dunkl analysis.

Besides, I have served as a supervisor for five PhD students: Nestor Costa, Alberto Debernardi, Ainur Jumambaeva, Aizhan Ydyrys, and Askhat Mukanov. Nestor Costa studied optimal decoding and related problems of harmonic analysis. Alberto Debernardi continued working on his PhD dissertation focusing on convergence of Fourier transforms of general monotone functions. Ainur Jumabaeva studied the (L_p, L_q) inequalities for best approximation and moduli of smoothness of the generalized Liouville derivatives. Aizhan Ydyrys obtained several results on asymptotical behavior of double trigonometric series with convex and monotone coefficients. Askhat Mukanov investigated different types of convergence of trigonometric series.

I have served as an editor of the following journals: Journal of Mathematical Analysis and Applications, Abstract and Applied Analysis, Bulletin of Mathematical Analysis and Applications, and The Scientific World Journal.

I was the main organizer of the Research program "Constructive Approximation and Harmonic Analysis" in the Centre de Recerca Matemàtica (March-July, 2016). In particular, we organized:

May 2^{nd} to 6^{th}, 2016: Workshop on Function Spaces and High-dimensional Approximation,

May 30^{th} to June 4^{th}, 2016: Advanced course on Constructive Approximation and Harmonic Analysis,

June 6^{th} to 10^{th}, 2016: Conference on Harmonic Analysis and Approximation Theory (HAAT 2016).

□ Publications

Articles

- F. Dai, H. Feng, S. Tikhonov, *Reverse Hölder's inequality for spherical harmonics*, Proc. Amer. Math. Soc. **144(3)** (2016), 1041–1051, arXiv:1408.1877

- F. Dai, S. Tikhonov, *Weighted fractional Bernstein's inequalities and their applications*, J. d'Analyse Math. **129(1)** (2016), 33–68, arXiv:1307.0207.

- D. Gorbachev, V. Ivanov, S. Tikhonov, *Pitt's inequalities and uncertainty principle for generalized Fourier transform*, International Mathematics Research Notices, **23** (2016), 7179–7200, arXiv:1507.06445.

- D. Gorbachev, V. Ivanov, S. Tikhonov, *Sharp Pitt inequality and logarithmic uncertainty principle for Dunkl transform in* L^2, J. Approx. Theory **202** (2016), 109–118, arXiv:1505.02958.

- E. Nursultanov, M. Ruzhansky, S. Tikhonov, *Nikolskii inequality and Besov, Triebel-Lizorkin, Wiener and Beurling spaces on compact homogeneous manifolds*, Annali della Scuola Normale Superiore di Pisa, Classe di Scienze (5) XVI (2016), 981–1017, arXiv:1403.3430.

- M. Ruzhansky, S. Tikhonov, *Methods of Fourier analysis and approximation theory*, in Applied and Numerical Harmonic Analysis, Birkhäuser (2016), 1–18.

Books or book chapters

- M. Ruzhansky, S. Tikhonov, *Methods of Fourier Analysis and Approximation Theory*. Applied and Numerical Harmonic Analysis, 226 pp. Springer Basel (Birkhäuser) (2016), ISBN: 978-3-319-27466-9.

□ Research projects

- *Methods of constructive approximation and Fourier analysis*. Ministerio de Ciencia e Innovación MTM2014-59174-P. From 2015 to 2017. P.I.: Sergey Tikhonov.

- *Optimal methods of digital signal compression and recovery*. Grant of Ministry of Education and Science of the Republic of Kazakhstan. From 2015 to 2017.

- *Grup de teoria de funcions de la UAB/UB*, 2014SGR-289. Grups de recerca (SGR-DGR), the Generalitat de Catalunya. From 2014 to 2016.

□ Activity in research training

Supervision of research students

PhD supervision

- Néstor Costa (doctorate student at the CRM, supported by CRM).

- Alberto Debernardi (doctorate student at the CRM and UAB, supported by CRM).

• Ainur Jumabayeva (doctorate student at the CRM and UAB, partially supported by CRM).

• Askhat Mukanov (doctorate student at the CRM and UAB, partially supported by CRM).

□ Scientific activities

Participation

Invited lectures in conferences

• S. Tikhonov. Conference in Workshop on Function Spaces and High-dimensional Approximation, Barcelona. May 2^{nd} to 6^{th}, 2016

Colloquium talks

• S. Tikhonov. Delft University of Technology, The Netherlands.

• S. Tikhonov. Nepal Mathematical Society.

• S. Tikhonov. Università degli Studi di Perugia, Spain.

Seminars

• S. Tikhonov. Functional Analysis Seminar, Université de Franche-Comté, Besançon, France.

• S. Tikhonov. Mathematics of Computation, Hausdorff Center for Mathematics, Germany.

• S. Tikhonov. Approximation Theory Seminar, Steklov Mathematical Institute, Moscow, Russia.

Research stays

• December, 16: Invited Researcher, Institute of Mathematics of Acad. of Sciences, Prague, Czech Republic.

□ Other activities

• Member of Editorial board:

  · Analysis Mathematica;

  · Journal of Mathematical Analysis and Applications;

  · Abstract and Applied Analysis, Bulletin of Mathematical Analysis and Applications;

  · The Scientific World Journal.

Juan Calvo

The main goal of the project under which Juan Calvo was recruited is to produce a multiscale model for kidney cancer and angiogenesis. This involves the theoretical formulation of such a model, a careful mathematical analysis of it, its implementation as a computational tool and its calibration against relevant data coming from image analysis and blood analysis bio-markers. Fundamentals steps have been carried during the aforementioned period towards a computational implementation of a multiscale model for the proliferation of kidney tumors, laying also the foundations of the required framework for performing calibration against data, while some stages of the theoretical analysis of the model have been performed along our advancements on the previous points.

□ Publications

Articles

- J. Calvo, J. Campos, V. Caselles, O. Sánchez, and J. Soler, *Pattern formation in a flux limited reaction-diffusion equation of porous media type*. Inventiones Mathematicae textbf206 (2016), 57–108.

□ Activity in research training

Supervision of research students

Undergraduate project supervision

- (with Andrei Korobeinikov) Co-mentorship of Silvia Pagliarini (Master Thesis, "Mathematical modelling of marine bacteriophges evolution).

Participation in scientific activities

Conference attendance

- European Study Group with Industry: ESGI 2016. Barcelona (Centre de Recerca Matemàtica), January 25^{th} to 29^{th}, 2016.

Research stays

- January 18^{th} to 22^{nd}, 2016, Laboratoire Jacques-Louis Lions, Université Pierre et Marie Curie.
- European Study Group with Industry: ESGI 2016. CRM, January 25^{th} to 29^{th}, 2016.

Vincent Cregan

In 2016, my research focused on two areas, namely nanoscience and phase change phenomena. In relation to nanoscienc, I considered three distinct problems. These are:

1) Nanoparticle growth via solution is one of the most popular methods for nanoparticle synthesis. In collaboration with the Inorganic Nanoparticles Group in the Catalan Institute of Nanoscience and Nanotechnology, I devised models to explain the interactions between nanoparticles and their surroundings during growth. Initially, I considered a diffusion model for the growth of a single particle. This was then extended to a system of nanoparticles. I have shown good qualitative agreement between my model and data for cadmium selenide nanoparticles.

2) Recent experimental evidence has shown that nanofluids do not provide the greatly enhanced heat transfer predicted in the past. Despite seemingly conclusive proof there is still a great deal of theoretical research stating the opposite result. My colleagues in the Industrial Mathematics Group and I studied previous mathematical treatments and demonstrated that the disagreement can be traced to several issues including the incorrect formulation of the governing equations; the use of parameter values orders of magnitude different to the true values model choices that are based on permitting a reduction using similarity variables as opposed to representing an actual physical situation; presentation of results using different scalings for each fluid.

3) Solar energy has the potential to solve one of the most pressing needs facing modern society: namely the development of an environmentally friendly and sustainable energy source. The current challenge is to establish a truly widespread, cost-effective system, which efficiently converts solar energy. NDASCs use a solution of nanoparticles and fluid to absorb sunlight, and have the capacity to harness solar energy significantly more efficiently than traditional collectors. This research has been presented at two international conferences (i.e., NanoMath 2016, MACSI10) this past year. Following on from my 2015 NDASC paper in the International Journal of Heat and Mass Transfer, I have been working with PhD candidate Gary O'Keefe (University of Limerick, Ireland) who is extending my research to examine more complex collector configurations (e.g., parabolic trough collector).

I have also been using applied mathematical techniques to explain industrial processes that involve phase change phenomena. In particular, I developed models for three systems. These are:

1) Phase change material (PCM) contact melting is a process where a PCM is placed in contact with a surface that is maintained above the melt temperature. The solid begins to melt so that a thin fluid layer develops between the two surfaces. The weight of the solid acts to squeeze out the liquid, and thus the melt layer remains thin. A standard approximation when modelling this process is to assume that the material properties are temperature-invariant. Typically, this approach is applicable when there are small temperature changes in the system of interest. However, this is not always the case, and thus the aim of my research was to investigate the impact of temperature-dependent properties on contact melting. I recently submitted a paper on this topic to the International Journal of Heat and Mass Transfer.

2) In collaboration with Waterford Crystal (Ireland) and Dr. William Lee (University of Portsmouth), I developed a model for the growth of lead sulphate particles in a gravity separation system. The particles are an undesirable by-product, and the model was used to ascertain the optimal system temperature configuration such that particle extraction is maximised.

Our research was published in the Journal of Physics: Conference Series.

3) Finally, I am collaborating with Dr. Adewunmi Fareo (University of the Witwatersrand) and Prof. Brian Wetton (University of British Columbia) on developing models to explain the so-called boiling crisis. Whilst boiling has been studied extensively, the underlying physics are still not fully understood. Due to the complexity of the process, full models have not been developed to predict the boiling heat fluxes as a function of heater surface superheat. Our model will combine elements from fluid flow, heat transfer and moving boundary phenomena. The goals are to (i) derive analytical expressions for the heat transfer coefficient, before and after film boiling (ii) describe in detail film boiling, and (iii) ascertain the key factors leading to the boiling crisis.

□ Publications

Articles

- G.J. O'Keefe, S.L. Mitchell, T.G. Myers, and V. Cregan, *The effect of depth-dependent velocity on the performance of a nanofluid based direct absorption solar collector*. Progress in Industrial Mathematics at ECMI 2016 Proceedings.
- V. Cregan, T.G. Myers, S.L. Mitchell, H. Ribera Ponsa, and M. Calvo Schwarzwalder, *Nanoparticle growth via the precipitation method*. Progress in Industrial Mathematics at ECMI 2016 Proceedings.
- V. Cregan and William T. Lee, *Optimisation of lead sulphate settling process*. Proceedings of MURPHYS-HSFS 2016: Workshop on Slow-Fast Systems and Systems with Hysteresis.

Preprints

- V. Cregan, T.G. Myers, S.L. Mitchell, H. Ribera Ponsa, and M. Calvo Schwarzwälder, *Nanoparticle evolution via the precipitation method*. (In preparation).
- V. Cregan, J. Williams, and T.G. Myers, *Contact melting of a phase change material with linear temperature-dependent thermal conductivity and viscosity*. (Submitted to International Journal of Heat and Mass Transfer).
- T.G. Myers, Adewunmi Fareo, V. Cregan, and B. Wetton. *The boiling crisis at the nanoscale*. (In preparation).

Scientific reports

- R. Bacsa, W. Bacsa, M. Calvo Schwarzwalder, V. Cregan (report coordinator), M. Fernandez-Pendas, S. Fernandez-Mendez, B. Florio, N. Gomez Bastus, A. Marquina, I. Moyles, T.G. Myers, H. Ribera Ponsa, J. Piella, S. Rusconi, S. Serna, and C. Vazquez-Cendon, *Synthesis of monodisperse spherical nanocrystals*. Proceedings of the 115th Study Group Mathematics with Industry (Barcelona). 2016.

Other

- V. Cregan, *Nanoparticle synthesis via precipitation from solution*. European Consortium for Mathematics in Industry Blog. 2016.

Scientific activities

Participation in scientific activities

Invited lectures in conferences

- V. Cregan, Invited speaker to MACSI10. University of Limerick (Ireland). December 2016.
- V. Cregan, Speaker at Nanomath 2016. CEMES-CNRS (France). June 2016.
- V. Cregan, Speaker at ECMI 2016. University of Santiago de Compostela (Spain). June 2016.

Matt Hennessy

I joined the CRM in September 2016 to take up a Marie Curie Individual Fellowship. I am based in the Industrial Mathematics group, where I work with Tim Myers and Marc Calvo to develop new mathematical models that describe thermal transport and phase change on the nanoscale. We are collaborating with research staff in the Physics department at UAB to address relevant problems in this area and to validate our theoretical models with their experimental data.

I have also been involved in two major projects with collaborators at Imperial College London. The first project pertains to developing predictive mathematical models that can be used to control photopolymerisation, which is a versatile solidification process that has applications in 3D printing and photolithography. The second project involves modelling the evaporation and absorption of solvent from thin multi-component films with application to personal care products such as deodorants. By carrying out an asymptotic analysis of a simple model of evaporation and absorption, I was able to obtain analytical expressions that can easily be used to extract values for key physical parameters from experimental data. The results of these two projects were presented at the APS Division of Fluid Dynamics Annual Meeting in Portand, Oregon, USA.

At the end of 2016, I began working as part of an international team to address issues relating to the spontaneous combustion of lithium-ion batteries. The goal of this work is to systematically derive a simplified mathematical model that captures the key physical processes that occur during the charging and discharging of a battery (charge transport and heat generation). The model will then be used to understand and predict the conditions that lead to the onset of thermal runaway. This is joint work with Iain Moyles (University of Limerick, Ireland), Brian Wetton (University of British Columbia, Canada) and Tim Myers (CRM).

Publications

Articles

- M.G. Hennessy, C.J.W. Breward, and C.P. Please. *A two-phase model for evaporating solvent-polymer mixtures*. SIAM J. Appl. Math., **76(4)** (2016), 1711–1736.

• M. Tinguely, M.G. Hennessy, A. Pommella, O.K. Matar, and V. Garbin. *Surface waves on a soft viscoelastic layer produced by an oscillating microbubble*. Soft Matter, **14** (2016), 4247–4256.

Preprints

• M.G. Hennessy, A. Vitale, J.T. Cabral, and O.K. Matar, *Monomer diffusion in static and evolving polymer networks during frontal photopolymerisation*.

• F.E. Valera, A. Vitale, M.G. Hennessy, J.F. Douglas, and J.T. Cabra, *Sculpting frontal photopolymerised materials through interfacial instabilities*.

