Symposium of Physics and Mathematics FCFM-IFM

November 26th to 28th, 2018

PROGRAM

Monday, November 26th

9:00 – 10:00 hrs Jorge Luis López-López

“Cónicas y sus aplicaciones”

Las cónicas son curvas muy sencillas, pero la naturaleza escoge la sencillez para regularse. En esta plática me gustaría revisar algunas propiedades de las cónicas, y aplicaciones a óptica, gravitación e ingeniería. El reto es dar un plática usando únicamente conceptos geométricos elementales, sin usar cálculo ni conceptos más avanzados.

10:00 – 11:00 hrs Clayton Shonkwiler

“What's the Probability a Random Triangle is Obtuse? An Introduction to Geometric Probability, Shape Spaces, Group Actions, and Grassmannians”

“Three Points are taken at random on an infinite Plane. Find the chance of their being the vertices of an obtuse-angled Triangle.'' This is the text of Lewis Carroll's Pillow Problem #58, from 1884. This and similar problems (e.g., “what's the probability that a random quadrilateral is convex?'') sparked intense debate in the 19th century as mathematics was just starting to get to grips with what it means to choose something “at random'', spawning the fields of geometric probability and measure theory. In this talk, I will present a modern approach to these problems that interprets random polygons as random points on special spaces called Grassmannians and then uses tools from differential geometry. In particular, I will present the exact probability that a triangle is obtuse and that a polygon is convex, as well as precise statements about extreme triangles. This provides an introduction to an active area of mathematical research devoted to understanding random shapes which has important applications in modeling biological and synthetic polymers.

11:00 – 11:30 hrs Coffee Break

11:30 – 12:30 hrs Henry Adams

“An introduction to applied topology”

This talk is an introduction to topology, the study of shapes and surfaces, as applied to data analysis and to sensor networks. The shape of a dataset often reflects important patterns within, and I will describe topological tools for visualizing and understanding high-dimensional datasets. One such dataset with an interesting shape is the conformation space of the cyclo-octane molecule, which is a Klein bottle glued to a 2-sphere along two circles. As a second application, I will show how topology has been applied to coverage problems in mobile sensor networks.

12:30 – 13:30 hrs Michael DiPasquale

“Piecewise Linear Functions, Projecting Polytopes, and Equilibrium Stresses”

Piecewise linear functions are a crucial tool for approximating functions or surfaces in many different contexts. In numerical analysis, a key question is to determine `how many' piecewise linear functions there are over a subdivision in the plane. We introduce this question by way of several examples, paying special attention to the fact that piecewise linear functions have especially interesting behavior over planar polygonal subdivisions. This fact was known more than 100 years ago by the mathematician and physicist James Clerk Maxwell. His observation was that a planar graph has a `lift' precisely when it has something called an `equilibrium stress.' Maxwell's observation was used in mechanical engineering for a long time, but was

Tuesday, November 27th

9:00 – 10:00 hrs Juan Bosco Frías-Medina
¿De qué va la geometría algebraica?
El objetivo de esta plática es dar una visión global acerca de qué es la geometría algebraica así como algunos aspectos históricos sobre su desarrollo.

10:00 – 11:00 hrs Vittoria Bonanzinga
"Gotzmann monomials in four variables"
Let R be the polynomial algebra in n variables over a field. Determining which monomial ideals in R have the Gotzmann property is notoriously difficult. A characterization was achieved in n = 3 variables by Murai in 2007, see [M]. The problem is completely open for n ≥ 4. A natural intermediary step towards a general solution in any number n of variables is to restrict attention to those monomial ideals I = hui which are Borel-fixed and Borel-generated by a single monomial u. In that respect, we say that u is a Gotzmann monomial if the ideal hui has the Gotzmann property. The question of determining all Gotzmann monomials is itself a very difficult problem. In July 2018, in a joint work with Shalom Eliahou, we achieved a surprisingly intricate full solution of this problem in n = 4 variables. The corresponding 30 pages article has been submitted in a high level international journal in August 2018, see [BE]. In this talk, I'll present the main results contained in [BE]. For n ≥ 5, the characterization of Gotzmann monomials is still open.

