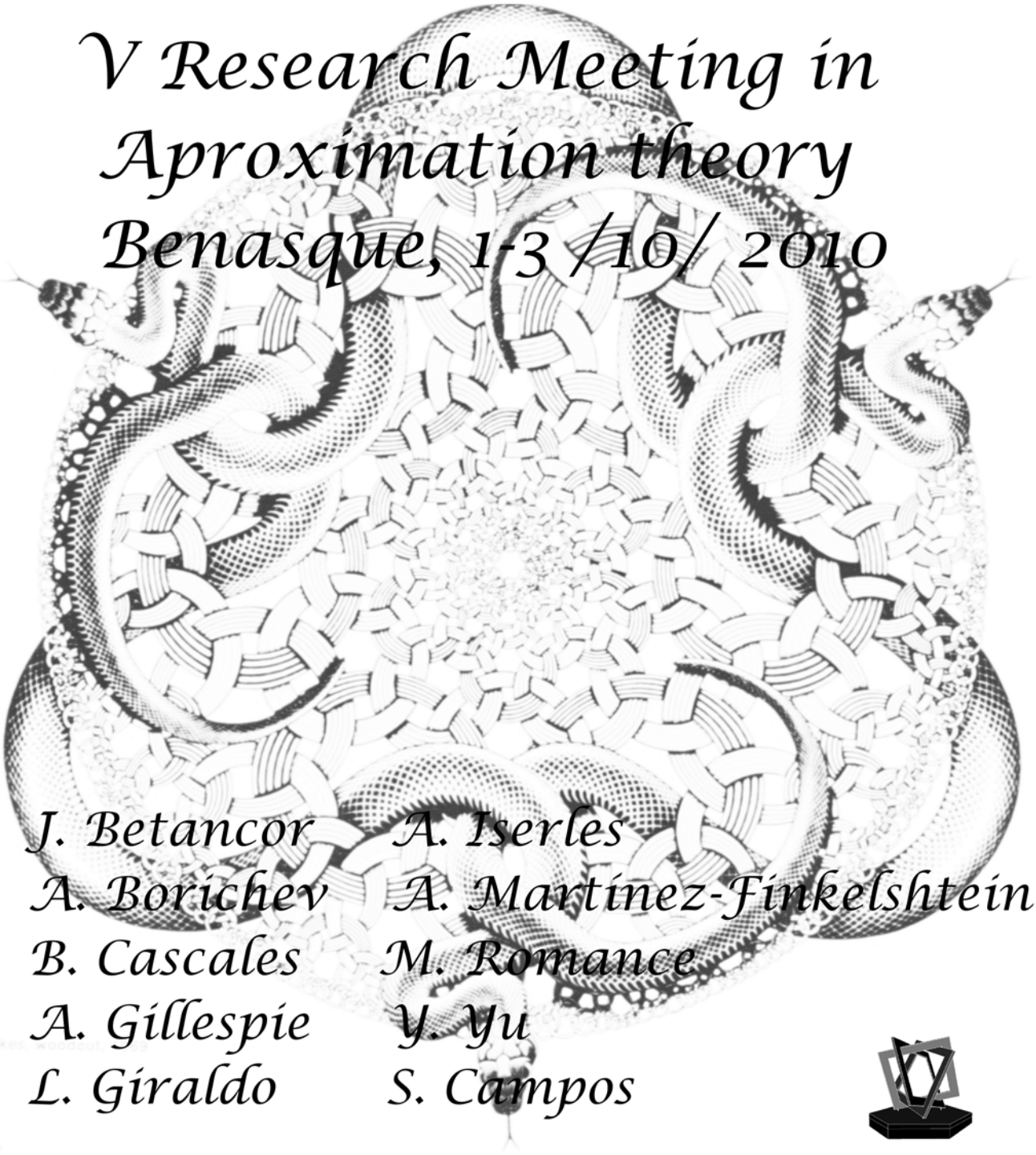
# V Research Meeting in Aproximation theory Benasque, 1-3 /10/ 2010