• G.L. Ferretti, M.G. Hennessy, O.K. Matar, and J.T. Cabral, *A dynamic vapour sorption study of aqueous salt and humectant thin films*.

□ Research projects

• *Mathematical Modelling of Nanoscale Heat Flow and Phase Change*, European Commission H2020-MSCA-IF-2015, Grant number 707658. Principal investigator: Tim Myers 2. Mathematical Modelling of Nanoscale and Energy Technologies, 2016 New Foundations grant from the Irish Research Council. Principal investigator: Iain Moyles.

□ Teaching activity

Lectures and short courses

• *Mathematical models in technology*. UPC. Bachelor's degree in Mathematics. September–December 2016.

□ Activity in research training

• Supervision of research students.

• PhD supervision: Marc Calvo (doctoral student at the CRM).

• MSc supervision: Aloisius R. Purnama (MSc student at Imperial College London, now a PhD student at the University of Cambridge).

□ Scientific activities

Participation

Invited lectures in conferences

• M. G. Hennessy, *Swelling-induced instabilities in growing polymer networks*. Invited talk at the MACSI Seminar Series. University of Limerick, Limerick, Ireland, November 2016.

• M. G. Hennessy, *Controlled topological transitions in thin-film polymer mixture phase separation*. Invited talk at the Royal Academy of Engineering/Institute of Molecular Sciences and Engineering Symposium on Polymer Science and Engineering. Imperial College London, London, UK, July 2016.

Communications in conferences

• M. G. Hennessy, A minimal model of solvent evaporation and absorption in thin films. American Physical Society Division of Fluid Dynamics Annual Meeting 2016. Portland, Oregon, USA, November 2016.

• M. G. Hennessy, Swelling-induced instabilities in growing polymer networks. American Physical Society Division of Fluid Dynamics Annual Meeting 2016. Portland, Oregon, USA, November 2016.

Santiago Molina

During 2016 I have been working on p-adic L functions attached to automorphic forms, Hida families of automorphic forms and Stark-Heegner-Darmon points on modular abelian varieties. I have submitted a paper where I study the exceptional zero phenomenon of the anticyclotomic (definite and indefinite) p-adic L-function attached to a Hilbert automorphic form. I have started a joint work with X. Guitart and M. Mardeu on Stark-Heegner-Darmon points. I have started a joint work with X. Guitart and V. Rotger on p-adic L-functions attached to triples of automorphic forms and I have started a joint work with L. Gehrmann on higher weight anticyclotomic p-adic L-functions. Moreover, I have organized a seminar on *Perfectoid spaces and modular curves at infinite level* at the IMUB.

□ Publications

Preprints

• S. Molina, *Eichler-Shimura isomorphism and group cohomology on aritmetic groups*. To appear in Journal of Number Theory. `https:arxiv.org/abs/1701.00611`.

Helmut Schmidt

Since June 2016 I was a postdoctoral researcher in the Computational Neuroscience Group at the CRM (led by Alex Roxin), funded by the Barcelona Graduate School of Mathematics.

My research was focussed on modelling the dynamics of networks of spiking neurones, and to investigate the potential role of different dynamic states of such networks in information processing and short-term memory. At the core

of my research was a model that describes the macroscopic dynamics of neuronal networks in the limit of large numbers of neurones, thus facilitating analytical and numerical methods to investigate these problems. In particular, I have been involved in two projects, the first of which was aimed at investigating how oscillations can switch brain states, such as short episodes of increased neuronal activity related short-term memory. As a result, we identified distinct frequency bands with different functional roles, which can either evoke, maintain, or clear short-term memory states. The second project revolved around investigating the formation of patterns and localised solutions in spatially extended neuronal networks. We have identified several mechanisms that can lead to the formation of such solutions, ranging from classical 'Snakes-and-Ladders' structures, to the emergence of localised solutions due to spatial inhomogeneities.

□ Publications

Preprints

- H. Schmidt, *Exploring the functional role of oscillations in networks of spiking neurons*. (In preparation.)

□ Scientific activities

Participation

Communications in conferences

- H. Schmidt, *Macroscopic response of quadratic integrate-and-fire neurons to oscillatory forcing*. Brainmodes, December 1^{st} to 2^{nd}, 2016, Brussels (poster).

Isabel Serra

During 2016, I was postdoctoral researcher in Complex System Group of the CRM as a member of the mathematic research collaborative programme of "la Caixa" Foundation.

My research activities on my fundamental knowledge were divided on the methodological development in order to improve the use of Extreme Value Theory (EVT) with real data and the theoretical development of EVT. The first was developed in several frameworks on complex system, the main project was joining with Department of Physics in UB on the treatment of collected data from Synthetic Earthquakes for developing bivariate statistic methodologies, which is a project of collaborative mathematic programme with "la Caixa" Foundation. Simultaneously, the analysis of real earthquakes was developed, see my Preprints. The second was in collaboration with Department of mathematics of the UAB and the University of Nantes, see preprints.

The transfer research activities were developed the Institute of Photonic Sciences, Mediterranean Technology Park (ICFO). The ICFO collaboration was characterized by analyzing cerebral blood flow dynamics during individual obstructive sleep apnea events measured by hybrid diffuse optics, see my Conference proceedings.

I did some industrial transfer activities derived from exploiting my fruitfully research on modelling

processes, which was a join work with an international company (confidential) and Applied Statistics Service (SEA).

My public engagement activity is concentrated in taking part in several conferences and teach in several Master studies. Moreover, I was supervising several Final Degree projects on risk analysis of Spanish continuous market portfolios. Several times I was a member of the Master Thesis committee.

Finally, I participated as a member of the organizing committees of some research activities and I was a guest editor for an special issue in Journal of Data Analysis and Technical Statistics.

□ Publications

Articles

- J. Serrà, I. Serra, A. Corral, J.L. Arcos, *Ranking and significance of variable-length similarity-based time series motifs*. Journal Expert Systems with Applicatons **55** (2016), 452–460.

Preprints

- I. Serra and A. Corral, *Deviation from power law of the global seismic moment distribution*. Submitted.
- P. Rochet, I. Serra, *The mean/max statistic in extreme value analysis*. `https://arxiv.org/abs/1606.08974`. Submitted.
- J. del Castillo, J. Daoudi, and I. Serra, *The full-tails gamma distribution applied to model extreme values*. Submitted

Books or book chapters

- C. Gregori, P. Zirak, I. Blanco, P. Bramon, A. Fortuna, A. Mola, G. Cotta, M. Mayos, I. Serra, T. Durduran, *Characterization of cerebral hemodynamics during obstructive sleep apnea by diffuse optics*. Conference paper in OSA Biomedical Optics, Florida, (2016).
- C. Gregori, I. Blanco, P. Zirak, M. Giovannella, A. Fortuna, A. Mola, G. Cotta, M. Mayos, I. Serra, T. Durduran, *Cerebral hemodynamic response to an orthostatic challenge in patients with severe obstructive sleep apnea before and after two years of continuous positive air pressure treatment*. Conference paper in OSA Biomedical Optics, Florida, (2016).

□ Research projects

- *Grup de Recerca en Matemàtica Col·laborativa del CRM*. AGAUR, Generalitat de Catalunya, grant 2014SGR-01307. From 2014 to 2016. IP: Álvaro Corral (CRM)

□ Teaching activity

Lectures and short courses

- *Temporal estimation of rate*. UB-UPC. Master's degree in Statistics and Operations Research (MESIO). Febraury 2016 (20h.)
- *La predicció de la Borsa I el passeig aleatori*. CRM. Introducció a la matemàtica financera. September 2016 (2h.)

• *Statistics in finance*. UB-UPC. Master's degree in Statistics and Operations Research (MESIO). November 2016 (12h.)

• *Extreme value analysis in insurance*. UB-UPC. UB. Màster universitario en ciencias actuariales y financieras (MCCAF). November 2016 (16h.)

• *Random walk model by finance data*. UAB-CRM. Màster de Matemàtiques per als Instruments Financers (MMIF). December 2016 (16h.)

□ Scientific activities

Organisation

• II BGSMath Junior meeting. May 15

• Member of local commity of *12th Metaheuristics International Conference: MIC2017 and XXIX International Biometric Conference (IBC 2018)*.

Participation

Invited lectures in conferences

• I. Serra, *Model for management risk of burglaries* in 9th International Conference of the ERCIM. Computational and Methodological Statistics (CMStatistics2015), Seville, Spain.

Seminars

• I. Serra, *Exponential families for modelling tails*. Seminar in University of Nantes, Dept. Statistics

Courses attended

• *Topological Data Analysis*, Curso organizado por el Servicio de Estadística Aplicada (SEA).

2.2.3. Col·laboradors Científics

Durant l'any 2016, 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 Microreologia de Biofluids del CRM (vegeu 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; Ricard Alemany, de Crèdit Andorrà Financial Group i Néstor Costa, de Hohner Automáticos S.L.

2.2.3. Scientific Collaborators

During the year 2016, 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 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 Ricard Alemany, from Crèdit Andorrà Financial Group i Néstor Costa, from Hohner Automáticos S.L.

Ricard Alemany

Ricard Alemany works at Crèdit Andorrà Financial Group, an Andorran based institution, as the Managing Director of Market Risk. He teaches risk management on the Master on Mathematics for Financial Instruments degree program at the Centre for Mathematical Research (MMIF). Ricard has also served as a scientific collaborator in the Financial Mathematics and Risk Control research group at CRM since August 2014.

He is an IESE visiting professor of Financial Risk Management in the Department of Finance at the IESE Business School.

Ricard participates in the analysis of existing credit risk rating methodologies. Emphasis was placed on deriving an explicit probability of default at a given time horizon. Efforts were also directed at incorporating the effects driven by both global developing trends and natural cyclical trends. Particular attention was focused on issues relating to monetary policies and their effects on the perception of risk premium.

Néstor Costa

Néstor Costa Jimeno is a pre-doctoral student developing an Industrial PhD between a research center and a company: Centre de Recerca Matemàtica and Hohner Automáticos S.L, respectively. He is graduted in physics in the Universitat de Barcelona, and he received the MsC in Photonics from the Universitat Politècnica de Catalunya. In the company, he is part of the R+D+i department, performing innovation tasks focused in the optical rotary encoder field. His work is mainly focused on providing and testing different optical ideas with strong mathematical basis.

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/`.

Publications

Articles

- C. Trejo-Soto, E. Costa-Miracle, I. Rodriguez-Villareal, J. Cid, T. Alarcón, A. Hernández-Machado, *Capillary filling at the microscale: Control of fluid front using geometry*. Plos-one, 0153559 (2016), 1–18.

Patents

- I. Rodríguez-Villarreal, T. Alarcón, J. Colomer, A. Hernández-Machado, P. Miribel. Method apparatus for measuring viscosity of Newtonian and Non-Newtonian fluids. Patent application number: 15382248.1-1553, (2015).

Research projects

- *Dynamics of interfacial systems at the micro and nanoscale: Biomembranes and microfluidics*. Ministerio de Economía y Competitividad. Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia FIS2013-47949-C2-1-P. From 2014 to 2017. 72.600 euros. Coordinator: A. Hernandez-Machado.

Scientific activities

Participation

Invited lectures in conferences

- A. Hernández-Machado, *Phase-field models for the dynamic evolution of shapes in membranes: Red blood cells and liposomes*. XII World Conference on Computational Mechanics, Seoul, Corea, July, 2016.

Seminars

- A. Hernández-Machado *Nonlinear rheology of blood at the microscale*. Imperial College, London (United Kingdom), 2016.

2.2.4. Estudiants de doctorat

Presentem a continuació els estudiants de doctorat dels grups del centre i la seva activitat més rellevant durant el 2016. Tal com s'ha anat indicant en altres part d'aquesta memòria, les beques d'aquests estudiants es financien per diverses fonts: beques competitives de la Generalitat de Catalunya (FI) o del Ministeri (FPI, FPU), beques del programa de recerca col·laborativa "la Caixa"-CRM, beques pròpies del CRM i una beca del programa especial de l'Obra Social de "la Caixa" vinculada a la Universitat Politècnica de Catalunya. A l'apartat 2.6.1. es detalla la procedència de cadascuna de les beques.

2.2.5. PhD Students

Next we present the postgraduate students of the CRM research groups and their activity along the year 2016. As pointed out in other parts of this report, the grants of these students are funded from different sources: competitive grants of the Generalitat de Catalunya (FI) or Spanish Ministeries (FPI, FPU), grants from the "la Caixa"-CRM program collaborative research, CRM-funded grants and one grant from a special program of the "la Caixa" Foundation, which is based at the Universitat Politècnica de Catalunya. Details about the sourcing of each fellowship are given in Section 2.6.1.

Publications

Articles

- C. Trejo-Soto, **E. Costa**, I. Rodriguez-Villarreal, J. Cid, T. Alarcón, A. Hernández-Machado, *Capillary filling at the microscale: control of fluid front using geometry*. PLoS ONE **11(4)** (2016), e0153559. `https://doi.org/10.1371/journal.pone.0153559`.

- **R. de la Cruz**, P. Guerrero, F. Spill, T. Alarcón, *Stochastic multi-scale models of competition within heterogeneous cellular populations: Simulation methods and mean-field analysis*, Journal of Theoretical Biology **407**, 161–183 (2016).

- **A. Debernardi**, *Maximal values for the simultaneous number of null components of a vector and its Fourier transform*. Reports@SCM **2**, 1–10 (2016), doi:10.2436/20.2002.02.6.

- J. Menendez, **N. Folguera**, E. Cuyàs, S. Fernández-Arroyo, J. Joven, and T. Alarcón, *Accelerated geroncogenesis in hereditary breast-ovarian cancer syndrome*. Oncotarget **7(11)**, 11959–11971 (2016).

- **V. Navas**, E. Vives, *Influence of the aspect ratio and boundary conditions on universal finite-size scaling functions in the athermal metastable two-dimensional random field Ising mode*. Physical Review E **93(2)**, 022129 (2016).

- **V. Navas**, Á. Corral, E. Vives, *Avalanches and force drops in displacementdriven compression of porous glasses*. Physical Review E **94(3)**, 033005 (2016).

- **H. Ribera**, B. Wetton, T.G. Myers, *Cellular Automata model for substitutional binary diffusion in solids*. (In preparation).

- **H. Ribera**, B. Wetton, T.G. Myers, *Mathematical model for substitutional binary diffusion in solids*. (In preparation).

- **H. Ribera** and T.G. Myers, *Optimising the heat balance integral method in spherical and cylindrical Stefan problems*. (To be submitted).

