BGSMath María de Maeztu Unit of Excellence 2015-2019 Closing Workshop

Aula B7
Faculty of Mathematics and Informatics
University of Barcelona
Historical Building

6 June 2019
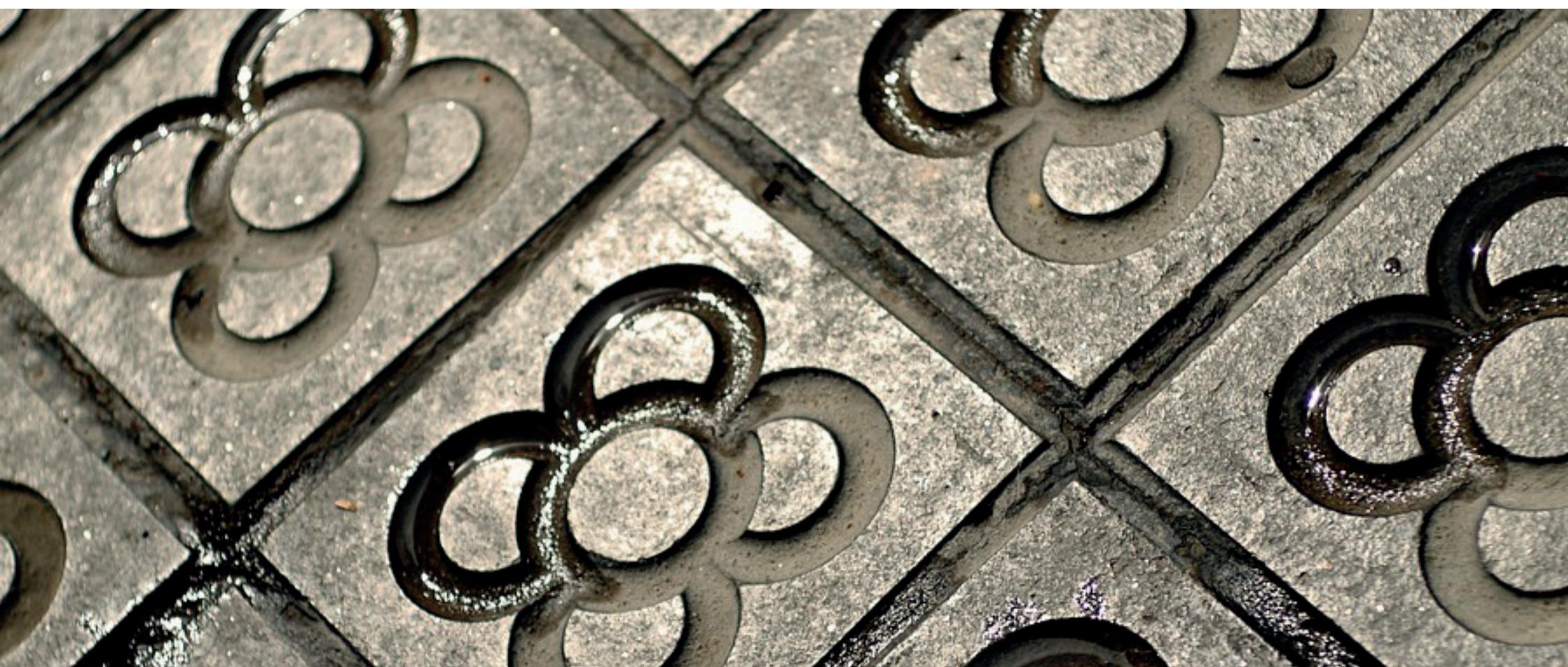
PROGRAMME OF THE DAY

8.45   Registration

9.00   Opening Session
Marc Noy   Scientific Director of the BGSMath-María de Maeztu
                        Unit of Excellence
Marta Sanz-Solé   BGSMath Director

9.15   **Eric Urban**   Eisenstein congruences and Euler systems

*I will explain the construction of new Euler systems using congruences between Eisenstein
series and cusp forms of various levels and weight. The local global compatibility of the
p-adic Langlands correspondence will be used to control the integrality of the Euler system.*

10.15   Coffee break
            Location: First floor - Claustre de ciències

10.45   **Matteo Cozzi**   Some recent results on nonlocal minimal
                                    surfaces

*The fractional perimeter is a geometric functional introduced in 2010 by Caffarelli,
Roquejoffre & Savin in connection with phase transition and diffusion problems involving
longrange interactions. Its minimizers, nonlocal minimal surfaces, have been the object of
great interest in recent years. In my talk, I will provide an introduction to nonlocal minimal
surfaces, discussing some motivations for their study, the most important progresses made
so far in their analysis, and several interesting questions about them that have not been
answered yet.*