J. Betancor
A. Borichev
B. Cascales
A. Gillespie
L. Giraldo
A. Iserles
A. Martínez-Finkelshtein
M. Romance
Y. Yu
S. Campos

*Este congreso ha sido financiado por*

*Grupo de Investigación de Excelencia ``Análisis Matemático y Aplicaciones´´ E-64 de D.G.A.*

*Red Investigación de los Pirineos*

*Instituto Universitario de Matemáticas y Aplicaciones, I.U.M.A.*

*Agradecemos al Centro de Ciencias de Benasque ``Pedro Pascual´´ las facilidades prestadas para su realización.*

*Los organizadores*

**V EITA-2010 October 1-3**

| **Friday 1 October** | **Saturday 2 October** | **Sunday 3 October** |
|---|---|---|
| | 9.30-10.15 **A. Iserles** | 9.15-9.40 **S. Campos** |
| | 10.20-11.05 **Y. Yu** | 9.45-10.30 **A. Martínez - Finkelshtein** |
| | 11.10-11.30 *Coffee-Break* | 11.00 *Departure from Benasque (220 km, 3 hours)* |
| 11.00 *Departure from Zaragoza (220 km, 3 hours)* | 11.30- 12.15 **A. Borichev** | 14.30 *Arrival at Zaragoza* |
| 14.30 *Arrival at Benasque* | 12.20-13.05 **A. Gillespie** | |
| 15.00 *Lunch* | 13.10-15.55 *Lunch* | |
| | 16.00-16.45 **B. Cascales** | |
| 17.30-18.15 **L. Giraldo** | 16.50-17.35 **J. Betancor** | |
| 18.20- 19.05 **M. Romance del Río** | 18.00-20.00 *Short Excursion* | |
| 21.00 *Dinner* | 21.00 *Dinner* | |

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# Time Schedule

**Friday, October 1st**

**11.00** *Departure from Zaragoza to Benasque. Bus from Campus Plaza San Francisco*

**14.30** *Arrival at Benasque. Gran Hotel de Benasque*

**15.00** *Lunch. Restaurante Gran Hotel de Benasque*

**17.20–17.30** *Opening Ceremony. Centro de Ciencias de Benasque, "Pedro Pascual"*

**17.30–18.15 L. Giraldo**, Universidad Complutense de Madrid (Spain)

*Jacobian mates for complex polynomial maps with 1-dimensional fibers*

**18.20–19.05 M. Romance**, Universidad Rey Juan Carlos (Spain)
*Centrality and controllability of complex networks: An analytical approach*

**21.00** *Dinner.* Restaurante Hotel Ciria. Precio 15 + IVA.

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# Time Schedule

**Saturday, October 2nd**

**09.30–10.15 A. Iserles**, University of Cambridge (United Kingdom)
*From asymptotics to numerics of highly oscillatory integrals*

**10.20–11.05 Y. Yu**, University of California (USA)
*Sharp Bounds on the Entropy of the Poisson Law and Related Quantities*

**11.10–11.30** *Coffee break*

**11.30–12.25 A. Borichev**, Université Aix-Marseille (France)
*Weighted completeness of polynomials and exponentials on the real line*

**12.20–13.05 G. Gillespie**, University of Edinburgh (United Kingdom)
*Norm growth of iterates of a class of invertible operators*

**13.10-15.55** *Lunch. Restaurante Gran Hotel de Benasque*

**16.00–16.45 B. Cascales**, Universidad de Murcia (Spain)
*The Bishop-Phelps-Bollobás theorem and Asplund operators*

**16.50–17.35 J. Betancor**, Universidad de La Laguna (Spain)
*$L^p$ and BMO boundedness for variation operators associated with semigroups and Riesz transforms in the Schrödinger setting*