- **H. Ribera** and T.G. Myers. A mathematical model for nanoparticle melting with size-dependent latent heat and melt temperature. Microfluidics and Nanofluidics **20**, 147 (2016).

- J. Aljadeff, D. Renfrew, **M. Vegué**, and T.O. Sharpee, *Low-dimensional dynamics of structured random networks*. Physical Review E 93, 022302 (2016).

Preprints

- V. Cregan, T.G. Myers, S.L. Mitchell, **H. Ribera**, M. Calvo Schwarzwälder, *Nanoparticle evolution via the precipitation method*. (In preparation).

- **A. Debernardi**, *Uniform convergence of double sine integrals of general monotone functions*. Accepted to the journal Analysis Mathematica.

- **A. Debernardi**, *Uniform convergence of sine transforms of general monotone function*. Submitted to the journal Mathematische Nachrichten.

Scientific reports

- R. Bacsa, W. Bacsa, M. Calvo Schwarzwälder, V. Cregan (report coordinator), M. Fernandez-Pendas, S. Fernandez-Mendez, B. Florio, N. Gómez Bastus, A. Marquina, I. Moyles, T. G. Myers, H. Ribera, S. Rusconi, S. Serna, C. Vázquez-Cendón, and J. Piella (2016), *Synthesis of monodisperse spherical nanocrystals*. Proceedings of the 115th ESGI, Centre de Recerca Matemàtica (Spain).

Conference proceedings

- **H. Ribera** and T.G. Myers. *A model for nanoparticle melting with a Newton cooling condition and size-dependent latent heat*. Proceedings of the 19th European Conference on Mathematics for Industry, University of Santiago de Compostela (Spain).

□ Research projects

- *Multiscale modelling and analysis in systems biology and biomedicine,* Ministery of Science and Innovation (MCINN)-Spanish government, MTM2015-71509-C2-1-R. From 01-01-2016 to 31-12-2018. Principal investigator: Tomás Alarcón, **R. de la Cruz**.

□ Diffusion activity

- T. Myers, **M. Calvo-Schwarzwälder**, *Bojos per les Matemàtiques: Tasta la Matemàtica Industrial al CRM*, CRM, April 2^{nd}, 2016.

□ Teaching activity

- **R. de la Cruz**, *Simulació i remostreig i aplicaciones*, Estadística Aplicada, Universidad Autónoma de Barcelona, 2016 (6 hours).

□ Scientific activities

Organisation

- **B. Rovira** Organizer *3rd Barcelona Computational Neuroscience Retreat*, November 24^{th} to 26^{th}, 2016.

Participation

Scientific activities

- **E. Beltrán**, International Workshop on Genopytpe-Phenotype Mapping, Cambridge, September 9^{th} to 11^{th}, 2016.
- **E. Beltrán**, International Conference on Systems Biology, Barcelona, 16^{th} to 20^{th}, 2016.

• **M. Calvo-Schwarzwälder**, *European Study Group with Industry: ESGI 2016*, CRM, January 25^{th} to 29^{th}, 2016.

• **M. Calvo-Schwarzwälder**, *19th European Conference on Mathematics for Industry: ECMI 2016*, Universidade de Santiago de Compostela, June 13^{th} to 17^{th}, 2016.

• **E. Costa**, 115th European Study Group with Industry: ESGI 2016. January 25^{th} to 29^{th}, 2016, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona (Spain).

• **E. Costa**, Member of the team working on *Predicting burglaries in Catalonia*.

• **G. Colldeforns**, 115th European Study Group with Industry: ESGI 2016. January 25^{th} to 29^{th}, 2016, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona (Spain).

• **G. Colldeforns**, 10th Annual LSE Department of Statistics Risk and Stochastics Conference. April 21^{st} to 22^{nd}, 2016. Winton, London (England).

• **G. Colldeforns**, Attendance to the Czech, Slovenian, Austrian, Slovak and Catalan mathematical societies meeting: CSASC2016. September 20^{th} to 23^{th}, 2016. Institut d'Estudis Catalans, Barcelona (Spain).

• **A. Debernardi**, Intensive Research Programme on Constructive Approximation and Harmonic Analysis at Centre de Recerca Matemàtica, consisting on 3 one-week conferences and a 3-day advanced course.

• **C. Fanelli**, Organizer of 124th European Study Group with Industry, Consiglio Nazionale delle Ricerche (CNR), Roma, August 29^{th} to September 2^{nd}, 2016.

• **N. Folguera**, 115th European Study Group with Industry: ESGI 2016. January 25^{th} to 29^{th}, 2016, Centre de Recerca Matemàtica (CRM), Bellaterra, Barcelona (Spain). Member of the team working on 'Predicting burglaries in Catalonia'.

• **A. Nurtay**, CRM weekly Camp Seminar, 2016.

• **A. Nurtay**, European Study Group with Industry: ESGI, Barcelona, Spain. January 25^{th} to 29^{th}, 2016.

• **G. Prat**, IDIBAPS Compte lab weekly Journal Club.

• **G. Prat**, CRM weekly Camp Seminar

• **G. Prat**, IDIBAPS Compte lab weekly lab meeting.

• **B. Rovira** ETIC 4th Doctoral Student Workshop International Conference on Mathematical NeuroScience (ICMNS). May 30^{th} to June 1^{st}, 2016.

• **B. Rovira** Barcelona Computational, Cognitive and Systems Neuroscience (BARCCSYN) 2016, June 16^{th} to 17^{th}, 2016.

• **M. Vegué**, Barcelona Computational and Systems Neuroscience, June 16^{th} and 17^{th}, 2016.

Invited lectures in conferences

- **G. Prat**, *Attractor models of perceptual decision making exhibit a resonant performance for non-zero noise level*, International Conference on Artificial Neural Networks, Barcelona, Spain.

- **G. Prat**, *Attractor models of perceptual decision making exhibit a resonant performance for non-zero noise level*, I International Conference on Mathematical Neuroscience, Nice, France.

- **G. Prat**, *Attractor models of perceptual decision making exhibit a resonant performance for non-zero noise leve*, Barcelona Computational, Cognitive and Systems Neuroscience, Barcelona, Spain.

Communications in conferences

- **E. Beltrán**, *Dynamics of signaling and information transmission through the ErbB system*. International Workshop on Genopytpe-Phenotype Mapping, Cambridge, September 2016.

- **M. Calvo-Schwarzwälder**, *Novel heat conduction models to describe heat transfer at the nanoscale*. Oral presentation given in Nanomath 2016, CEMES-CNRS, Toulouse, June 27^{th} to 30^{th}, 2016.

- **G. Colldeforns**, *Computation of Market Risk measures with stochastic liquidity horizon by Shannon wavelet expansions* at the II BGSMath Junior Meeting. May 13^{th}, 2016. Institut d'Estudis Catalans (IEC), Barcelona (Spain).

- **G. Colldeforns**, *Computing market risk measures with stochastic holding period by using Shannon wavelet expansions* at SIAM Student Chapter Delft. May 23^{rd}, 2016. TU Delft, Delft (the Netherlands).

- **G. Colldeforns**, *Computation of Market Risk measures with stochastic liquidity horizon* at the 19th European Conference on Matematics for Industry (ECMI). June 13^{th} to 17^{th}, 2016. Universidad de Santiago de Compostela, Santiago de Compostela (Spain).

- **G. Colldeforns**, *Wavelets for quantifying credit risk portfolio losses under multi-factor models* at the MAC seminar from Centrum Wiskunde & Informatica (CWI). December 20^{th}, 2016. Amsterdam (the Netherlands).

- **R. de la Cruz**, *The effects of intrinsic noise on the behaviour of bistable cell regulatory systems under quasi-steady state conditions*. Poster communication: 10th European Conference on Mathematical and Theoretical Biology & SMB Meeting ECMTB2016. The University of Nottingham, July 2016.

- **R. de la Cruz**, *The effects of intrinsic noise on the behaviour of bistable cell regulatory systems under quasi-steady state conditions*. Poster communication: 2nd Annual Conference of the Imperial SIAM student chapter. Imperial College London, June 2016.

• **N. Folguera**, Poster exhibition: *Mathematical modelling of oncometabolic reprogramming of somatic cells*) and attendance to the Opening Workshop within the scientific programme "Stochastic Dynamical Systems in Biology: Numerical Methods and Applications." 18^{th} to 22^{nd}, January 2016. Isaac Newton Institute (INI) for Mathematical Sciences, Cambridge (UK).

• **N. Folguera**, Poster exhibition: *Robustness of bistable gene regulatory circuits under epigenetic regulation: noise-enabled bifurcations in optimal transition path theory*) and attendance to the Workshop Multiscale Methods for Stochastic Dynamical Systems in Biology, within the scientific programme "Stochastic Dynamical Systems in Biology: Numerical Methods and Applications." February 29^{th} to March 4^{th}, 2016. International Centre for Mathematical Sciences (ICMS), Edinburgh (UK).

• **N. Folguera**, *Robustness of epigenetic states: the roles of oncometabolic transformation and aging* at the II BGSMath Junior Meeting. May 13^{th}, 2016. Institut d'Estudis Catalans (IEC), Barcelona (Spain).

• **N. Folguera**, Poster exhibition. MURPHYS-HSFS 2016 Workshop. June 13^{th} to 17^{th}, 2016. Centre de Recerca Matemàtica (CRM).

• **N. Folguera**, Invited talk within the Minisymposia: *Towards translational pharmacology: the fair share of mathematical science*. 19th European Conference on Matematics for Industry (ECMI). June 13^{th} to 17^{th}, 2016. Universidad de Santiago de Compostela, Santiago de Compostela (Spain).

• **N. Folguera**, Poster exhibition *Robustness of bistable gene regulatory circuits under epigenetic regulation* and attendance to the 10th European Conference on Mathematical and Theoretical Biology and SMB Annual Meeting. July 11^{th} to 15^{th}, 2016. University of Nottingham, Nottingham (UK).

• **V. Navas**, *Avalanches in the Random Field Ising Mode*. BGSMath II Junior Meeting. Barcelona (2016).

• **V. Navas**, *Avalanches in deformation-driven compression of porous glasse*. Summer School in Complex Systems GEFENOL. Pamplona (2016).

• **V. Navas**, Poster presentation: *Avalanches in strain-driven comrpession of porous glasses*. V Jornades Complexiat.cat. Barcelona (2016).

• **V. Navas**, Poster presentation: *Influence of the aspect ratio and boundary conditions on universal finite-size scaling functions in the athermal metastable twodimensional random field Ising mode*. 26th StatPhys. Lyon (2016).

• **V. Navas**, Poster presentation: *Avalanches and force drops in displacement-driven compression of porous glasses*. Conference on Hysteresis, Avalanches and Interfaces in Solid Phase Transformation. University of Oxford. Oxford (2016).

• **A. Nurtay**, European Conference on Mathematical and Theoretical Biology/ SMB annual conference, Nottingham, United Kingdom (Poster presentation), July, 11^{th} to 15^{th}, 2016.

• **A. Nurtay**, Workshop MURPHYS-HSFS-2016, Barcelona, Spain (A presentation followed by a panel discussion), June 13^{th} to 13^{th}, 2016.

• **A. Nurtay**, V Jornades Complexitat.cat, Barcelona, Spain (Poster presentation), May 19^{th}, 2016.

• **A. Nurtay**, II Junior Meeting BGSMath, Barcelona, Spain (Individual report), May 13^{th}, 2013.

• **H. Ribera** and T. G. Myers, *Mathematical modelling of nanoparticle evolution: Phase change and the Kirkendall effect*. Nanomath 2016. CEMES-CNRS (France). June 2016.

• **H. Ribera** and T. G. Myers, *A model for nanoparticle melting with a Newton cooling condition and size-dependent latent heat*. ECMI 2016. University of Santiago de Compostela (Spain). June 2016.

• **G. Prat**, Poster: *Attractor models of perceptual decision making exhibit a resonant performance for non-zero noise level*. FENS, Copenhagen, Denmark.

• **B. Rovira**, *Basins of attraction in neural networks: A computational study*. ETIC 4th Doctoral Student Workshop, March 11^{th}, 2016. Poster presentation.

• **B. Rovira**, *Basins of attraction in neural networks: A computational study*. International Conference on Mathematical NeuroScience (ICMNS) 2016, May 30^{th} to June 1^{st}, 2016. Oral presentation, selected in best 30% abstracts of the congress.

• **B. Rovira**, *Basins of attraction in neural networks: A computational study*. Barcelona Computational, Cognitive and Systems Neuroscience (BARCCSYN) 2016, June 16^{th} to 17^{th}, 2016. Poster presentation.

• **M. Vegué**, *Different models of network connectivity can explain "non-random" features of cortical microcircuits*. International Conference on Mathematical Neuroscience, Juan-les-Pins (Antibes). May 30^{th}, to June 1^{st}, 2016.

Seminars

• **A. Debernardi**, *Uniform convergence of sine transforms of general monotone functions*. Seminar talk given at Funktionenräume, Friedrich-Schiller-Universität Jena, Germany, and at Analysis Seminar, Universität Leipzig, Germany.

• **V. Navas**, *Labquakes: Avalanches in compression experiments of porous glasses*. London Mathematical Laboratory (London). September 2016.

• **H. Ribera**, *Applicable Analysis Seminar*. Department of Mathematics, Simon Fraser University (Canada). November 2016.

• **M. Vegué**, *Different models of network connectivity can explain "non-random" features of cortical microcircuits"*. Weekly seminar, Group for Neural Theory, École Normale Supérieure de Paris. May 2016.