11.45   **Tere M. Seara**   Oscillatory orbits in the planar three body
                                    problem

*In this talk, we prove the existence of oscillatory motions for any value of the masses of
the primaries assuming they move in ellipses whose eccentricity is small enough, as a
consequence of the transversal intersection of the stable and unstable manifolds of periodic
orbits at "infinity", and using techniques of Arnold diffusion. We also extend these results to
the general case (work in progress). (More details about this abstract on the web)*

12.45   Lunch break
            *The lunch will take place at the Jardins de Mercè Rodoreda at the
            Institut d'Estudis Catalans - carrer del Carme 47. It is a 15-minute walk
            from the venue of the conference.*

PROGRAMME OF THE DAY

14.30 **Simeon Ball**   Maximum distance separable codes: recent advances and applications

In this talk, I will start with a description of the classical Reed-Solomon codes and mention decoding algorithms for these codes. But for the main part of the talk, I will consider the geometrical object (known as an arc) which one obtains by taking the set of columns of a generator matrix of a linear MDS code over a finite field Fq and considering this set of columns as a set of points in PG(k − 1, q), the (k − 1)-dimensional projective space. (More details about this abstract on the web)

15.30 Coffee break
Location: First floor - Claustre de ciències

16.00 **Josep Sardanyés**   Characterising disease-free attractors with dynamical systems

Dynamical systems allow to characterise the population dynamics of pathogens such as RNA viruses or the evolutionary dynamics of cancer. These nonlinear systems, which have a huge impact on health and epidemics, are currently investigated from different perspectives including experimental, clinical, and theoretical research. In this talk I will introduce mathematical and computational models showing the presence of bifurcations involving disease-free attractors. That is, dynamical asymptotic states implying viruses extinction or tumour cells clearance. First, I will focus on the evolutionary dynamics of RNA viruses under different replication modes. Second, within the field of cancer evolution, I will introduce the so-called trans-heteroclinic bifurcation. This global bifurcation, which involves an exchange of stability between two equilibrium points with a heteroclinic connection, governs a discontinuous transition towards tumour cells' extinction.

17.00 **Martin Sombra**   Measuring the solution set of a system of polynomial equations

Polynomials appear in a wide variety of contexts in Mathematics, Engineering and Computer Science. Polynomials in those situations are not random but come up with a certain structure that is important to exploit. A relevant result in this direction is the classical Bernstein-Kushirenko theorem, giving a bound for the number of solutions in the algebraic torus of a system of polynomial equations in terms of their Newton polytopes. In this talk, I will present advances towards an arithmetic analogue of this result, bounding the bit length of such a solution set. This will give us the pretext for an excursion into the arithmetic intersection theory of toric varieties, a fascinating subject at the crossroad of algebraic geometry, number theory and combinatorics.

18.00 Closing

BRIEF DESCRIPTION

The Barcelona Graduate School of Mathematics was recognized in 2015 as a María de Maeztu (MdM) Excellence Centre by the Spanish Government. The recognition was supported by a 2-million-euro grant for the period 2015-2019. The MdM grant has been essential for the consolidation and success of the BGSMath project and for its international recognition. Through the MdM grant, 20 PhD and 15 postdoctoral positions have been covered with talented national and international researchers. Many activities have been funded through the MdM grant, including Advanced Graduate Courses, Intensive Research Programs, Junior Meetings, Colloquia, Workshops with industry, events celebrating International Day of Women and Girls in Science, and internships for master's students, among others. The BGSMath/MdM excellence program finishes this year. This workshop celebrates this success story, by highlighting some relevant scientific results in the main research areas of BGSMath obtained within the program.

SPEAKERS' BIOSKETCHES

Eric Urban (Columbia University, USA)

He studied at the Ecole Normale Superieure de Lyon and obtained his PhD in Orsay in 1994 under the supervision of Jacques Tilouine before entering at the CNRS in 1995 as researcher and later director of research . He was dètachè from the CNRS to be Hedrick assistant professor at UCLA from 1997 to 2000 and he is full professor at Columbia University since 2006. He earned the Lenfest distinguished Columbia Faculty award in 2005. He was an invited speaker at the ICM in Madrid in 2006 and a Guggenheim Fellow in 2007. His works are on the arithmetic aspects of theory of automorphic forms. In particular, he studies their p-adic families and their implications to the study of deformations of Galois representations to address fundamental questions of Iwasawa theory and cases of the Bloch-Kato conjectures on the Tamagawa numbers attached to motives. Together with Chris Skinner, he proved the Main Conjecture in the Iwasawa theory of p-ordinary elliptic curves which has important consequence for the rank zero case of the p-part of the Birch and Swinnerton-Dyer conjecture.