**18.00–20.00** *Short Guide Excursion to Benasque and surrondings*

**21.00** *Dinner.* Restaurante Hotel Ciria. Precio 15 + IVA.

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# Time Schedule

**Sunday, October 3rd**

**09.15–09.40 J. Saúl Campos**, Universidad Autónoma Metropolitana-Iztapalapa (México)
*Regularities and subpectras for Waelbroeck algebras*

**9.45–10.30 A. Martínez-Finkelshtein**, Universidad de Almería (Spain)
*Multiple orthogonal polynomials and asymptotics of random non-intersecting paths*

**11.00** *Departure from Benasque to Zaragoza. Bus from Gran Hotel de Benasque*

**14.30** *Arrival at Zaragoza. Campus Plaza San Francisco*

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# $L^p$ and BMO boundedness for variation operators associated with semigroups and Riesz transforms in the Schrödinger setting

**Jorge J. Betancor**

In this paper we establish the $L^p$- and BMO- boundedness properties of the variation operators associated with the heat semigroup, Riesz transforms and commutator between Riesz transforms and multiplication by $BMO(\mathbb{R}^n)$-functions in the Schrödinger setting.

**Keywords:** Variation operator, Schrödinger, Riesz transforms.

**Mathematics Subject Classification 2000:** 42B20, 42B35

[1]Departamento de Análisis Matemático
Universidad de La Laguna
Av. Fco. Sánchez, s.n., 38271 La Laguna, Tenerife, Espaa
jbetanco@ull.es

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# Weighted completeness of polynomials and exponentials on the real line

**Alexander Borichev**

Consider a finite positive measure on the real line. Suppose that polynomials are dense in the space $X$ of functions square summable with respect to this measure. We would like to know what perturbations of the measure preserve this property. An analogous problem is studied for weighted exponential approximation. This is a joint work with M.Sodin.

Centre de Mathématiques et Informatique
Université Aix-Marseille
39 rue Joliot-Curie, 13453 Marseille, France
borichev@cmi.univ-mrs.fr

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# Regularities and subpectras for Waelbroeck algebras

**J. Saúl Campos Orozco, Antoni Wawrzyńczyk**

We introduce regularities in locally convex Waelbroeck in such a way that each regularity defines a joint spectrum on the algebra that satifies the spectral mapping formula.

**Keywords:** regularity, joint spectrum, spectral mapping formula.

**Mathematics Subject Classification 2000:** 46J20,46H20

## References

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Departamento de Matemáticas
Universidad Autoóma Metropolitana-Iztapalapa
AP 55-534, 09430 México D.F, México.
sul@xanum.uam.mx
awaw@xanum.uam.mx

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# The Bishop-Phelps-Bollobás theorem and Asplund operators

**R. M. Aron**[1], **B. Cascales**[2], **O. Kozhushkina**[3]

In this lecture we will present a strengthening of the Bishop-Phelps property for operators that in the literature is called the Bishop-Phelps-Bollobás property. Let $X$ be a Banach space and $L$ a locally compact Hausdorff space. We prove that if $T : X \to C_0(L)$ is an Asplund operator and $\|T(x_0)\| \approxeq \|T\|$ for some $\|x_0\| = 1$, then there is an norm attaining Asplund operator $S : X \to C_0(L)$ and $\|u_0\| = 1$ with $\|S(u_0)\| = \|S\| = \|T\|$ such that $u_0 \approxeq x_0$ and $S \approxeq T$. As particular cases we obtain: (A) if $T$ is weakly compact, then $S$ can also be taken being weakly compact; (B) if $X$ is Asplund (for instance, $X = c_0$), the pair $(X, C_0(L))$ has the Bishop-Phelps-Bollobás property for all $L$; (C) if $L$ is scattered, the pair $(X, C_0(L))$ has the Bishop-Phelps-Bollobás property for all Banach spaces $X$.