Research stays

- Reserch visit at Centrum Wiskunde & Informatica (CWI). May 24^{th} to 27^{th}, 2016. Amsterdam (the Netherlands). (**G. Colldeforns**)
- Reserch visit at Centrum Wiskunde & Informatica (CWI). December 5^{th} to 21^{st}, 2016. Amsterdam (the Netherlands). (**G. Colldeforns**)
- May–July, 2016: Department of Mathematics-University College London (3 months). (**R. de la Cruz**)
- Visiting Research Student. London Mathematical Laboratory (London). Supervised by Dr. Nicholas R. Moloney. (**V. Navas**)
- Six-weeks visiting researcher at the London Mathematical Laboratory (LML) as part of the modelling tasks of my Ph.D. (**V. Navas**)
- Visiting International Research Student. The University of British Columbia (Canada). Supervised by Professor Brian Wetton. (**H. Ribera**)
- Three-month visiting researcher at the Institute of Applied Mathematics (IAM) as part of my Ph.D. working on the nano-Kirkendall effect. (**H. Ribera**)
- Visiting at the group of Tobias Donner, UKE-Hamburg. September 20^{th} to December 20^{th}. (**G. Prat**)
- Visiting PhD student at the group of Srdjan Ostojic, Group for Neural Theory, École Normale Supérieure de Paris, May 1^{st} to July 30^{th}, 2016 (**M. Vegué**)
- Visiting student at the Industrial Mathematics group, Centre de Recerca Matemàtica, October 1^{st} to 31^{st}. (**C. Fanelli**)

Courses attended

- *3rd Barcelona Summer School on Stochastic Analysis*. June 27^{th} to July 1^{st}, 2016. Centre de Recerca Matemàtica (CRM), Barcelona (Spain). (**G. Colldeforns**)
- *Reviewing Core Statistics*. November-December 2016. Centre de Recerca Matemàtica (CRM), Barcelona (Spain). (**G. Colldeforns**)
- *10th European Conference on Mathematical and Theoretical Biology & SMB Meeting* ECMTB2016, July 2016. (**R. de la Cruz**)
- *Curs de Bioinformàtica per a la Recerca Biomèdica*, organised by Unitat d'Estadística i Bioinformàtica (UEB) de la Vall d'Hebron Institut de Recerca (VHIR). Nov 2016. Facultat de Medicina, Hospital Universitari Vall d'Hebrón. (**N. Folguera**)
- *Reviewing Core Statistics*. November-December 2016. Centre de Recerca Matemàtica (CRM), Barcelona. (**N. Folguera**)
- *Workshop ABIGMAP: Avalanches in Biophysics, Geophysics, Materials and Plasmas*. Universidad Carlos III de Madrid (**V. Navas**)

• Graduate Mathematical Modelling in Industry Workshop. The University of British Columbia (Canada). August 2016. (**H. Ribera**)

• II BGSMath Junior Meeting. Barcelona (Spain). May 2016. (**H. Ribera**)

□ Other activities

• Co-tutoring: Marc Marugán (UAB), Internship at CRM, *Hyperbolic heat equation*. (**M. Calvo-Schwarzwälder**)

• Co-tutoring: Ariadna Moreno (IES Alba del Vallès), Treball de Recerca, *Les matemàtiques a nanoescala*. (**M. Calvo-Schwarzwälder**)

• Organizer CAMP Seminar. (**R. de la Cruz**)

• *Solución problema 283*. La Gaceta de la RSME **19** (2016), 594–595, `gaceta.rsme.es/abrir.php?id=1356`. (**R. de la Cruz**)

• Member of the "Comissió de Tercer Cicle", Mathematics Department, Universitat Autònoma Barcelona. (**N. Folguera**)

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

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

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 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.

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

2.4. Thematic networks

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.

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.

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, i des de 2014 compta amb el suport generós de la

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; starting in 2014 these networks receive also

Fundació "la Caixa", dins del programa de recerca en Matemàtica Col·laborativa (vegeu el Capítol 1 d'aquesta memòria).

Les xarxes temàtiques actuals al CRM són les següents:

- Xarxa Temàtica en Neurociència Computacional

La Xarxa de Biologia Computacional es va posat en marxa durant el 2014, amb una conferència inicial celebrada el febrer de 2015.

Les activitats d'aquesta xarxa poden veure's a

the generous support of "la Caixa" Foundation, within the research program on Collaborative Mathematics (see Chapter 1 of this report).

The current list of CRM Thematic Networks is the following:

- *Thematic Network in Computational Neuroscience*

The Thematic Network on Computational Biology started its activity in 2014; the first colloquim of the network was held on February 2015.

The activities of these networks can be checked at

www.crm.cat/en/Research/Networks/Pages/default.aspx

2.5. Investigadors visitants

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 tres tipus diferents:

- Estades de recerca al CRM.
- Estades de recerca en col·laboració.
- Places "Lluís Santaló" per a visitants d'Amèrica llatina (finançada per l'IEC).

El llistat de visitants de 2016 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.

2.5. List of visitors

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

- *Visiting the CRM.*
- *Research in pairs at CRM.*
- *"Lluís Santaló" visiting positions for Latin-American researchers (sponsored by IEC).*

The list of 2016 visitors is the following. This list does not include CRM staff researchers nor visitors whose stay was shorter than eight days.

Dominik Adolf	Rutgers University
Sailaubay Aidana	Al-Farabi Kazakh National University
Zelfira Aigazinova	L.N. Gumilyov Eurasian National University
Gabdolla Akishev	Karaganda State University

Viktor Avrutin	Università degli studi di Urbino
Aigul Badespayeva	L.N. Gumilyov Eurasian National University
John T. Baldwin	University of Illinois
Dmitriy Bilyk	University of Minnesota
Andrii Bondarenko	Norwegian University of Science and Technology
Will Boney	Carnegie Mellon University
Elena Bossolini	Technical University of Denmark
Jean-Luc Bouchot	RWTH Aachen University
Andrew Brooke-Taylor	University of Bristol
Chris Budd	University of Bath
Claudio Buzzi	Universidade Estadual Paulista
Filippo Calderoni	Università degli Studi di Torino
Federico Cantero Morán	Universitat de Barcelona
Tiago de Carvalho	Universidade Estadual Paulista
Juan Andres Castillo Valenzuela	Universidad de Sonora
Albert Cohen	Université Pierre et Marie Curie
Alessandro Colombo	Politecnico di Milano
Matteo Cozzi	Università degli studi di Milano
David Chillingworth	University of Southampton
Joao Carlos da Rocha Medrado	Universidade Federal de Goiás
Kamila da Silva Andrade	Universidade Estadual de Campinas
Paulo Ricardo da Silva	Universidade Estadual Paulista
Feng Dai	University of Alberta
Laura de Carli	Florida International University
Tiago de Carvalho	Universidade Estadual Paulista
Natasha Dobrinen	University of Denver
Manuel Dominguez-Pumar	Universitat Politècnica de Catalunya
Óscar Domínguez	Universidad Complutense de Madrid
Douglas Duarte Novaes	Universidade Estadual de Campinas
Mirna Dzamonja	University of East Anglia
Roderick Edwards	Universitat de Vic
Abdelali El Aroudi	Universitat Rovira i Virgili
Francesc Fité Naya	Universitat Politècnica de Catalunya

Brendan James Florio	Limerick University
Francesc Font Martinez	Limerick University
Matthew Foreman	University of California at Irvine
Sakae Fuchino	Kobe University
Michael Ganzburg	Hampton University
Auzerkhan Gauhar	
Paul Glendinning	University of Manchester
Amiran Gogatishvili	Academy of Sciences of the Czech Republic
Otavio M.L. Gomide	Universidade Estadual de Campinas
Dmitry Gorbachev	Tula State University
Ricard Grèbol Jiménez	Universitat Autonòma de Barcelona
Rami Grossberg	Carnegie Mellon University
Antoni Guillamon Grabolosa	Universitat Politècnica de Catalunya
Duisenbek Gulnur	Al-Farabi Kazakh National University
Istvan Gyongy	University of Edinburgh
Bin Han	University of Alberta
Makoto Hayashi	Nihon University
Kaitlin Hill	Northwestern University
Olga V. Holtz	University of California at Berkeley
Tapani Hyttinen	University of Helsinki
Daisuke Ikegami	University of California at Berkeley
Valerii Ivanov	Tula State University
Monday Iyamu	
Mike Jeffrey	Bristol University
Ainur Jumabayeva	L.N. Gumilyov Eurasian National University
Georgios Kafanas	University of Bristol
Asaf Karagila	The Hebrew University of Jerusalem
Juliette Kennedy	University of Helsinki
Thimjo Koca	Universitat Autònoma de Barcelona
Menachem Kojman	Ben-Gurion University of the Negev
Yurii Kolomoitsev	Institute of Mathematics of NAS of Ukraine
Ainur Kuspakova	Al-Farabi Kazakh National University
Jean A. Larson	University of Florida

Dany Leviatan	Tel Aviv University
Elijah Liflyand	Bar-Ilan University
Victor Lozovanu	Università degli studi di Milano
Robert Lubarsky	Florida Atlantic University
Jaume Llibre	Universitat Autònoma de Barcelona
Gulzhaina Madibekova	Al-Farabi Kazakh National University
Menachem Magidor	The Hebrew University of Jerusalem
Bayan Mambetova	Al-Farabi Kazakh National University
Tere Martínez-Seara	Universitat Politècnica de Catalunya
Marc Marugán Camí	Universitat Autonòma de Barcelona
Javad Mashreghi	Université Laval
David Masip Bonet	Universitat Autonòma de Barcelona
Adrian Mathias	Université de La Réunion
Svitlana Mayboroda	University of Minnesota
Askerbay Meruyert	Al-Farabi Kazakh National University
Ingrid Meza Sarmiento	Universidade de São Paulo
Ricardo Miranda	Martins Unicamp
William Mitchell	University of Florida
Michael P. Mortell	University College Cork
Askhat Mukanov	L.N. Gumilyov Eurasian National University
Víctor Navas Portella	Universitat de Barcelona
Nikolay Nefedov	Moscow State University
Yerlan Nursultanov	L.N. Gumilyov Eurasian National University
Gary O'keeffe	Limerick University
Alexander Olevskii	Tel Aviv University
Gerard Olivar Tost	Universidad Nacional de Colombia
Josep M. Olm	Universitat Politècnica de Catalunya
Silvia Pagliarini	Università degli Studi di Verona
Francesc Perera Domènech	Universitat Autonòma de Barcelona
Clara Peset	Universitat Autonòma de Barcelona
Jill Pipher	Brown University
Sofia Helena Piltz	Oxford Centre for Industrial and Applied Mathem.
Thibaut Putelat	Laboratoire de Mécanique des Solides, E. Polytech.

Andrew Roberts	Cornell University
Jirí Rosický	Jirí Rosický
Daniel Salgado Rojo	Universitat Autonòma de Barcelona
Tomás Sanz Perela	Universitat Politècnica de Catalunya
Galiya Sarsembayeva	L.N. Gumilyov Eurasian National University
Ralf Schindler	University of Münster
Andreas Seeger	University of Wisconsin - Madison
Toktassyn Serzhan	Al-Farabi Kazakh National University
Alexei Shadrin	University of Cambridge
Elena Shchepakina	Samara State Aerospace University
David Simpson	Massey University
Serhii Stasiuk	National Academy of Sciences of Ukraine
Eoghan Staunton	National University of Ireland Galway
Alexander Stokolos	Georgia Southern University
Ioannis Souldatos	University of Detroit Mercy
Vladimir Temlyakov	University of South Carolina
Marco Antonio Teixeira	Universidade Estadual de Campinas
Sergey Thikonov	ICREA-CRM
Michael Thoreau Lacey	Georgia Institute of Technology
J. Tomás Lázaro	Universitat Politècnica de Catalunya
Stevo Todorcevic	University of Toronto
Zhibek Uassilova	Al-Farabi Kazakh National University
Olena Usoltseva	Taras Shevchenko National Univercity of Kyiv
Vadim Utkin	The Ohio State University
Jouko Väänänen	University of Helsinki
Paul Antonio Valle Trujillo	CITEDI-IPN
Monica van Dieren	Stanford University
Boban Velickovic	Université Paris Diderot-Paris 7
Andrés Villaveces	Universidad Nacional de Colombia
Simon Webber	University of Bristol
Aizhan Ydyrys	L.N. Gumilyov Eurasian National University
Martin Zeman	University of California at Irvine
Meruyert Zhanyspayeva	L.N. Gumilyov Eurasian National University

En total, el CRM ha hostatjat 373 mesos d'estada d'investigadors al llarg de l'any 2016.

2.6. La formació en recerca

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 2016.

2.6.1. La Unitat de Formació Doctoral

El CRM ofereix la possibilitat a estudiants graduats de participar en un projecte de tesi doctoral dins d'un grup de recerca o d'una xarxa temàtica del CRM. Els estudiants de doctorat del CRM s'inscriuen a la Unitat de Formació Doctoral del CRM (UFD-CRM). Cal que compleixin els requisits necessaris per ser admesos en un programa de doctorat en matemàtiques de les universitats catalanes i queden automàticament inscrits a la Barcelona Graduate School of Mathematics. La UFD està coordinada actualment per Álvaro Corral, amb el suport de l'equip de direcció del CRM.

La UFD compta amb un programa d'activitats que consisteixen en:

- Un cicle de cursos de perfeccionament impartits per investigadors i/o col·laboradors de les xarxes temàtiques del CRM. Aquests cursos s'integren dins de la Barcelona Graduate School of Mathematics, i, per tant, queden a disposició de tots els estudiants de doctorat de l'àrea de Barcelona. Els temes d'aquests cursos seran d'interès general per a tots els estudiants.

- Un seminari juvenil organitzat pels estudiants sobre una base mensual i amb la participació només de joves investigadors (estudiants de doctorat i postdoctorats).

Summing up, the CRM has hosted 373 months of stays of researchers during 2016.

2.6. Research training

There are three training levels at CRM: undergraduate and masters, doctoral and post-doctoral. 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 2016.

2.6.1. The Doctoral Training Unit

The CRM offers the possibility for graduate students to engage in a PhD Dissertation project within a research group or thematic network of CRM. Doctoral students of CRM are enrolled in the CRM-Doctoral Training Unit (UFD-CRM). They are required to fulfill the requisites to be admitted to a doctoral programme in Mathematics in a Catalan university and they become automatically enrolled in the Barcelona Graduate School of Mathematics. The UFD is currently co-ordinated by Álvaro Corral with the support of the CRM direction team.

The UFD has a programme of activities consisting of:

- *A cycle of advanced courses given by CRM researchers and/or collaborators from the thematic networks. These courses will be integrated within the Barcelona Graduate School of Mathematics, and thus made available to all the PhD students of the Barcelona area. The subjects of these courses will be of general interest for all students.*

- *A junior seminar organised by the students on a monthly basis and attended only by junior researchers (PhD students and postdocs).*

- Un taller anual on els estudiants presentaran informes sobre l'estat actual de les seves tesis.

- *An annual workshop where students will present reports of the current state of their theses.*

El estudiants de doctorat del CRM es financien a través de diferents fonts: beques competitives de la Generalitat de Catalunya (FI) o ministeris espanyols (FPI, FPU), beques del programa "la Caixa"-CRM d'investigació en matemàtica col·laborativa, beques finançades pel CRM i altres. Els estudiants de doctorat associats al CRM durant l'any 2016 han estat els següents (a la secció 2.2.4 trobareu informació detallada sobre la feina desenvolupada):

CRM PhD students are funded from different sources: competitive grants of the Generalitat de Catalunya (FI) or Spanish Ministeries (FPI, FPU), grants from the "la Caixa"-CRM program collaborative research, CRM-funded grants and others. PhD students associated to the CRM during this year (detailed information on their research can be found in section 2.2.4):

Elisa Beltrán is working on her PhD thesis, supervised by Tomás Alarcón since October 2014. Funded by Spany Minestry.

