IX Conferencia de Matemáticos Ecuatorianos en París (CON-MAT-E-P)

Lunes 6 - Viernes 10 de noviembre 2023

Institut Henri Poincaré, sala 201 Maryam Mirzakhani,
11 rue Pierre et Marie Curie, 75005 París - Francia.

Programa

Lunes 6 de Noviembre

Hora	Orador
10h00 - 10h50	María Eugenia Martinez
11h00 - 11h50	Estefanía Loayza*
12h00 - 14h00	*almuerzo*
14h00 - 14h50	Christian Galarza
15h00 - 15h50	Murat Akman*
16h00 - 16h30	*pausa*
16h30 - 17h20	Juan Mayorga*
17h30 - 18h20	Cristina Sabando*

Martes 7 de Noviembre

Hora	Orador
10h00 - 10h50	Randy Llerena
11h00 - 11h50	Claire Alamichel
12h00 - 14h00	*almuerzo*
14h00 - 14h50	Patricio Guerrero
15h00 - 15h50	Jiao He*
16h00 - 16h30	*pausa*
16h30 - 17h20	Elena Ochoa*
17h30 - 18h20	Mariana Smit Vega García*

Miércoles 8 de Noviembre

Hora	Orador
10h00 - 10h50	David Llerena
11h00 - 11h50	Johana Jimenez*
12h00 - 14h00	*almuerzo*
14h00 - 14h50	Jessica Trespalacios*
15h00 - 15h50	Katherine Morales
16h00 - 16h30	*pausa*
16h30 - 17h20	Cristian Chica*
17h30 - 18h20	Carlos Cortez*

Jueves 9 de Noviembre

Hora	Orador
11h00 - 11h50	Sandra Gutierrez
12h00 - 14h00	*almuerzo*
14h00 - 14h50	Ronny Tonato*
15h00 - 15h50	Luis Miguel Torres
16h00 - 16h30	*pausa*
16h30 - 17h20	Alex Imba*
17h30 - 18h20	Silvia Ghinassi*

Viernes 10 de Noviembre

Hora	Orador
10h00 - 10h50	Gastón Vergara-Hermosilla
11h00 - 11h50	Kevin Contreras
12h00 - 14h00	*almuerzo*
14h00 - 14h50	Geremy Loachamín
15h00 - 15h50	Yandira Cuvero*
16h00 - 16h30	*pausa*
16h30 - 17h20	Carmen Judith Vanegas*
17h30 - 18h20	Evelyn Cueva*

- *Las conferencias de los oradores cuyo nombre contiene " * " serán realizada en línea.*

Resúmenes

- **Murat Akman (Essex)**. *A Minkowski problem and the Brunn-Minkowski inequality for nonlinear capacity.*

  The classical Minkowski problem consists in finding a convex polyhedron from data consisting of normals to their faces and their surface areas. In the smooth case, the corresponding problem for convex bodies is to find the convex body given the Gauss curvature of its boundary, as a function of the unit normal. The proof consists of three parts: existence, uniqueness and regularity.

  In this talk, we study a Minkowski problem for certain measure, called p-capacitary surface area measure, associated to a compact convex set E with nonempty interior and its $p-$harmonic capacitary function (solution to the p-Laplace equation in the complement of E). If μ_p denotes this measure, then the Minkowski problem we consider in this setting is that; for a given finite Borel positive measure μ on $\mathbb{S}^{n-1}$, find necessary and sufficient conditions for which there exists a convex body E with $\mu_p = \mu$. We will discuss the existence, uniqueness, and regularity of this problem which have deep connections with the Brunn-Minkowski inequality for p-capacity and Monge-Ampère equation.

- **Claire Alamichel (Paris-Saclay)**. *Modelling and numerical simulations of cell motility.*

  Cell motility is a biological mechanism involved in a number of biological phenomena such as immune response, wound healing, embryogenesis or cancer development. First, I will present a rigid model in dimension 2 describing cell motility and present a numerical scheme in order to run numerical simulations of this model and to study the trajectories of cells. Secondly, I will present how to model the cell nucleus rigidly and present a numerical scheme of this model with the cell nucleus as well as some numerical results.