**Keywords:** Bishop-Phelps, Bollobás, fragmentability, Asplund operator, weakly compact operator, norm attaining

**Mathematics Subject Classification 2010:** 46B22, 47B07

## References

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[1,3]R. M. Aron and O. Kozhushkina
Department of Mathematical Sciences
Kent State University
Kent, OH 44242, USA
aron@math.kent.edu
okozhush@math.kent.edu

[2]B. Cascales
Departamento de Matemáticas
Universidad de Murcia
30100 Espinardo. Murcia. Spain
beca@um.es

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# Norm growth of iterates of a class of invertible operators

**Alastair Gillespie**

I shall discuss the problem of estimating the rate of growth as $|n| \to \infty$ of $\|U^n\|$, where $U$ is an invertible operator on a Banach space $X$ with a spectral decomposition of the form

$$U = \int_{0-}^{2\pi} e^{i\lambda}\, dE(\lambda)$$

for some family $E(\cdot)$ of projections on $X$. The geometry of $X$ has a role to play and of particular interest is the case when $X$ is a Hilbert space. Here, the bilateral shift on the weighted sequence space $\ell_w$, where $w$ is an $A_2$ weight, is a motivating example.

**Keywords:** spectral decompositions, trigonometrically well-bounded operators, norm growth, $A_2$ weights

**Mathematics Subject Classification 2000:** 47B38, 47B40

School of Mathematics and
Maxwell Institute for Mathematical Sciences
University of Edinburgh
James Clerk Maxwell Building
Mayfield Road
Edinburgh EH9 3JZ, Scotland
t.a.gillespie@ed.ac.uk

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# Jacobian mates for complex polynomial maps with 1-dimensional fibers

**L. Giraldo**

In this talk, we will consider a geometric approach to the following problem: given a dominant polynomial map $(F_2, \ldots, F_n) : \mathbb{C}^n \longrightarrow \mathbb{C}^{n-1}$, when does it exist a polynomial $F_1$ such that $(F_1, F_2, \ldots, F_n)$ is a local biholomorphism?

These local biholomorphisms are called Keller maps, as Keller formulated in 1939 a famous conjecture (known as Jacobian conjecture, and still open): such a map has a polynomial inverse. We will recall some of the known facts on that conjecture.

This is joint work with A. Bustinduy (Univ. Antonio de Nebrija) y J. Muciño-Raymundo (Instituto de Matemáticas de la UNAM, Morelia, México).

**Keywords:** complex polynomial maps, holomorphic vector fields and foliations

Dep. Geometría y Topología. Facultad de Matemáticas.
Universidad Complutense de Madrid.
Plaza de Ciencias 3, Ciudad Univesitaria. 28040 Madrid.
luis.giraldo@mat.ucm.es

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# From asymptotics to numerics of highly oscillatory integrals

**Arieh Iserles**

In this talk we review recent work on the computation of highly oscillatory integrals. While classical quadrature methods are useless in this context, proper understanding of the asymptotics of such integrals leads to a number of very powerful techniques. We will introduce in detail Filon-type methods, commenting briefly upon Levin-type methods and the approach of numerical steepest descent. This will be followed by a brief review of a number of applications: to Lie-group methods for ODEs, exponential integrators and asymptotic/numeric techniques for highly-oscillatory DEs, modified Fourier expansions and spectral problems for Fredholm equations.

**Keywords:** High oscillation, asymptotic expansions, the Stokes theorem, numerical quadrature, ordinary differential equations, exponential integrators, Fourier expansions, Birkhoff series

**Mathematics Subject Classification 2000:** 65D32,65T40

Department of Applied Mathematics and Theoretical Physics
University of Cambridge
Wilberforce Rd
Cambridge CB3 0WA
United Kingdom ai@damtp.cam.ac.uk

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# Multiple orthogonal polynomials and asymptotics of random non-intersecting paths

**Andrei Martínez-Finkelshtein**

Multiple orthogonal polynomials are a generalization of orthogonal polynomials in which the orthogonality is distributed among a number of orthogonality weights. They appear in random matrix theory in the form of special determinantal point processes that are called multiple orthogonal polynomial (MOP) ensembles. The correlation kernel in such an ensemble is expressed in terms of the solution of a Riemann-Hilbert problem, that is of size $(r+1)\times(r+1)$ in the case of $r$ weights [1].