Marc Calvo is working on his PhD thesis, supervised by Tim Myers since December 2015. Funded by "la Caixa"-CRM.

Gemma Colldeforns is working on her PhD thesis, supervised by Luis Ortiz since September 2014. Funded by "la Caixa"-CRM.

Enric Costa is working on his PhD thesis, supervised by Tomás Alarcón since November 2014. Funded by CRM program.

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

Alberto Debernardi is working on his PhD thesis, supervised by Sergey Tikhonov since January 2014. Funded by CRM program.

Núria Folguera is working on her PhD thesis, supervised by Tomás Alarcón since November 2014. Funded by "la Caixa"-CRM.

Víctor Navas is working on his PhD thesis, supervised by Álvaro Corral since December 2015. Funded by "la Caixa"-CR.

Anel Nurtay is working on her PhD thesis, supervised by Andrei Korobeinikov since March 2015. Funded by "la Caixa"-CRM.

Genís Prat is working on his PhD thesis, supervised by Alexander Roxin since September 2014. Funded by "la Caixa"-CRM.

Helena Ribera is working on her PhD thesis, supervised by Tim Myers since October 2014. Funded by "la Caixa"-CRM.

Bernat Rovira is working on his PhD thesis, supervised by Alex Roxin since January 2014. Funded by FPI scholarship.

Marina Vegué is working on her PhD thesis, supervised by Alexander Roxin since November 2013. Funded by "la Caixa"-Becas España.

2.6.2. Curs de màster

El Màster de Matemàtiques per als Instruments Financers es va impartir per divuitena vegada el 2016 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 avaluació i control de riscos.

El màster està estructurat en tres etapes: dues de teòriques (cadascuna amb 120 hores de docència) i una tercera etapa pràctica en una empresa de finances. La responsabilitat del màster recau en una Comissió Acadèmica i un Comitè Executiu. L'any 2016 han acabat el màster 20 alumnes.

2.6.2. Master's Course

The CRM master's course on Financial Mathematics was held for the eighteenth time in 2016 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 2016 a total of 20 students completed the master's course.

2.6.3. Estades d'iniciació a la recerca

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 2016, un total de 15 estudiants van participar en aquest programa:

2.6.3. Internships for initiation to research

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 2016, 15 students visited the CRM within this program:

- Irina Espejo (Sistemes Complexos/Complex Systems)
- Jordina Francès (Neurociència Computacional/*Computational Neuroscience*)
- Antonio Lozano (Matemàtica Financera i Control de Riscos/Financial Mathematics and Risk Control)
- Carles Riera (Matemàtica Industrial/Industrial Mathematics)
- Jermy Williams (Matemàtica Financera i Control de Riscos/Financial Mathematics and Risk Control)
- Silvia Pagliarini (Epidemiologia Matemàtica/Mathematical Epidemiology)
- Juan Borrego (Matemàtica Industrial/Industrial Mathematics)
- Clara Peset (Neurociència Computacional/*Computational Neuroscience*)
- Alfonso Martínez (Neurociència Computacional/*Computational Neuroscience*)
- Marc Marugán (Matemàtica Industrial/Industrial Mathematics)
- Thimjo Koca (Neurociència Computacional/*Computational Neuroscience*)
- David Masip (Epidemiologia Matemàtica/Mathematical Epidemiology)
- Daniel Salgado (Matemàtica Industrial/Industrial Mathematics)
- Ricard Grèbol (Matemàtica Industrial/Industrial Mathematics)
- Curial Gallart (Matemàtica Industrial/Industrial Mathematics)

3

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 corresponent de la web del CRM, actualment a *Visitors& Events > Scientific Events*.

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

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

Applications can be formulated by following the guidelines given in the Visitors& Events > Scientific Events section of the CRM website.

`http://www.crm.cat/ca/Activities/Pagines/CallsForActivities.aspx`

El CRM també organitza *activitats divulgatives* i *seminaris de recerca*.

The CRM also organises Dissemination Activities and Research Seminars.

3.1. Programes de recerca

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

3.1. Research Programmes

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

Els programes de recerca del CRM duren, normalment, entre dos i cinc mesos. S'estructuren en dos vessants: els investigadors visitants i les activitats programades. Cada programa té un comitè científic responsable de planificar les activitats incloses en el programa, elaborar la llista dels investigadors visitants i lliurar un informe final. Típicament, en un programa hi participen investigadors locals a temps complet, investigadors visitants a temps complet, 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.

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 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.

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 2016. La informació general sobre els programes de recerca es pot trobar a

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 2016 are described below. General information of Research Programmes can be found at

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

3.1.1. CRM Research Programme on Nonsmooth Dynamics

February to April, 2016

Organizing Committee	Mike Jeffrey	University of Bristol
	Alessandro Colombo	Politecnico di Milano
	J. Tomás Lázaro	Universitat Politècnica de Catalunya
	Josep M. Olm	Universitat Politècnica de Catalunya
Scientific Committee	Bernard Brogliato	INRIA Grenoble
	Jaume Llibre Saló	Universitat Autonòma de Barcelona
	Tere Martínez-Seara	Universitat Politècnica de Catalunya
	Gerard Olivar Tost	Universidad Nacional de Colombia
	Petri Piiroinen	National University of Ireland Galway

Enrique Ponce Núñez	Universidad de Sevilla
Marco Antonio Teixeira	Universidade Estadual de Campinas
Nathan van de Wouw	Technische Universiteit Eindhoven

Summary

This program will take stock of recent advances in Nonsmooth Dynamics and where the field is going. As a general theory of how switches, impacts, and other discontinuities affect dynamical systems, Nonsmooth Dynamics has always been strongly informed by applications. By bringing theoretical and practical insights together at a time of rapidly growing interest, we will try to solve some major outstanding problems in an intensive but open forum.

The Foundations theme will discuss fundamental theory, from its basic assumptions, to breakthroughs in bifurcation theory and novel behaviour at singularities. Particular attention will be paid to how these impact existing and future numerical methods, focussing on the open challenges in developing a theory of nonsmooth dynamics that is fully relevant to real world systems.

The New Directions theme we will bring together many applications and models, solving specific problems and at the same time seeking common methods and ideas. We will ask how nonsmooth dynamics can best contribute to forming new and better models of real world dynamics. There will be no restriction on the applications of interest, but they will certainly include climate, economics, life sciences, networks, chemical reactions, mechanics of rigid bodies, and control electronics.

All program information can be found at:
`http://www.crm.cat/en/Activities/Curs_2015-2016/Pages/Advances-in-Nonsmoothe-Dynamics.aspx`

Visiting Researchers

Kamila da Silva Andrade (Universidade Estadual de Campinas), Viktor Avrutin (Universität Stuttgart), Victoria Booth (University of Michigan), Elena Bossolini (Technical University of Denmark), Chris Budd (University of Bath), Claudio Buzzi (Universidade Estadual Paulista), Juan Andres Castillo (Universidad de Sonora), Alan Champneys (University of Bristol), David Chillingworth (University of Southampton), Alessandro Colombo (Politecnico di Milano), Joao Carlos Da Rocha Medrado (Universidade Federal de Goiás), Paulo Ricardo da Silva (Universidade Estadual Paulista), Tiago de Carvalho (Universidade Estadual Paulista), Gianne Derks (University of Surrey), Manuel Dominguez-Pumar (Universitat Politècnica de Catalunya), Douglas Duarte (Universidade Estadual de Campinas), Roderick Edwards (University of Victoria), Abdelali El Aroudi (Universitat Rovira i Virgili), Cinzia Elia (Università degli Studi di Bari), Paul Glendinning (University of Manchester), Antoni Guillamon (Universitat

Politècnica de Catalunya), Ernst Hairer (Université de Genève), Makoto Hayashi (Nihon University), Kaitlin Hill (Northwestern University), Stephen John Hogan (University of Bristol), Mike Jeffrey (University of Bristol), Georgios Kafanas (University of Bristol), Piotr Kowalczyk (Manchester Metropolitan University), J. Tomàs Lázaro (Universitat Politècnica de Catalunya), Otavio M.L. Gomide (Universidade Estadual de Campinas), Julie Leifeld (University of Minnesota), Grzegorz Litak (Lublin University of Technology), Jaume Llibre (Universitat Autonòma de Barcelona), Tere Martínez-Seara (Universitat Politècnica de Catalunya), Ingrid Meza (Universidade de São Paulo), Ricardo Miranda (Unicamp), Umberto Montanaro (Università degli Studi di Napoli), Arne Nordmark (KTH Mechanics), Gerard Olivar (Universidad Nacional de Colombia), Josep M. Olm (Universitat Politècnica de Catalunya), Petri Piiroinen (National University of Ireland Galway), Sofia Helena Piltz (Oxford Centre for Industrial and Applied Mathem.), Enrique Ponce (Universidad de Sevilla), Thibaut Putelat (Laboratoire de Mécanique des Solides, E. Polytech.), David Simpson (Massey University), Anne Skeldon (University of Surrey), Eoghan Staunton (National University of Ireland Galway), Marco Antonio Teixeira (Universidade Estadual de Campinas), Vadim Utkin (The Ohio State University), Peter Varkonyi (Budapest University of Technology and Economics), Fernando Verduzco (Universidad de Sonora), Simon Webber (University of Bristol), Marian Wiercigroch (University of Aberdeen).

Activities

- **Weekly Seminar**

Speakers

David Simpson, Massey University
Noisy sliding motion and a probabilistic notion of forward evolution through a two-fold
February 11^{th}, 2016

Paul Glendinning, University of Manchester
Less is more: Bifurcations of piecewise smooth systems
February 18^{th}, 2016

Victoria Booth, University of Michigan
Dynamics of sleep-wake regulation
February 25^{th}, 2016

Sofia Helena Piltz, Oxford Centre for Industrial and Applied Mathematics
A piecewise-smooth, two smooth, and a fast-slow system for plankton population dynamics
March 3^{rd}, 2016

Vadim Utkin, The Ohio State University
Comments to solution continuation method by A.F. Filippov
March 10^{th}, 2016

Douglas Novaes, Universidade Estadual de Campinas
Regularization of hidden dynamics
March 17^{th}, 2016

Georgios Kafanas, University of Bristol
Controlling an active filter by nesting of variable structure controller
March 17^{th}, 2016

Jaume Llibre, Universitat Autònoma de Barcelona
Analytic computation of periodic solutions of piecewise differential systems
April 7^{th}, 2016

Marco Antonio Teixeira, Universidade Estadual de Campinas
Integrability of non-smooth dynamical systems
April 21^{th}, 2016

• Conference on "Open Problems in Nonsmooth Dynamics"
February 1^{st} to 5^{th}, 2016
Participants: 79

Speakers

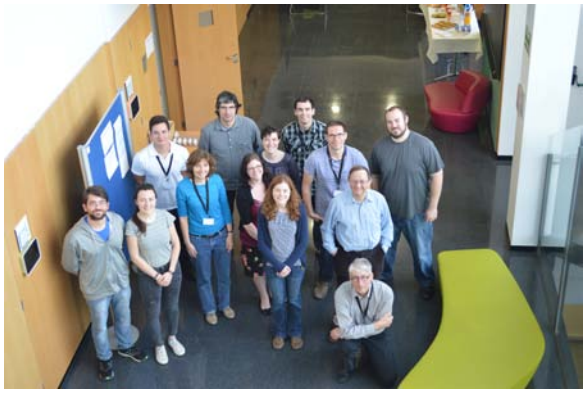
Mate Antali (Budapest University of Technology and Economics), Viktor Avrutin (Universität Stuttgart), Tamás Baranyai (Budapest University of Technology and Economics), Luis Benadero (Universitat Rovira i Virgili), Chris Bick (University of Exeter), Elena Blokhina (University College of Dublin), Carles Bonet (Universitat Politècnica de Catalunya), Elena Bossolini (Technical University of Denmark), Mireille Broucke (University of Toronto), Kanat Camlibel, Murilo Cândido, Alex Carlucci (Universitat Autonòma de Barcelona), Juan Castillo (University of Groningen), Alan Champneys (University of Brist), David Chillingworth (University of Southampton), Alessandro Colombo (Politecnico di Milano), Zoltan Dombóvári (Budapest University of Technology and Economics), Manuel Dominguez-Pumar (Universitat Politècnica de Catalunya), Douglas Duarte (Universidade Estadual de Campinas), Abdelali El Aroudi (Universitat Rovira i Virgili), Vasfi Eldem (Okan University), Christian Camilo Erazo (Università degli Studi di Napoli), Marina Esteban (Universidad de Sevilla), Wilker Fernandes (Universidade de São Paulo), Luiz Fernando, Michael Field (Imperial College London), Davide Fiore (University of Naples Federico II), Laura Gardini (Università degli studi di Urbino), Paul Glendinning (University of Manchester), Albert Granados (Technical University of Denmark), Toni Guillamon (Universitat Politècnica de Catalunya), Peter Harte (University College Dublin), John Hogan (University of Bristol), Gemma Huguet (Universitat Politècnica de Catalunya),

Luigi Iannelli (University of Sannio in Benevento), Mike R. Jeffrey (University of Bristol), Jun Jiang (State Key Lab. for Strength and Vibration), Georgios Kafanas (University of Bristol), Gabriella Keszthelyi (Eötvös Loránd University), Kristian Uldall Krsitiansen (Technical University of Denmark), Alex Küronya (Frankfurt University), Rachel Kuske (The University of British Columbia), Claude Lacoursière (Umea University), J. Tomàs Lázaro (Universitat Politècnica de Catalunya), Julie Leifeld (University of Minnesota), Tere Martínez-Seara (Universitat Politècnica de Catalunya), Ricardo Miranda (Unicamp), Tamás G. Molnar (Budapest University of Technology and Economics), Karin Mora (University of Paderborn), Ehud Moshe (Bar-Ilan University), Gerard Olivar (Universidad Nacional de Colombia), Josep M. Olm (Universitat Politècnica de Catalunya), Yizhar Or (echnion Israel Institute of Technology), Chara Pantazi (Universitat Politècnica de Catalunya), Leonardo Pereira Costa, Petri Piiroinen (National University of Ireland Galway), António Pinto (Técnico Lisboa), Camille Poignard (Inria Biocore), Enrique Ponce (Universidad de Sevilla), Rafel Prohens (Universitat de les Illes Balears), Thibaut Putelat (Laboratoire de Mécanique des Solides, E. Polytech.), Wilker T. Resende Fernandes, Si Mohamed Sah (Royal Institute of Technology KTH), Gökhan Sahan (Izmir Institute of Technology), David Simpson (Massey University), Sarah Spurgeon (University of Kent), Eoghan Staunton (National University of Ireland Galway), Gábor Stépán (Budapest University of Technology and Economics), Pascal Stiefenhofer, Iryna Sushko (National Academy of Sciences of Ukraine), Antonio E. Teruel (Universitat de les Illes Balears), J. Tomás Lázaro (Universitat Politècnica de Catalunya), Joan Torregrosa (Universitat Autonòma de Barcelona), Francisco Torres (Universidad de Sevilla), Peter Varkonyi (Budapest University of Technology and Economics), Zsolt Verasztó (Budapest University of Technology and Economics), Catalina Vich (Universitat de les Illes Balears), Simon Webber (University of Bristol), Marian Wiercigroch (University of Aberdeen).