[BE] V. Bonanzinga, S. Eliahou, Gotzmann monomials in four variables, (30 pages, submitted August 2018).
[M] S. Murai, Gotzmann monomial ideals, Illinois J. of Math. 51, n.3, 843–852, (2007).

11:00 – 11:30 hrs Coffee Break

11:30 – 12:30 hrs Petr Zhevandrov
"Rayleigh-Bloch waves trapped by periodic perturbations"
It is well-known that a uniform submarine ridge serves as a waveguide for surface water waves, that is, it gives rise to trapped modes. What happens if instead of a uniform ridge one considers a periodic (say, in the x-direction) series of bumps of small height? The answer is as follows: this perturbation generates a so-called Rayleigh-Bloch (RB) wave which is quasiperiodic in x, decays exponentially in the orthogonal direction and is a solution to the Helmholtz equation which describes water waves in the shallow water approximation. Moreover, the first embedded threshold of the continuous spectrum of the unperturbed problem also generates an RB mode but only when a certain geometric condition is satisfied by the perturbation. When this condition is violated, the trapped mode becomes a complex resonance with small imaginary part and the reflection and transmission coefficients for the corresponding scattering problem present drastic changes in a neighborhood of the real part of the resonance. We obtain explicit formulas for these objects in the form of series in powers of the small parameter characterizing the magnitude of the perturbation.

12:30 – 13:30 hrs Gabriel Espinosa-Pérez
"Propiedades Mecánicas de Monocapas Mixtas de DPPC y POPE"
En esta plática presentaremos los recientes resultados obtenidos en estudios de las propiedades mecánicas de monocapas mixtas compuestas por un lípido insaturado: palmitoyl-oleoyl-glycero-posphoethanolamine (POPE) y un lípido saturado: dipalmitoyl-glycero.posphocoline (DPPC). Se realizaron compresiones isotérmicas y deformaciones de cizallamiento sinuosidades, las fases y sus texturas fueron observadas con microscopio de ángulo de Brewster. Los resultados encontrados indican que el comportamiento de las monocapas mixtas es afectado por la miscibilidad de ambos lípidos. En la región bifásica, el módulo elástico de compresión aumenta con la cantidad de fase LC, pero su comportamiento es más complejo que el esperado por un modelo simple de medio efectivo. Discutiremos la causa de estas discrepancias.

16:00 – 17:00 hrs **Pablo Martínez-Torres**

“Nanopartículas de oro y óxidos metálicos en aplicaciones de SERS y como fungicidas”

Se presenta un método práctico para la fabricación de sustratos nanoestructurados de aluminio-oro para el realzamiento de la señal Raman (SERS) y la incorporación de nanopartículas de oro en una matriz de alumina con la capacidad de mantener su actividad SERS ante la exposición a temperaturas extremas. Además, se evaluó la aplicabilidad de los sustratos en el monitoreo de imatinib, droga usada en el tratamiento de cáncer, permitiendo emplear la espectroscopia Raman como una herramienta rápida para el monitoreo de pacientes en tratamiento. Por otro lado, se evaluó la actividad antifúngica de nanomateriales de óxidos metálicos (ZnO, MgO, ZnO: MgO y compósitos de ZnO: Mg (OH)2), preparados en diferentes condiciones de síntesis, frente a las cepas de C. gloeosporioides obtenidas de papaya y aguacate.

Wednesday, November 28th

9:00 – 10:00 hrs **Alexis García-Zamora**

“Introducción a las curvas algebraicas”

Explicaremos las definiciones básicas de la Geometría Algebraica a través del concepto de curvas algebraicas planas. Se presentarán su relación con otra partes de las matemáticas, como la topología o el cálculo.