A number of models of non-intersecting Brownian motions give rise to a MOP ensemble. We illustrate the problem with a model of $n$ non-intersecting squared Bessel processes in the confluent case: all paths start at time $t=0$ at the same positive value $x=a$, remain positive, and are conditioned to end at time $t=T$ at $x=0$. In the limit $n\to\infty$, after appropriate rescaling, the paths fill out a region in the $tx$-plane. In particular, the paths initially stay away from the hard edge at $x=0$, but at a certain critical time $t^*$ the smallest paths hit the hard edge and from then on are stuck to it.

A key fact is that the positions of the paths at any time $t$ constitute a multiple orthogonal polynomial ensemble, corresponding to a system of two modified Bessel-type weights. As a consequence, there is a $3\times 3$ matrix valued Riemann-Hilbert problem characterizing this model, that can be analyzed in the large $n$ limit using the Deift-Zhou steepest descent method. A key ingredient is a vector equilibrium problem for two measures, that describes the limiting mean particle density.

The results described were obtained in collaboration with A. B. J. Kuijlaars and F. Wielonksy, and are part of [2] and of a paper in preparation.

**Keywords:** Diffusion process, random walks, non-intersecting paths, determinantal point processes, asymptotics, orthogonal polynomials, Riemann-Hilbert analysis

**Mathematics Subject Classification 2000:** 42C05, 31A15, 60G55

## References

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Department of Statistics and Applied Mathematics,
University of Almería,
04120 Almería, Spain
andrei@ual.es

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# Centrality and controllability of complex networks: An analytical approach

**Miguel Romance**

Centrality is power. One of the main topics in the study of real life complex networks, such as social networks or internet-based networks, is determining the role of each node in the structure and dynamic of the network. From the Google search engine to marketing analysis in social networks, it is critical to quantify the influence of each node in the network's hierarchy. In this talk we will start by presenting the mathematical framework of computing the influence of each node by means of centrality measures, including the Bonacich centrality [1] and the celebrated Google's PageRank centrality [2]. After this introduction, we will proof some analytical solutions of the inverse centrality problem of finding a node with a prescribed centrality [4] and we consider the controllability of complex directed network, by presenting some algorithms to compute a controlling set of nodes in a given network [3].

The solutions of the inverse centrality problem are obtained by using the Perron-Frobenius theory and classic linear algebra results [3] that illustrate the power of analytical techniques in the field of complex network theory, besides the numerical random test used in the usual literature.

*This is a joint work with R. Criado from Universidad Rey Juan Carlos.*

**Keywords:** Bonacich centrality, PageRank centrality, controllability of networks

**Mathematics Subject Classification 2000:** 05C50, 05C82, 68R10

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Departamento de Matemática Aplicada
Universidad Rey Juan Carlos
C/Tulipán s/n, 28933 Móstoles, Madrid (Spain)
miguel.romance@urjc.es

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# Sharp Bounds on the Entropy of the Poisson Law and Related Quantities

**José A. Adell**[1], **Alberto Lekuona**[2], **Yaming Yu**[3]

The Shannon entropy of the Poisson distribution with mean $\lambda$, denoted by $H(\lambda)$, is a fundamental quantity in information theory that does not admit an easy analytic form. We derive upper and lower bounds for $H(\lambda)$ that are asymptotically tight and easy to compute. For example, we have, for all $\lambda > 0$,

$$-\frac{5}{6\lambda} - \frac{1}{6\lambda^2} \leq H(\lambda) - \frac{1}{2}\log(2\pi\lambda) - \frac{1}{2} \leq \frac{1}{6\lambda},$$

$$-\frac{31}{24\lambda^2} - \frac{33}{20\lambda^3} - \frac{1}{20\lambda^4} \leq H(\lambda) - \frac{1}{2}\log(2\pi\lambda) - \frac{1}{2} + \frac{1}{12\lambda} \leq \frac{5}{24\lambda^2} + \frac{1}{60\lambda^3},$$

and further inequalities up to arbitrary high orders. Expansions and inequalities for related quantities are also discussed. Connection with an asymptotic series of Ramanujan is mentioned.