• **Climate Modeling Workshop**
March 30^{th} *to April* 1^{st}, 2016
Participants: 22

Speakers

Chris Budd (University of Bath), Paul Glendinning (University of Manchester), Kaitlin Hill (Northwestern University), Rachel Kuske (The University of British Columbia), Julie Leifeld (University of Minnesota), Courtney Quinn (University of Exeter), Andrew Roberts (Cornell University).



• **Advanced Course on "Piecewise Smooth Dynamical Systems"**
April 11^{th} *to* 15^{th}, 2016
Participants: 30

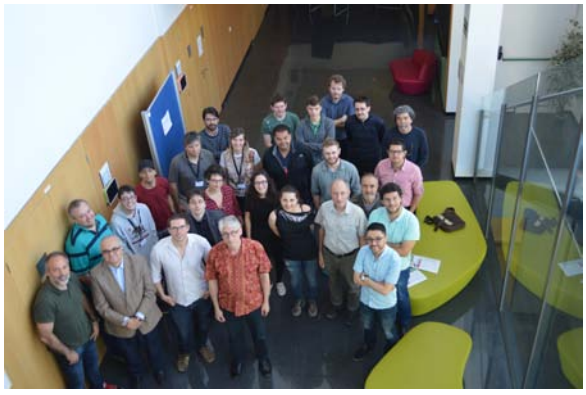
Lecturers

Mike Jeffrey, University of Bristol
Introduction to the dynamics of piecewise smooth flows.

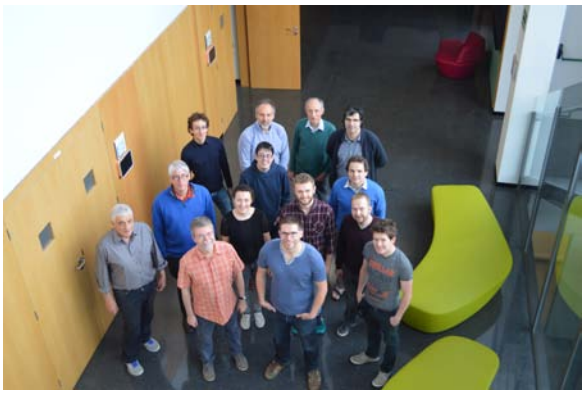
Paul Glendinning, University of Manchester
Introduction to the dynamics of piecewise smooth maps.

Contributed

Abdelali El Aroudi (Universitat Rovira i Virgili), Jaume Llibre (Universitat Autònoma de Barcelona), Gerard Olivar (Universidad Nacional de Colombia), Enrique Ponce (Universidad de Sevilla).



• **Summary Session on "Nonsmooth Dynamics, the way forward"**
April 25^{th} *to* 29^{th}, 2016
Participants: 14



3.1.2. CRM Research Programme on Constructive Approximation and Harmonic Analysis

March to July, 2016

Coordinators	Dmitriy Bilyk, University of Minnesota
	Feng Dai, University of Alberta
	Vladimir Temlyakov, University of South Carolina
	Sergey Tikhonov, ICREA-CRM
Scientific Committee	Konstantin Dyakonov, ICREA-Universitat de Barcelona
	Alex Iosevich, University of Rochester
	Christoph Thiele, Universität Bonn

Summary

This research program focuses on the interaction between constructive approximation and harmonic analysis. The aim is to facilitate broader and deeper interaction among researchers in these fields.

Approximation theory seeks to approximate complicated functions by simpler functions from certain classes and to evaluate the errors inevitably arising in such approximations. This field draws its methods from various areas of mathematics such as functional analysis, variational analysis, probability etc. Constructive approximation strives to explicitly find the best (or nearly best) approximants in such problems which is of tremendous importance in numerous applications.

Harmonic analysis is a very old branch of mathematics which investigates the behavior of functions using their time and frequency features as well as various (orthogonal) decompositions. Despite a long history, this field is very vital today with numerous open problems and active research areas, such as weighted inequalities, time-frequency analysis, multilineal analysis, singular integrals on rectifiable sets and many others. Harmonic analysis reveals exciting connections to other branches of mathematics, such as geometric measure theory, complex analysis, convex and discrete geometry.

Among all these relations, a very special place is taken by the link between harmonic analysis and approximation theory (this interplay is well known: trigonometric polynomials, wavelets, frames, other (quasi) orthogoAnal systems, hyperbolic cross approximations play an important role in approximation and are a subject of active ongoing research).

All program information can be found at:
`http://www.crm.cat/en/Activities/Curs_2015-2016/Pages/IRP-Approximation-and-Harmonic-Analysis.aspx`

Visiting Researchers

Javad Abdalkhani (The Ohio State University), Zelfira Aigazinova (L.N. Gumilyov Eurasian National University), Ramazan Akgün (Balikesir University), Gabdolla Akishev (Karaganda State University), Murat Akman (Instituto de Ciencias Matemáticas), Rauan Akylzhanov (University of Stavanger), Chiara Alba (Imperial College London), Jonas Azzam (Universitat Autonòma de Barcelona), Aigul Badespayeva (L.N. Gumilyov Eurasian National University), Biswaranjan Behera (Indian Statistical Institute Kolkata), Pablo Manuel Berná (Universidad de Murcia), Dmitriy Bilyk (University of Minnesota), Andrii Bondarenko (Norwegian University of Science and Technology), Barry Booton (Florida Atlantic University), Nattapong Bosuwan (Mahidol University), Jean-Luc Bouchot (RWTH Aachen University), Martin Buhmann (Justus-Liebig Universität Giessen), Glenn Byrenheid (Universität Bonn), Petr Chunaev (Universitat Autonòma de Barcelona), Albert Cohen (Université Pierre et Marie Curie), José Manuel Conde (Consejo Superior de Investigaciones Científicas), Galia Dafni (Concordia University), Wolfgang Anton Dahmen (RWTH Aachen University), Feng Dai (University of Alberta), Pei Dang (University of Macau), Laura De Carli (Florida International University), Alberto Debernardi (Centre de Recerca Matemàtica), Ronald DeVore (Texas A&M University), Francesco DiPlinio (Francesco Di Plinio), Óscar Domínguez (Universidad Complutense de Madrid), Borislav Draganov (Institute of Mathematics and Informatics), Douadi Drihem (Université Mohamed BOUDIAF – M'Sila), Karol Dziedziul (Gdansk University of Technology), Diogo Oliveira e Silva (Hausdorff Center for Mathematics), Michela Egidi (Technische Universität Chemnitz), Yuri Farkov (Russian Prd. Acad. of Ntl. Economy and Public Adm.), Han Feng (University of Alberta), Veronique Fischer (University of Bath), Jean-Pierre Gabardo

(McMaster University), Michael Ganzburg (Hampton University), Ji Gao (Community College of Philadelphia), Gustavo Garrigos (Universidad de Murcia), Amiran Gogatishvili (Academy of Sciences of the Czech Republic), Alexander Goncharov (Bilkent University), Dmitry Gorbachev (Tula State University), Stepan Grigoriev (Florida International University), Shaoming Guo (Indiana University), Bin Han (University of Alberta), Deguang Han (University of Central Florida), Eugenio Hernández (Universidad Autónoma de Madrid), Aicke Hinrichs (Johannes Kepler Universität Linz), Olga V. Holtz (University of California at Berkeley), Alexander Iosevich (University of Rochester), Daniyal Israfilov (Balikesir University), Valerii Ivanov (Tula State University), Christopher Kacwin, Dmitrii Karp (Far Eastern Federal University), Van Kien (Friedrich-Schiller Universität Jena), Yurii Kolomoitsev (Institute of Mathematics of NAS of Ukraine), Martin Krepela (Karlstad University), Thomas Kühn (Universität Leipzig), Dany Leviatan (Tel Aviv University), Eli Levin (The Open University of Israel), Elijah Liflyand (Bar-Ilan University), Entao Liu (Georgia Institute of Technology), Itay Londner (Tel Aviv University), Nesibe Manav (Gazi Üniversitesi), Joaquim Martin (Universitat Autonòma de Barcelona), Andrei Martínez (Universidad de Almeria), Jordi Marzo (Norwegian University of Science and Technology), Javad Mashreghi (Université Laval), Svitlana Mayboroda (University of Minnesota), Sebastian Mayer (Universität Bonn), Michael Lacey (Georgia Institute of Technology), Carolina Mosquera (Universidad de Buenos Aires), Mihalis Mourgoglou (Universitat Autonòma de Barcelona), Marvin Mueller (Universität Trier), Askhat Mukanov (L.N. Gumilyov Eurasian National University), Selma Negzaoui (University of Monastir), Artur Nicolau (Universitat Autonòma de Barcelona), Yerlan Nursultanov (L.N. Gumilyov Eurasian National University), Timur Oikhberg (University of Illinois), Alexander Olevskii, (Tel Aviv University), Walter Andrés Ortiz (Universitat Autonòma de Barcelona), Ioannis Parissis (Universidad del País Vasco), Isaac Pesenson (Temple University-CCP), Jill Pipher (Brown University), Stamatis Pouliasis (Sabanci University), Malabika Pramanik (The University of British Columbia), Laura Prat (Universitat Autonòma de Barcelona), Andriy Prymak (University of Manitoba), Carmelo Puliatti (Università degli studi di Padova), Pablo Quijano (Universidad Nacional del Litoral), Senthil Raani (Indian Institute of Science, Education & Research), Hermann Render (University College Dublin), Fulvio Ricci (Scuola Normale Superiore di Pisa), Aleksandr Rotkevich (St. Petersburg State University), Eduard Roure (Universitat de Barcelona), Olli Saari (Aalto University), Deividas Sabonis (Technische Universität München), Galiya Sarsembayeva (L.N. Gumilyov Eurasian National University), Hans-Jürgen Schmeisser (Friedrich-Schiller Universität Jena), Daniel Seco (Universitat de Barcelona), Andreas Seeger (University of Wisconsin - Madison), Alexei Shadrin (University of Cambridge), Winfred Sickel (Friedrich-Schiller Universität Jena), Ilona Simon (University of Pécs), Birendra Singh (Indian Institute of Technology Roorkee), Scott Spencer (Georgia Institute of Technology), Serhii Stasiuk (National Academy of Sciences of Ukraine), Vladimir Stepanov

(Peoples Frienship University of Russia), Alex Stokolos (Georgia Southern University), Vladimir Temlyakov (University of South Carolina), Michael Thoreau (Georgia Institute of Technology), Sergey Tikhonov (Centre de Recerca Matemàtica), Xavier Tolsa (Universitat Autonòma de Barcelona), Hans Triebel (Friedrich-Schiller Universität Jena), Mario Ullrich (Johannes Kepler Universität Linz), Tino Ullrich (Universität Bonn), Ignacio Uriarte (Michigan State University), Andre Uschmajew (Universität Bonn), Olena Usoltseva (Taras Shevchenko National University of Kyiv), Joan Verdera (Universitat Autonòma de Barcelona), Pablo Vinuesa (University of Bath), Yitzhak Weit (University of Haifa), Jochen Wengenroth, (Universität Trier), Aizhan Ydyrys (L.N. Gumilyov Eurasian National University), Wenrui Ye (University of Alberta), Hong Yue (Georgia College), Sule Yüksel (Gazi Üniversitesi), Meruyert Zhanyspayeva (L.N. Gumilyov Eurasian National University).

Activities

• Weekly Seminar

Speakers

Valeriy Ivanov, Tula State University
Basic inequalities in approximation theory and Dunkl transforms
May 27^{th}, 2016

Andrey Bondarenko, NTNU
Extreme values of the Riemann zeta function
May 20^{th}, 2016

Alexei Shandrin, University of Cambridge
Markov-type inequalities and their applications
May 26^{th}, 2016

• Workshop on Function Spaces and High-dimensional Approximation

May 2^{nd} to 6^{th}, 2016
Participants: 37

Speakers

Pablo M. Berná (Polytechnic University of Valencia), Dmitriy Bilyk (University of Minnesota), Martin Buhmann (Justus-Liebeg University), Glenn Byrenheid (Hausdorff Center for Mathematics), Laura De Carli (Florida International University), Feng Dai (University of Alberta), Victor Didenko (Universiti Brunei Darussalam), Oscar Domínguez (Universidad Complutense de Madrid), Christopher Kacwin (Hausdorff Center for Mathematics), Thomas Kühn (Universität Leipzig), Svitlana Mayboroda (University of Minnesota), Sebastian Mayer (Hausdorff Center for Mathematics), Erlan Nursultanov (Eurasian

University), Diogo Oliveira e Silva (Mathematical Institute of the University of Bonn), Hans-Jürgen Schmeisser (Friedrich-Schiller Universität Jena), Winfried Sickel (Friedrich-Schiller Universität Jena), Serhii Stasyuk (Institute of Mathematics, Kyiv), Vladimir Temlyakov (University of South Carolina), Sergey Tikhonov (Centre de Recerca Matemàtica), Hans Triebel (Friedrich-Schiller Universität Jena), Tino Ullrich (Hausdorff Center for Mathematics), André Uschmajew (Hausdorff Center for Mathematics),

- **Advanced Course by Jill Pipher**

May 9^{th} *to* 11^{th}*, 2016*
Participants: 20

Lecturer

Jill Pipher, Brown University
Multi-parameter Fourier analysis

- **Advanced Course on Constructive Approximation and Harmonic Analysis**

May 30^{th} *to June* 4^{th}*, 2016*
Participants: 56

Lecturers

Albert Cohen, Université Pierre et Marie Curie, France
High dimensional polynomial approximation of PDEs

Wolfgang Dahmen, RWTH Aachen, Germany
Greedy algorithms for selection of reduced bases and tensor approximation in high dimensions

Ron DeVore, Texas A&M University
Overview of high dimensional approximation, optimal recovery, and data assimilation

Andreas Seeger, University of Wisconsin-Madison
Singular integral forms and a problem on mixing flows

Vladimir Temlyakov, University of South-Carolina
Hyperbolic cross approximation

Tino Ullrich, Bonn University
Hyperbolic cross approximation

• Conference on Harmonic Analysis and Approximation Theory (HAAT 2016)
June 6^{th} *to* 10^{th}, 2016
Participants: 84

Speakers

Albert Cohen (Université Pierre et Marie Curie), Bin Han (University of Alberta), Alexander Iosevich (University of Rochester), Michael Lacey (Georgia Institute of Technology), Alexander Olevskii (Tel Aviv University), Jill Pipher (Brown University), Malabika Pramanik (The University of British Columbia), Fulvio Ricci (Scuola Normale Superiore di Pisa), Andreas Seeger (University of Wisconsin-Madison).