- **Cristian Chica (Minnesota)**. *Mathematical models for platform competition.*

  Platform businesses have immensely grown in the last several decades due to the widespread adoption of communication technologies. For example, the sales of Amazon, which is a platform, have grown from $148 millions in 1997 to $386 billions in 2020. Platforms facilitate the interaction between different types of users, such as buyers and sellers (Amazon and eBay), drivers and riders (Uber and Lyft) and content creators and consumers (YouTube, Twitch and Spotify). Their business model has become very popular, but its careful study is still in an early stage, where the first research works are from the beginning of this century. There are still many open questions and, in particular, a complete model of platform competition is still far from reach. In this talk, I will introduce the main models for platform competition, I will discuss the mathematics behind these models. At last, I will present some open problems.

- **Kevin Contreras (Ecole Supérieure de Physique et Chimie Industrielle)**. *Modelamiento matemático de la deflectometría y sus aplicaciones en la industria.*

  La deflectometría es una técnica óptica que presenta hoy en día un renovado interés. La gama de superficies medibles abarca desde superficies planas hasta superficies de forma libre con pendientes elevadas, con dimensiones que oscilan entre milímetros y varios metros. Lo ilustramos con varias aplicaciones: mediciones de lentes oculares, mediciones de grandes espejos y mediciones en línea en fabricación de ultraprecisión sin necesidad de entrar en contacto con la muestra. Describimos propiedades importantes de la deflectometría y comparamos sus posibilidades y limitaciones con las de la interferometría. Trataremos de discutir sus principales ventajas y limitaciones así como las herramientas matemáticas que permitirian desarrollar el potencial de la deflectometría en el futuro.

- **Carlos Cortez (Northwestern University)**. *Cohomología sintómica de álgebras polinomiales truncadas.*

  Sea R un anillo conmutativo y p un primo. La cohomología sintómica $\mathbb{Z}_p(i)(R)$ (donde $i \in \mathbb{Z}_{\geq 0}$) ha recibido renovada importancia por su aparición como las piezas graduadas asociadas a la filtración motívica de Bhatt-Morrow-Scholze en la homología cíclica topológica $TC(R)$. Junto al teorema de Dundas-Goodwillie-McCarthy que relaciona $TC(R)$ con K-teoría algebraica, esto ha permitido a Sulyma simplificar el cómputo de $K(R)$ para $R = \mathbb{F}_p[x]/x^n$ y a Antieau-Krause-Nikolaus realizar varios de los primeros cálculos en el caso $R = \mathbb{Z}/p^n$.

  En esta charla daré un resumen de esta historia y procederé a explicar cómo extender ideas de Sulyma a nuevas álgebras polinomiales truncadas. Específicamente, para anillos de la forma $R = \mathbb{F}_p[x, y]/(x^a, x^b - y^c)$, describo un algoritmo computacional implementado en SageMath para obtener primero su cohomología prismática $\mathbb{\Delta}_R$ junto con su filtración de Nygaard y, a partir de ellas, la cohomología sintómica $\mathbb{Z}_p(i)(R)$.

- **Evelyn Cueva (EPN)**. *Uniqueness analysis for Exponential-decay Transforms with application in fluorescence imaging.*

  Exponential decay models are valuable tools for comprehending dynamic processes in various fields, such as fluorescence imaging. In these models, the intensity or amplitude of a signal decreases exponentially over time, providing valuable insights into the underlying physical, chemical, or biological phenomena. While exponential decay finds broad applications, there are specific scenarios in which considering the time-of-flight (TOF) term is essential. This paper delves into the significance of the TOF term, particularly in the context of short-lived events in Fluorescence Lifetime Imaging with Optical Projection Tomography (FLIM-OPT). It presents a uniqueness result for solving an inverse problem when dealing with piecewise constant lifetimes, along with a back-projection formula for recovering the ratio between fluorescence distribution and lifetime.

- **Yandira Cuvero (EPN)**. *Procesos Gaussianos y análisis Bayesiano para la determinación de procesos puntuales espaciales.*

  Los procesos puntuales permiten modelar una diversidad de eventos que se desarrollan en el espacio, estos buscan estudiar la importancia que el espacio tiene la estructura del modelo. Para describir un proceso puntual, se puede utilizar su medida de intensidad. En particular, los procesos de Cox Log-Gaussianos, considera como medida de intensidad un proceso Gaussiano. El presente trabajo estudia la construcción del proceso Gaussiano aditivos mediante métodos Bayesianos considerando un proceso influenciado por dos factores tipo ANOVA. Se obtiene como resultado una estimación en distribución del conteo de eventos en una región determinada. Para mostrar la aplicación de esta metodología, se muestra su uso para una base de datos correspondiente a la flotación mineral, en la cual, mediante la introducción de gas en un reactor, permitiendo que este flote y se recolecte de su superficie.