**Keywords:** asymptotic expansion, central moments, complete monotonicity, entropy bounds, integral representation, Poisson channel

**Mathematics Subject Classification 2000:** 41A60, 94A17

[1]Departamento de Métodos Estadísticos
Facultad de Ciencias, Universidad de Zaragoza
Pedro Cerbuna 12, 50009, Zaragoza, Spain
adell@unizar.es

[2]Departamento de Métodos Estadísticos
Facultad de Ciencias, Universidad de Zaragoza
Pedro Cerbuna 12, 50009, Zaragoza, Spain
lekuona@unizar.es

[3]Department of Statistics
University of California
Irvine, CA 92697-1250, USA
yamingy@uci.edu

## Lista de Participantes V EITA 2010

## Research meeting in Aproximation Theory

## Benasque, 1-3 de octubre de 2010

- **ADELL, José A.:** Universidad de Zaragoza
- **ALFARO, Manuel:** Universidad de Zaragoza
- **ALFARO GARCÍA, María Pilar:** Universidad de Zaragoza.
- **BASTERO, Jesús:** Universidad de Zaragoza
- **BERNUES, Julio:** Universidad de Zaragoza
- **BETANCOR, Jorge,** Universidad de La Laguna
- **BORICHEV, Alexander:** Universite Aix-Marseille
- **CAMPOS OROZCO, José Saúl:** Universidad Autónoma Metropolitana-Iztapalapa.
- **CANTERO, María José:** Universidad de Zaragoza
- **CASCALES, Bernardo:** Universidad de Murcia
- **CIAURRI, Óscar:** Universidad de La Rioja
- **DE NATIVIDADE, Maria:** UAM
- **GALÉ GIMENO, José Esteban:** Universidad de Zaragoza
- **GALLARDO GUTIERREZ, Eva Antonia:** University of Zaragoza
- **GILLESPIE, T Alastair:** University of Edinburgh
- **GIRALDO, Luis:** Universidad Complutense, Madrid
- **ISERLES, Arieh:** University of Cambridge
- **LEKUONA, Alberto:** University of Zaragoza
- **MARTINEZ-FINKELSHTEIN, Andrei:** University of Almeria
- **MASSANEDA, Xavier:** Universitat de Barcelona
- **MIANA SANZ, Pedro José:** Universidad de Zaragoza
- **MONTANER, Jesús María:** Universidad de Zaragoza
- **MORAL, Leandro:** Universidad de Zaragoza
- **PEÑA, Ana:** Universidad de Zaragoza
- **PÉREZ RIERA, Mario:** Universidad de Zaragoza
- **PHUNG, Van Manh:** Université Paul Sabatier
- **REZOLA, Marisa:** Universidad de Zaragoza
- **ROMANCE DEL RIO, Miguel:** Universidad Rey Juan Carlos
- **ROYO ESPALLARGAS, Juanjo:** Universidad de Zaragoza
- **RUIZ BLASCO, Francisco J.:** Universidad de Zaragoza
- **SANCHEZ-LAJUSTICIA, Luis:** Universidad de Zaragoza
- **SANGÜESA, Carmen:** University of Zaragoza
- **STINGA, Pablo Raúl:** Universidad Autónoma de Madrid
- **THOMAS, Pascal:** Université Paul Sabatier
- **VARONA, Juan Luis:** Universidad de La Rioja
- **VELÁZQUEZ, Luis:** Universidad de Zaragoza
- **YU, Yaming:** University of California,