Contributed

Javad Abdalkhani (The Ohio State University), Mamoon Ahmed, Mura Akman, Biswaranjan Behera (Indian Statistical Institute Kolkata), Jean-Luc Bouchot (RWTH Aachen University), Petr Chunaev (Universitat Autonòma de Barcelona), Borislav R. Draganov (Institute of Mathematics and Informatics), Karol Dziedziul (Gdansk University of Technology), Yuri A. Farkov (Russian Prd. Acad. of Ntl. Economy & Public Adm.), Han Feng (University of Alberta), Veronique Fisher (Imperial College London), Jean-Pierre Gabardo (McMaster University), Michael I. Ganzburg (Hampton University), Ji Gao (Community College of Philadelphia), Alexander Goncharov (Bilkent University), Deguang Han (University of Alberta), Daniyal M. Israfilov (Balikesir University), Dimitrii Karp (Far Eastern Federal University), Yuri Kolomoitsev (Institute of Mathematics of NAS of Ukraine), András Kroo, Entau Liu (Georgia Institute of Technology), Itay Londner (Tel Aviv University), Jordi Marzo (Norwegian University of Science and Technology), Javad Mashreghi (Université Laval),

Askhat Mukanov (L.N. Gumilyov Eurasian National University), Selma Negzaoui (University of Monastir), Isaac Pesenson (Temple University-CCP), Stamatis Pouliasis (Sabanci University), Andriy Prymak (University of Manitoba), Senthil Raani (Indian Institute of Science, Education & Research), Hermann Render (University College Dublin), Aleksandr Rotkevich (St. Petersburg State University), Guitta Sabiini, Pravati Sahoo, Daniel Seco (Universitat Autonòma de Barcelona), Alexey Shadrin (University of Cambridge), Ilona Simon (University of Pécs), Alex Stokolos (Georgia Southern University), Olena Usoltseva (Taras Shevchenko National University of Kyiv), Jochen Wengenroth (Universität Trier), Hong Yue (Georgia College).

3.1.3. CRM Research Programme on Large Cardinals and Strong Logics

September 5^{th} *to December* 16^{th}, 2016

Scientific Organizers	Menachem Magidor	Professor of Mathematics, Einstein Institute of Mathematics of The Hebrew University of Jerusalem
	Ralf Schindler	Universität Münster
	Jouko Väänänen	Professor of Mathematics, University of Helsinki

Summary

Many natural mathematical concepts cannot be expressed in first-order logic but need stronger logics. Among such concepts are the freeness of a group, separability of a space, completeness of an order, etc. This led to the introduction of the concept of a generalized quantifier, which made it possible to compare model-theoretic and set-theoretic definability of various mathematical concepts. It turned out that there is a close connection between the two.

By a *strong logic* we mean model-theoretically defined extensions of first-order logic, such as first-order logic with generalized quantifiers, infinitary logics, second-order logic, as well as higher-order logics. The study of strong logics runs immediately into questions that depend essentially on set-theoretical assumptions beyond the standard ZFC axioms, such as infinitary combinatorial principles and the existence of large cardinals. It is therefore crucial to be able to pinpoint the position of a given strong logic in the set-theoretical definability hierarchy, thus helping us understand better the set-theoretical nature of the logic, and therefore of the mathematical notions it can express.

This program will bring to the CRM a diverse group of international high-level researchers working in strong logics, large cardinals, the foundations of set theory, and the applications of set-theoretical methods in other areas of mathematics, such as algebra, set-theoretical topology, category theory,

algebraic topology, homotopy theory, C^*-algebras, measure theory, etc. In all these areas there are not only direct set-theoretical applications but also new results and methods, which are amenable to the expressive power of strong logics.

All program information can be found at:
`http://www.crm.cat/en/Activities/Curs_2016-2017/Pages/IRP-Large-Cardinals-and-Strong-Logics.aspxx`

Visiting Researchers

Dominik Adolf (Rutgers University), David Asperó (University of East Anglia), John T. Baldwin (University of Illinois), Will Boney (Carnegie Mellon University), Jörg Brendle (Kobe University), Andrew Brooke-Taylor (University of Bristol), Filippo Calderoni (Università degli Studi di Torino), Natasha Dobrinen (University of Denver), Mirna Dzamonja (University of East Anglia), Matthew Foreman (University of California at Irvine), Sakae Fuchino (Kobe University), Rami Grossberg (Carnegie Mellon University), Tapani Hyttinen (University of Helsinki), Daisuke Ikegami (Tokyo Denki University), Asaf Karagila (The Hebrew University of Jerusalem), Juliette Kennedy (University of Helsinki), Menachem Kojman (Ben-Gurion University of the Negev), Vadim Kulikov (University of Helsinki), Jean A. Larson (University of Florida), Paul Larson (Miami University), Robert Lubarsky (Florida Atlantic University), Menachem Magidor (The Hebrew University of Jerusalem), Maryanthe Malliaris (University of Chicago), Sheila Miller (New York City College of Technology), William Mitchell (University of Florida), Jirí Rosický (Masaryk University), Ralf Schindler (Universität Münster), Philipp Schlicht (Universität Bonn), Dima Sinapova (University of Illinois at Chicago), Ioannis Souldatos (University of Detroit Mercy), Stevo Todorcevic (University of Toronto), Jouko Väänänen (University of Helsinki), Monica van Dieren (Robert Morris University), Boban Velickovic (Université Paris Diderot-Paris 7), Matteo Viale (Università degli Studi di Torino), Andrés Villaveces (Universidad Nacional de Colombia), Philip Welch (University of Bristol), William Hugh Woodin (Harvard University), Martin Zeman (University of California at Irvine).

Activities

- **Weekly Seminar**

Speakers

Bob Lubarsky, Florida Atlantic University
More on Topological Models
Wednesday, October 5^{th}, 2016

Boban Velickovic, Université Paris Diderot-Paris 7
Ranks of Maharam algebras
Tuesday, October 11^{th}, 2016

Adrian Mathias, Université de La Réunion
Linking descriptive set theory to symbolic dynamics
Tuesday, October 18^{th}, 2016

Tapani Hyttinen, University of Helsinki
Abstract elementary classes as a strong logic for model theory
Monday, October 31^{th}, 2016

Dominik Adolf, Rutgers University
Lower bounds for mutual stationarity on alternating cofinalities
Wednesday, November 23^{th}, 2016

Martin Zeman, University of California at Irvine
The core model for a Woodin cardinal
Wednesday, December 7^{th}, 2016

Natasha Dobrinen, University of Denver
The universal homogeneous triangle-free graph has finite Ramsey degrees
Wednesday, December 14^{th}, 2016

• Advanced Course on Large Cardinals and Strong Logics
September 19^{th} *to* 23^{rd}*,* 2016
Participants: 32

Lecturer

Menachem Magidor and Jouko Väänänen

Tutorial on Strong Logics and Large Cardinals: The Large Cardinals Section

Tutorial on Strong Logics and Large Cardinals: The Strong Logics Section.

• Workshop 1: Set-theoretical Aspects of the Model Theory of Strong Logics
September 26^{th} *to* 30^{th}*,* 2016
Participants: 35

Speakers

John T. Baldwin (University of Illinois), Will Boney (Carnegie Mellon University), Rami Grossberg (Carnegie Mellon University), Daisuke Ikegami (University of California at Berkeley), Vadim Kulikov (University of Helsinki), Paul Larson (Miami University), Robert Lubarsky (Florida Atlantic University), Philipp Luecke (Universität Bonn), Miguel Moreno (University of Helsinki), Jirí Rosický (Masaryk University), Monica van Dieren (Robert Morris University), Matteo Viale (Università degli Studi di Torino), Andrés Villaveces (Universidad Nacional de Colombia), W. Hugh Woodin (Harvard University).

• Young Researcher's Seminar Week
November 7^{th} *to* 11^{th}, 2016
Participants: 30

Speakers

Filippo Calderoni (Università degli Studi di Torino), Fabiana Castiblanco (Westfälische Wilhelms Universität Münster), Gabriel Goldberg (Harvard University), Chris Lambie-Hanson (Hebrew University), Stefan Miedzianowski (Universität Münster), Rahman Mohammadpour (Université Paris Diderot-Paris 7), Dorottya Sziraki (Alfréd Rényi Institute of Mathematics).

• Workshop 2: Applications of strong logics in other areas of mathematics
November 14^{th} *to* 18^{th}, 2016
Participants: 30

Speakers

Andrew Brooke-Taylor (University of Bristol), David Asperó (University of East Anglia), Mirna Dzamonja (University of East Anglia), Matthew Foreman (University of California at Irvine), Sakae Fuchino (Kobe University), Sheila Miller (The City University of New York), Bill Mitchell (University of Florida), Ralf Schindler (University of Münster), Dima Sinapova (The University of Illinois at Chicago), Philipp Schlicht (Universität Bonn), Boban Velickovic (Université Paris Diderot-Paris 7), Philip Welch (University of Bristol).

3.2. Congressos i Workshops

En aquest apartat es detallen els congressos i *workshops* que va organitzar el CRM durant l'any 2016 al marge dels programes de recerca.

3.2. Conferences and Workshops

This section lists the congresses and workshops organised by CRM during 2016 not included in research programmes.

European Study Group with Industry: ESGI 2016
January 25^{th} *to* 29^{th}, 2016
Participants: 48

Organisers

Tim Myers (Centre de Recerca Matemàtica), Joan Solà-Morales (Universitat Politècnica de Catalunya), Maria Aguareles (Universitat de Girona), Marta Pellicer (Universitat de Girona), Ernest Benedito (Universitat Politècnica de Catalunya), Àlex Haro (Universitat de Barcelona), Carlos Vázquez-Cendón (Universidade da Coruña),

Keynote Speakers

Victor Puntes (Institut Català de Nanotecnologia i Nanociència)
Size Focusing.

Pere Boqué (Unitat d'Anàlisi i Planificació – ATCOOR – DTSE – CGTSE – Mossos d'Esquadra)
A mathematical model for preventing burglaries in Catalonia? (in Catalan and English)

Alfredo Portone (CSUC)
Plasma boundary parametrization

Ernest Benedito (UPC)
Deriving Closed Form Solutions for the Material Wait time Problem. Strategic Planning and Modeling

Workshop on Positivity and Valuations

February 22^{nd} *to* 26^{th}, 2016
Participants: 40

Organisers

Maria Alberich-Carramiñana (Universitat Politècnica de Catalunya), Carlos Galindo (Universitat Jaume I, Castelló de la Plana), Alex Küronya (Goethe Universität, Frankfurt am Main), Joaquim Roé (Universitat Autònoma de Barcelona).

Speakers

Félix Delgado (Universidad de Valladolid), Victor Lozovanu (Université de Caen Normandie), Catriona MacLean (Institut Fourier), Francisco Monserrat (Universitat Politècnica de València), Tomasz Szemberg (University of Cracow), Bernard Teissier (Institut de Mathématiques de Jussieu), Michael Temkin (Einstein Institute of Mathematics), Amaury Thuillier (École Normale Supérieure de Lyon), Wim Veys (Katholieke Universiteit Leuven), Annette Werner (Goethe Universität Frankfurt).

MURPHYS-HSFS 2016 Workshop

June 13^{th} *to* 17^{th}, 2016
Participants: 38

Organisers

Andrei Korobeinikov (CRM), Mathieu Desroches (INRIA Sophia Antipolis Centre), Pavel Gurevich (Freie Universität Berlin), Michael P. Mortell (University College Cork), Dmitry Rachinskii (University of Texas, Dallas), Elena Shchepakina (Samara State Aerospace University), Sergey Tikhomirov (Max Planck Institute for Mathematics in the Science).

Speakers — Lluís Alsedà (Centre de Recerca Matemàtica), Markus Bär (Physikalisch-Technische Bundesanstalt, Berlin), Martin Brokate (Technische Universität München, Munich), Valentin Butuzov (The Moscow State University), Gary Friedman (Drexel University, Philadelphia), Armengol Gasull (Universitat Autònoma de Barcelona), Sabine Klapp (Technische Universität Berlin), Nikolai Nefedov (The Moscow State University), Michael P. Mortell (University College Cork), Dmitrii Rachinskii (University of Texas, Dallas), Sergei Sazhin (University of Brighton), Eckehard Schöll (Technische Universität Berlin).

BARCCSYN 2016

June 16^{th} *and* 17^{th}, 2016
Participants: 104

Organisers — Gemma Huguet (Universitat Politècnica de Catalunya), Roser Nadal (Universitat Autònoma de Barcelona), Vicky Puig (Institut Hospital del Mar d'Investigacions Mèdiques), Alex Roxin (Centre de Recerca Matemàtica).

Keynote Speakers — Agnès Gruart, Universidad Pablo de Olavide (Sevilla)
Functional brain states underlying learning and memory processes

Conference on Probability and Statistics in High Dimensions. A Scientific Tribute to Evarist Giné

June 20^{th} *to* 22^{nd}, 2016
Participants: 38

Organisers — Vladimir Koltchinskii (Georgia Institute of Technology), Gábor Lugosi (Universitat Pompeu Fabra), Richard Nickl (University of Cambridge), Marta Sanz-Solé (Universitat de Barcelona).