Tere Martínez-Seara (UPC - BGSMath)

She is full professor at the Dpt. de matemàtiques of the Universitat Politècnica de Catalunya. She is the leader of the UPC Dynamical Systems group, formed by more than 20 researchers working on theoretical and computer aspects of finite and infinite Dynamical Systems, with focus on Celestial Mechanics and mathematical Neuroscience. She has supervised 8 PhD. students. In 2015, she received the first Barcelona Dynamical Systems Prize and in the fall of 2018 she hold an Eisenbud Professorship (Simons Foundation) at MSRI (U. Berkeley). She works in Dynamical Systems, in analytical tools to study their global dynamics. Her works developed two tools which have been widely used in the area of Arnold Diffusion: the study of normally hyperbolic invariant manifolds and the theory of the "scatering map". She also works in a rigorous approach to singular perturbation theory: developing methods which allow to measure exponentially small phenomena which are relevant in the study of the global dynamics of a system like the exponentially small splitting of separatrices, one of the main phenomena producing chaos.

Martin Sombra (UB-BGSMath)

He is an ICREA Research Professor at the UB. He did a PhD thesis at the University of Buenos Aires, and postdoctoral stays at the MSRI at Berkeley, the IAS at Princeton, and the IMJ at Paris. He was also a Maître de Conférences at the University of Lyon, and a Full Professor at the University of Bordeaux. He is a member of the Board of Directors of the FoCM Society, and of the Advisory Board of the MEGA conferences. He currently works on problems at the interface of Algebraic Geometry, Number Theory and Complexity Theory, and collaborates with research groups in Barcelona, Madrid, Paris, Caen, Bordeaux, Santiago de Chile and Rochester.

Matteo Cozzi (University of Bath, UK)

He works in the area of Partial Differential Equations and Calculus of Variations. His main interests lie in the study of phase transition phenomena involving the presence of nonlocal effects. Matteo obtained his PhD in 2016 jointly from Università degli Studi di Milano and Université de Picardie Jules Verne. After that, he has been a Postdoctoral Fellow at WIAS Berlin and a BGSMath Postdoctoral Fellow at UPC Barcelona. From November 2018, he holds a Royal Society Newton International Fellowship at the University of Bath.

Simeon Ball (UPC-BGSMath)

Senior lecturer in the Department of Mathematics at Universitat Politècnica de Catalunya, Barcelona since 2007. Published over 50 articles and been awarded various prestigious grants, including the Advanced Research Fellowship from EPSRC in the UK and the Ramon y Cajal grant in Spain. In 2012, proved the MDS conjecture for prime fields, which conjectures that all linear codes over prime fields that meet the Singleton bound are short. This is one of the oldest conjectures in the theory of error-correcting codes. In 2015, published the book entitled "Finite Geometry and Combinatorial Applications" in the London Mathematical Society Student Text series of Cambridge University Press.

Josep Sardanyés (CRM-BGSMath)

He completed a BSc in Biology at Universitat de Barcelona (2002) and went on to earn a Master and a PhD in Biomedicine (2009) at the Complex Systems Lab (Universitat Pompeu Fabra, Institute of Evolutionary Biology CSIC-UPF). During my PhD thesis I worked on dynamical systems theory and complexity in biological systems. Upon obtention of my PhD degree, I moved to Valencia where I took up a postdoc position at the Institute of Molecular and Cellular Plant Biology (Consejo Superior de Investigaciones Científicas-UPV), where I went on with my research on virus dynamics and evolution. In 2011 I moved to San Francisco for a second postdoc at The David J. Gladstone Institutes (University of California San Francisco, UCSF), where I focused on the theoretical and computational study of HIV-1 dynamics. Then I moved again to the Complex Systems Lab were I completed a third postdoc (2012-2016) working on cancer evolution, theoretical ecology and systems and synthetic biology. In 2017 I started as a senior researcher at CRM receiving a postdoctoral grant from "la Caixa" foundation. I have recently obtained a "Ramon y Cajal" fellowship, also starting my own laboratory on nonlinear dynamics and evolution within the Computational and Mathematical Biology Group. I am also associate professor at Universitat Pompeu Fabra, teaching at the Bachelor's degree in Biomedical Engineering and at the Computational Biomedical Engineering Master.