

5th Meeting of Mexican Mathematicians in the World (21w5097)

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Overview of the Meeting

The conference “Mexican Mathematicians in the World” connected Mexican mathematicians residing abroad with their counterparts in Mexico by showcasing the current research of promising and well-established Mexican mathematicians, and by fostering focused, in-depth discussions about different aspects of the overall situation of Mathematics in Mexico.

This conference aimed to raise the academic profile and visibility of Mexican mathematics within the international scientific community, and to strengthen the individual and institutional links among Mexican mathematicians and Mexican institutions.

Outcomes and Achievements of the Meeting

The main objectives of the workshop were addressed as follows.

1. **Expand efforts to promote interaction among Mexican mathematicians around the world.** The meeting format, consisting of 15 scientific talks (5 talks in-person and 10 talks online), 1 poster session, 2 organized panels, and 2 talks about gender and Mathematics, all surrounded by plenty of interaction time during meals and coffee breaks, allowed for numerous interactions and networking among workshop participants. It is interesting to highlight that, due to the hybrid format of this workshop, our 126 participants came from 16 countries all over the world and 15 Mexican states.
2. **Disseminate the scientific work of Mexican mathematicians abroad.** There were scientific talks presented by Mexican mathematicians pursuing scientific careers in various countries in the Americas and Europe. Presentation highlights are detailed in

the next section. During the workshop, scientific talks were recorded using BIRS video facilities. These talks will remain available for participants and other interested scientists at the workshop website:

<https://www.birs.ca/events/2021/5-day-workshops/21w5097>

In addition, a new webpage of the Mexican mathematical community was builded. This website is an ongoing project and eventually it will be an interactive platform where users can ask/answer questions of different academic nature and advertise events and programs.

<http://matematicosmexicanos.com>

Finally, a new YouTube channel was created in order to implement a new archive for upcoming events and other related material. In particular, we uploaded several interviews with prominent female latin-american mathematicians.

<https://www.youtube.com/channel/UCFAa1OZbGyKTvtnlF74Dvw/featured>

3. **Foster collaboration between Mexican students and Mexican professors abroad.**

Among the remote participants we paid particular attention to students who live in Mexico. We organized parallel sessions where they could expose their work and we asked the more experienced participants to enter the sessions and give them comments of their works and suggestions and comments of different graduate programs in the world. We hope that the new website will also present support for students seeking advice.

4. **Job opportunities in academia and industry.** A panel was organized around this topic (Panel Oportunidades Laborales), featuring recognized leaders of the Mexican mathematical and scientific community: Alejandro Adem (University of British Columbia), María Jose Rhi Sausi (CONACyT), Victor Rivero (CIMAT), Yasmin Rios (UANL) and Jesús de Loera (UC Davis).

5. **Raise awareness of gender equality and minority issues in Mathematics.** As Mexican mathematicians we are all part of an under-represented group of the STEM community. We paid particular emphasis on women since they face intersectionality issues. Two talks were organized around this topic presented by Natalia García-Colin (Université libre de Bruxelles) and Pamela Harris (Williams College) and followed by a fruitful conversation among all the participants.

In addition to these talks, which took place during the workshop, we created a series of videos, available on YouTube, of gender and minorities in Mathematics in Latin America.

6. **Development and building together panel.** A final panel with experienced mathematicians with a strong interest in developing the Mexican community was organized. This panel included Gabriela Araujo (UNAM), Ana Rechtman (Université de Strasbourg), José Seade (UNAM) and Hamish Short (Aix Marseille Université). In the panel we discussed points to improved and different paths that the Mexican Mathematicians in the World can take in the near future to have a stronger and more effective impact.

We would also like to remark that this is the first event where the panels have a strong female presence. Before the panel used to be called "Directors panel" and most of the directors of Mexican institutions are male.

7. **Build and strengthen networks of global cooperation.** In addition to the above, a new team of organizers was formed, incorporating experienced and newly recruited members, to follow up with the organization of a similar event in 2023. A database of Mexican mathematicians living abroad is being maintained by this group, with the contribution of participants and other members of the Mexican mathematical community.