Lecturers — Stephane Boucheron (University Paris Diderot)
Extreme Tail Estimation, Concentration and Adaptivity

Eustasio del Barrio (Universidad de Valladolid)
A Fixed-Point Approach to Barycenters in Wasserstein Space

Juan Cuesta (Universidad de Cantabria)
A Test for the Functional Linear Model

Víctor de la Peña (Columbia University)
On an Approach to Boundary Crossing by Stochastic Processes

Friedrich Goetze (Bielefeld Universität)
Second Order Concentration of Measure

László Györfi (Budapest University of Technology and Economics)
Iterated and Sequential Portfolio St. Petersburg Games

Christian Houdré Georgia Technology)
Asymptotics for the Length of the Longest Common Subsequences

José R. León (Universidad Central de Venezuela)
An Application of Rice's Formula and Itô-Wiener Expansion: Central Limit Theorem for the Real Roots of a System of Random Multidimensional Polynomials

David Mason (University of Delaware)
The Breiman Conjecture

Pascal Massart (University Paris Orsay)
Some Thoughts and Results about Pairwise Comparison Estimator Selection

Carlos Matrán (Universidad de Valladolid)
Testability of Stochastic Dominance

David Nualart (University of Kansas)
Approximation Schemes for Stochastic Differential Equations Driven by a Fractional Brownian Motion

Dimitry Panchenko (University of Toronto)
Recent Results on the Sherrington-Kirkpatrick Type Spin Glass Models

Magda Peligrad (University of Cincinnati)
The Limiting Spectral Distribution in Terms of Spectral Density

Aad van der Vaart (Leiden University)
Statistical Inference for Some Network Models

Jon Wellner (University of Washington)
The Bennett Orlicz Norm

3.3. Cursos avançats

En aquest apartat es detallen els cursos avançats que va organitzar el CRM durant l'any 2016 al marge dels programes de recerca.

3.3. Advanced Courses

This section lists the advanced courses, not included in research programmes, organised by CRM during 2016.

3rd Barcelona Summer School on Stochastic Analysis

June 27^{th} *to juliol* 1^{st}, 2016
Participants: 104

Organisers	Lluís Quer-Sardanyons (Universitat Autònoma de Barcelona), Marta Sanz-Solé (Universitat de Barcelona), Frederic Utzet (Universitat Autònoma de Barcelona), Josep Vives (Universitat de Barcelona).
Lecturers	István Gyöngy (University of Edinburgh) *On Approximations of Stochastic PDEs* Martin Hairer (University of Warwick) *Regularity Structures*

Introducció a la Matemàtica Financera

5 al 7 de setembre del 2016
Participants: 26

Organisers	Juan Calvo (Universitat Pompeu Fabra), Antonin Chambolle (CMAP, École Polytechnique, CNRS), Bartomeu Coll (Universitat de les Illes Balears), Gloria Haro (Universitat Pompeu Fabra), Matteo Novaga (Università di Pisa), Philippe Salembier (Universitat Politècnica de Catalunya), Petia Radeva (Universitat de Barcelona / CVC).
Lecturers	Angel Calsina (Universitat Autònoma de Barcelona) *La Valoración de Derivats Financers i les Equacions en Derivades Parcials* Joan del Castillo (Universitat Autònoma de Barcelona) *Valoració d'Opcions* Lluís Quer (Universitat Autònoma de Barcelona) *Càlcul Estocàstics* Isabel Serra (Centre de Recerca Matemàtica) *La Predicció de la Borsa i el Passeig Aleatori* Maria Antònia Tarrazón (Universitat Autònoma de Barcelona) *Productes i Mercats Financers*

Reviewing Core Statistics

November 3^{rd}, 10^{th}, 17^{th} *and* 24^{th}, *and December* 1^{st}, 2016
Participants: 32

Coordinators	Alvaro Corral (Centre de Recerca Matemàtica), Isabel Serra (Centre de Recerca Matemàtica).

Organizing Commitee	Roberto de la Cruz (Centre de Recerca Matemàtica), Núria Folguera (Centre de Recerca Matemàtica), Marina Vegué (Universitat Politècnica de Catalunya).
Lecturers	Alejandra Cabaña (Universitat Autònoma de Barcelona)
	Isabel Serra (Centre de Recerca Matemàtica)

3.4. Seminaris del CRM

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

3.7. CRM Seminars

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

Coordinator/*Coordinator*: Roberto de la Cruz (CRM).

01/12/2016. Oleguer Sagarra, DRIBIA, *Non-binary maximum entropy network ensembles applied to the study of urban mobility*.

24/11/2016. Guillermo García-Pérez, Departament de Física de la Matèria Condensada, Universitat de Barcelona, *The complex architecture of primes and natural numbers*.

10/11/2016. David Miralles, Universitat Ramón Llull, *Interacting with objects: from interface to machine learning*.

06/10/2016. Lluís Alsedà, UAB, *Numerical computation of invariant objects with wavelets*.

13/09/2016. Rubén Pérez Carrasco, University College London, *Intrinsic noise profoundly alters the dynamics and steady state of morphogen-controlled bistable genetic switches*.

01/07/2016. Ramón Ferrer, Universitat Politècnica de Catalunya, *Compression and the origins of Zipf's law of abbreviation and other linguistic laws*.

26/05/2016. Claudia Trejo, Universitat de Barcelona, *Front microrheology of biological fluids*.

15/03/2016. Pilar Guerrero, UCL London, *Towards a model of growth and patterning in the vertebrate neural tube*.

Computational Neuroscience Seminar

Organitzadors/*Organisers*: Alex Roxin (CRM), Albert Compte (Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS)), Gustavo Deco (UPF), Jaime de la Rocha (Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS)), Antoni Guillamon (UPC), Ruben Moreno-Bote (Fundació Sant Joan de Déu), Jordi G. Ojalvo (UPC).

Quantitative Finance Seminar

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

23/06/2016. László Györfi, Budapest University of Technology and Economics, *Empirical growth optimal portfolio selections*.

21/03/2016. Wim Schoutens, Catholic University of Leuven, *New challenges in Mathematical Finance: Conic CVA and DVA*.

19/02/2016. María Suárez Taboada, Universidade da Coruña, *Resolución numérica de modelos de valoración de derivados de tipos de interés en el marco del LIBOR Market Model* .

01/02/2016. Thorsten Rheinländer, Vienna University of Technology, *On the stochastic heat equation and the limit order book*.

3.5. CRM Colloquium

- *Could the subprime crisis have been foreseen?*, March 17^{th}, 2016.

3.6. Other activities

- *Barcelona Topology Workshop (BaToWo 2016)*, December 16^{th} to 17^{th}, 2016.

4

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 2016, ha estat format per Enric Ventura (editor en cap) 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 2016.

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 2016, it was formed by Enric Ventura (Editor-in-Chief) and Raquel Hernández (editing 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 2016.

4.1. Advanced Courses in Mathematics CRM Barcelona

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

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.

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

Des de setembre de 2008 fins a finals de 2013, l'editor responsable d'aquesta sèrie va ser Carles Casacuberta (UB) qui va substituir en aquest càrrec a Manuel Castellet (UAB), que va iniciar la sèrie l'any 2001. Des de principis de 2014, el nou editor de la sèrie és Enric Ventura (UPC).

From 2008 to 2013, the responsible editor of this series was Carles Casacuberta (UB); he replaced Manuel Castellet (UAB), who started the series in 2001. Starting in 2014, the new editor of this series is Enric Ventura (UPC).

L'any 2016 han aparegut quatre volums d'aquesta sèrie:

The following four volumes of this series were published in 2016:

- Juan J. Morales-Ruiz, Alexey Bolsinov, Nguyen Tien Zung. *Geometry and Dynamics of Integrable Systems*, edited by Vladimir Matveev, Eva Miranda. Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2016. ISBN 978-3-319-33502-5
- Davar Khoshnevisan, René L. Schilling. *From Lévy-type Processes to Parabolic SPDEs*, edited by Lluís Quer-Sardanyons, Frederic Utzet. Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2016. ISBN 978-3-319-34119-4
- Vladimir Fock, Andrei Marshakov, Florent Schaffhauser, Constantin Teleman, Richard Wentworth. *Geometry and Quantization of Moduli Spaces*, edited by Luis Alvarez-Consul, Jorgen Ellegaard Andersen, Ignasi Mundet i Riera. Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2016. ISBN 978-3-319-33577-3
- Paul Hacking, Radu Laza, Dragos Oprea. *Compactifying Moduli Spaces*, edited by Gilberto Bini, Martí Lahoz, Emmanuele Macrì, Paolo Stellari. Advanced Courses in Mathematics CRM Barcelona, Birkhäuser, Basel, 2016. ISBN 978-3-0348-0920-7

4.2. Research Perspectives CRM Barcelona

L'any 2012, el Comitè Editorial del CRM es va embarcar en l'edició de resums ampliats de les comunicacions científiques del 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 dels esdeveniments del CRM i ajudar a actualitzar de manera fluïda l'estat de l'art en el camp de recerca corresponent. Un acord amb Birkhäuser permet que aquesta editorial es faci càrrec de la publicació d'aquests materials, que s'han concebut com a una subsèrie de la sèrie *Trends in Mathematics*, anomenada *Research Perspectives CRM Barcelona*.

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. An agreement was reached allowing Birkhäuser to publish these materials as a new subseries of the series Trends in Mathematics; the new subseries is named Research Perspectives CRM Barcelona.

- *Extended Abstracts Spring 2015: Interactions between Representation Theory, Algebraic Topology and Commutative Algebra*, edited by Dolors Herbera, Wolfgang Pitsch, Santiago Zarzuela. Research Perspectives CRM Barcelona, vol. 5, in *Trends in Mathematics* Birkhäuser, Basel, 2014. ISBN 978-3-319-45441-2

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

The series editors are Antoni Guillamon and Enric Ventura.

4.3. CRM Documents

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

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

Els volums de la sèrie publicats aquest any 2016 han estat els següents:

The next two volumes were published in 2016:

- *Reports of the CRM Research Programmes 2009/2010, 2010/2011*, edited by CRM Editorial Board, CRM Documents vol. **4**, 2016, ISBN: 978-84-608-7513-0.

4.3. Quaderns

La sèrie *Quaderns* recull el contingut d'activitats especialitzades, principalment els apunts lliurats prèviament pel professorat de cursos avançats del CRM. Durant l'any 2016 s'han publicat els exemplars següents:

Booklets in the Quaderns *series contain specialized texts, mostly preliminary notes delivered by the lecturers of the advanced courses held at the CRM. The following issues were printed in 2016:*

- Mike Jeffrey, Paul Glendinning. *Advanced Course on Piecewise smooth dynamical systems*, Vol. 75, April 2016.
- Vladimir Temlyakov, Albert Cohen, Ronald DeVore, Andreas Seeger, Tino Ullrich, Wolfgang Dahmener. *Advanced Course on Constructive Approximation and Harmonic Analysis*, Vol. 76, June 2016.
- Martin Hairer, Istvan Gyongy. *3rd BCN Summer School on Stochastic Analysis: A 2016 EMS Summer School*, Vol. 77, June 2016.
- Jouko Väänänen, Menachem Magidor. *Advanced Course on Large Cardinals and Strong Logics*, Vol. 78, September 2016.

4.4. Preprints

La sèrie de prepublicacions del CRM s'ha incrementat amb els 10 títols següents durant l'any 2016:

The CRM preprint series grew with the following 10 issues in 2016:

- Andrei Korobeinikov, Ellina Grigorieva, and Evgenii N. Khailovl. *Optimal controls for an SEIR model of endemically persisting infectious diseases with nonlinear incidence rate*, preprint no. 01/2016. (Pr1219)
- Andrei Korobeinikov and Anel Nurtay. *Mathematical modeling of the development of specialization in viral evolution*, preprint no. 02/2016. (Pr1220)
- Gabdolla Akishev. *Estimations of the best M-term approximations of functions in the Lorentz space with constructive methods*, preprint no. 03/2016. (Pr1221)
- Gabdolla Akishev. *On orders of approximation of the generalized Nikol'skii-Besov class in Lorentz spaces*, preprint no. 04/2016.

  (Pr1222)
- Amiran Gogatishvili, R.Ch. Mustafayev, and Tugçe Ünver. *Embeddings between weighted complementary local Morrey-type spaces and weighted local Morrey-type spaces*, preprint no. 05/2016. (Pr1224)
- Victoria Booth, Ismael Xique, Cecilia G. Diniz Behn. *A one-dimensional map for the circadian modulation of sleep in a human sleep-wake regulatory network model*, preprint no. 06/2016. (Pr1223)

- Ingrid Meza Sarmiento, Paulo Ricardo da Silva, Douglas Duarte Novaes. *Nonlinear regularization of discontinuous vector fields and singular perturbation*, preprint no. 07/2016. (Pr1225)
- Andrei Korobeinikov and Silvia Pagliarini. *Order reduction for a model of marine bacteriophage evolution*, preprint no. 08/2016. (Pr1226)
- Andrei Korobeinikov and David Masip Bonet. *A continuous phenotype space model of cancer evolution*, preprint no. 09/2016. (Pr1227)
- Josep Sardanyés, Jorge Duarte, Cristina Januário, C. Correia Ramos, Carla Rodrigues, Nuno Martins. *Optimal homotopy analysis of a chaotic HIV-1 model incorporating AIDS-related cancer cells*, preprint no. 10/2016. (Pr1228)

5 Resum econòmic *Financial Summary*

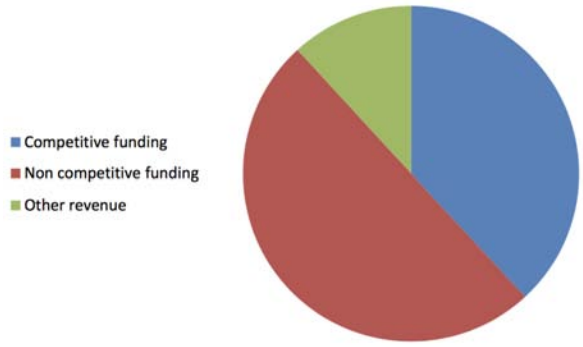
5.1 Ingressos — 5.1. Revenue

Ingressos competitius *Competitive funding*	709.816,06 €
Ingressos no competitius *Non-competitive funding*	933.053,58 €
Altres ingressos *Other revenue*	220.070,26 €
TOTAL	**1.862.939,90 €**

5.2 Despeses — 5.2. Expenses

Despeses de personal *Personnel expenses*	1.214.517,83 €
Despeses d'explotació *Operating expenses*	503.218,51 €
Altres despeses *Other expenses*	10.656,12 €
Amortització immobilitzat *Depreciation of intangibles*	188.802,50 €
Resultat financer (despesa) *Financial outcome (expenditure)*	16.507,87 €
Resultat exercici *Annual profit*	-70.762,93 €
TOTAL	**1.862.939,90 €**

Ingressos/Income



Despeses/Expenses