Presentation Highlights

The workshop included 15 research talks (in Spanish), covering a range of current research activity of the participants. Here is a summary of the highlights.

- Rodrigo Treviño (University of Maryland, USA) spoke about Lorentz gas and quasicrystals. His talk included an introduction to Lorentz gas, which is a model of statistical mechanics that dates back to the beginning of the 20th century and whose objective was to decipher the behavior of electrons within a crystal. At that time, a crystal was any solid whose molecular structure was periodic. This changed in the early 1980s with the discovery, made by Dan Shechtman, of solids whose molecular structure was not periodic and yet possessed ordered molecular structure. These solids were called "quasicrystals" and the discovery earned Shechtman the Nobel Prize in chemistry in 2011. Lorentz gas in periodic crystals has been studied since Sinai's work in the late 1960s, and its statistical properties have been known very well. In contrast, the vast majority of the statistical properties of Lorentz gas in quasicrystals are unknown to date. The talk addressed these systems and some results that have recently been obtained in the case of quasicrystals.
- Carlos Mejia-Monasterio (Universidad Politécnica de Madrid, Spain) spoke about rational billiards, polygons and their properties as transport models. His talk included the description of a polygonal billiard which is an example of pseudo-chaotic dynamics, consisting of a combination of integrable evolution and discontinuous jumps due to conic singularities that appear at the corners of the polygon. This pseudo-chaotic dynamics, characterized by null Lyapunov exponents, is responsible for the high sensitivity that the particle transport properties have on the details of the billiard geometry. In addition, his talk included a comprehensive introduction to billiards and their use as models of statistical mechanics. The talk addressed the statistics of particle displacement in a family of quasi-one-dimensional polygonal billiards. He showed that the transport of particles associated with their dynamics is characterized by a strong anomalous diffusion with a mean square displacement that scales in time faster than linearly and is part of a certain kind of universality. The displacement probability density exhibits exponential tails and is asymptotically dominated by ballistic fronts. In finite systems the

distribution of the first pass times is characterized by algebraic tails and with a mean value that diverges when the polygon is rational.

- Cintia Pacchiano (Aalto University, Finland) spoke about total variation flow in general metric spaces. Her talk focuses on the existence and the theory of regularity of variational solutions associated with the total variation flux (TVF) in a metric space. To this end, she adopted a variational approach to the study of TVF. Advantages of this approach include better convergence and stability properties. The talk discussed, for the first time, existence and regularity issues for parabolic problems with linear growth in metric spaces.
- Andrés Muñoz Medina (Google, USA) spoke about an introduction to statistical privacy. His talk included a historical overview of how the concept of privacy has evolved over the years. The talk addressed the concept of statistical privacy and how this concept quantifies a balance between the usefulness of statistical models and the protection of a user's data. During this talk, several open problems in this area were discussed and why a better mathematical understanding of this problem is necessary.
- Hector Cenicerros (University of California at Santa Barbara, USA) spoke about mathematics applied to the study of soft materials and complex fluids. His talk addressed the fundamental role that mathematical moderation, design, analysis, and the application of numerical methods have in the study of important systems such as soft materials and complex fluid formulations. A very current topic that was discussed during this talk is the amalgamation of deep machine learning (deep learning) with scientific computing to accelerate the discovery of new materials and how this novel approach could transform the way of doing scientific computing for a vast set of applications.
- Carmen Galaz-García (University of California at Santa Barbara, USA) spoke about representation spaces. Her talk included a brief introduction to higher Teichmüller theory through hyperbolic geometry and geometric group theory. During this talk, she highlighted that closed surfaces of genus greater than 1 admit many hyperbolic structures. These structures can be encoded algebraically by $\mathrm{PSL}(2, \mathbb{R})$ representations of their fundamental group. She wonders if such representation also holds geometric information about the closed surface. The answer is given by Anosov representations.
- José Andrés Rodríguez Migueles (LMU München, Germany) spoke about periods of continuous fractions and volumes of the complement of modular nodes. The talk highlights the correspondence between closed geodesics on the modular surface and periodic orbits of the geodesic flow in its unit tangent bundle. The isotopy class of any periodic orbit can be viewed as a knot in a 3-manifold. The exterior of these nodes is always a hyperbolic 3-manifold, and therefore has a well-defined volume. During this talk, he showed that there are sequences of closed geodesics in which said volume is linearly bounded in terms of the period in continuous fractions of the corresponding closed geodesic.

- Ian Gleason (University of Bonn, Germany) spoke about local Shimura varieties. His talk included an introduction of local Shimura varieties as well as a motivation of their study and its relevance to the local Langlands program. During this talk some historical developments in the development of the area were presented as well as some open questions about the geometry of local Shimura varieties.
- Enrique Torres (Trinity Western University, Canada) spoke about equations for finite groups. His talk focuses on the problem of counting solutions of systems of equations in terms of group characters. In particular, he talked about a classic Frobenius formula that counts the number of ways an element can be written as the commutator of two other elements, and he also described how this Frobenius formula can be extended to other counting problems. During this talk, he discussed how this topic has connections to other areas such as topology and probability.
- Emilia Alvarez (University of Bristol, UK) spoke about random matrices, number theory and correlated systems. Her talk included a presentation of the basic theory of random matrices and some of its applications. Random matrices appear in the statistics of certain correlated systems, for example in nuclear physics, in number theory, in financial markets, in climate science, in networks such as the internet, and in buses in Cuernavaca. During this talk, she gave an overview of the applications of random matrices to the zeros of functions of L in number theory (such as the Riemann zeta function) and to weather systems.
- Jose Ibrakim Villanueva Gutierrez (Hebrew University of Jerusalem, Israel) spoke about the main conjecture of Iwasawa. The classical Iwasawa main conjecture, which is actually a theorem (B. Mazur & A. Wiles 1984), reveals the links between arithmetic objects, p -adic L -functions, and complex L -functions. During this talk, he explained the relationships between the above-mentioned objects as well as its consequences. Finally he presented some generalizations. His talk was based on his book 'Amazing Infinite Towers: An Introduction to Iwasawa's Theory' written jointly with Michael Fütterer.
- Laura Matrajt (Fred Hutchinson Cancer Research, USA) spoke about optimal distribution of COVID-19 vaccines: Who to vaccinate first? She highlighted the fact that COVID-19 vaccines are the best tool we have to fight the pandemic. However, given the vaccine shortage, prioritizing who gets vaccinated first has been, and continues to be, unavoidable. During this talk, she described two projects in which, by combining mathematical models and optimization algorithms, she determined the optimal use of these precious resources. In the first project, she determined who should be vaccinated first, showing that the optimal use of COVID-19 vaccines depends on the efficacy of the vaccine and the number of vaccines available. In the second project, she considered who should be vaccinated and how many doses they should receive, finding

that the optimal distribution of vaccines depends on the efficacy of the first dose, viral transmission, and the number of vaccines available.

- Dialid Santiago (Citi, UK) spoke about quantitative risk problems in corporate and investment banking. During this talk she presented an overview of the different mathematical and computational tools used in the area of quantitative finance. She presented three problems that arise in different areas of the banking sector: modeling of expected loss, estimation of Correlation Matrices in large dimensions, and modeling of oil futures prices.
- Sarai Hernandez Torres (Technion - Israel Institute of Technology, Israel) spoke about metric spaces generated by random walks. During this talk she considered the intrinsic metric in two probabilistic models in \mathbb{Z}^d : the uniform spanning tree and random entanglements. Both models can be built with random walks and define fitted graphs in \mathbb{Z}^d . The metric space associated with these graphs is random, so she focused on properties that are satisfied with probability one (by taking the appropriate limit).
- Silvia Fernández-Merchant (California State University, USA) spoke about studying the geometric and topological structure of graph drawings in the plane. During this talk, she studied drawings of graphs in the plane in which the vertices are points and the edges are curves that join them. She is interested in optimizing parameters determined by the geometry or topology of these drawings. There are several famous problems in this area that are easy to understand and are generally still open. However, variants of these problems can be accessible at different levels. One of her favorite problems in this context is to minimize the number of edge crossings over all the plots of the entire graph. During her talk, she shared ideas and variations of this and similar problems.

Comments from Participants regarding Scientific Progress and Networks

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