- **Christian Galarza (ESPOL)**. *Multivariate skew-T regression with censored or missing responses.*

  Skew-t regression models have been widely used to model and analyze asymmetric heavy-tailed data. Moreover, observations in this kind of data can be missing or subject to some upper and/or lower detection limits because of the restriction of the experimental apparatus. We propose a novel robust regression model for multiple censored or missing data based on the multivariate skew-t distribution for such data structures. This approach allows us to model data with great flexibility, simultaneously accommodating heavy tails and skewness.

  We develop an analytically simple yet efficient EM-type algorithm to conduct maximum likelihood estimation of the parameters. The algorithm has closed-form expressions at the E-step that rely on formulas for the mean and variance of truncated multivariate Student's-t, skew-t, and extended skew-t distributions. Furthermore, a general information-based method for approximating the asymptotic covariance matrix of the estimators is also presented. Results obtained from the analysis of both simulated and real datasets are reported to demonstrate the effectiveness of the proposed method.

- **Silvia Ghinassi (University of Washington)**. *Conjuntos autosimilares y gráficos de Lipschitz.*

  Un conjunto de dimensión uno es puramente no rectificable si casi no tiene sombras. En otras palabras, si la intersección con gráficos de Lipschitz tiene medida cero. Â¿En qué dimensión se ven realmente entre sí los conjuntos puramente no rectificables y los gráficos de Lipschitz? Después de unas pocas respuestas preliminares, voy a presentar la construcción de gráficos de Lipschitz que cruzan conjuntos puramente no rectificables en dimensiones altas. Para empezar, tomamos en cuenta el caso especial de el conjunto de Cantor con quatro esquinas, y después vamos a generalizar la construcción para conjuntos autosimilares, i.e. atractores de sistemas iterativos de funciones que satisfacen una cierta condición de separación. Voy a incluir un montón de imágenes, e intentaré mantener la charla accesible a una audiencia general de matemáticos. La charla va a ser en inglés. Esto es un trabajo en curso junto con Blair Davey y Bobby Wilson.

- **Patricio Guerrero (KU Leuven)**. *Alineación de proyecciones en tomografía y reconstrucciones regularizadas como problemas de optimización.*

  En tomografía, previo al problema inverso de reconstrucción, se debe abordar un problema adicional de alineación de proyecciones. Propondremos soluciones para dicho problema en geometrías de adquisición en abanico (fan-beam) y cono (conebeam). Están basadas en un algoritmo de punto fijo y proyección de variable, planteados como un problema de optimización. Luego, se presentarán resultados preliminares con respecto al problema de reconstrucción en el caso particular de disponer de datos insuficientes, también como un problema de optimización regularizado, utilizando técnicas de dualidad.

- **Sandra Gutierrez (EPN)**. *The Integrated Vehicle and Pollster Routing Problem.*

  The National Statistics Bureau of Ecuador conducts monthly surveys to monitor the fluctuations of a vital economic indicator known as the "Consumer Price Index" (CPI). The CPI serves as a metric for tracking the average changes in prices paid by urban consumers for a specified basket of goods and services. To accomplish this essential task, a designated set of stores is meticulously chosen, and a set of pollsters gather the requisite data. These pollsters are transported from the Bureau's headquarters to the selected stores, using a homogeneous fleet of vehicles of fixed capacity. Additionally, for geographical or connectivity reasons, pollsters can move between stores either by pedestrian routes or available vehicles.

  In this study, we introduce the Integrated Vehicle and Pollster Routing Problem, presenting an integer programming model that seamlessly integrates the scheduling of pollsters' visits to selected stores with the optimal routing of the vehicle fleet tasked with their transportation. We delve into the computational complexity of this multifaceted challenge, propose a three-phase algorithm, and offer insightful findings based on practical, real-world scenarios.

  This is joint work with A. Miniguano-Trujillo, D. Recalde, L.M. Torres, and R. Torres.

- **Jiao He (Paris-Saclay)**. *Vanishing limit of a small solid in a three-dimensional incompressible viscous fluid.*

  In this talk, I will present our recent result on the study of the evolution of a small rigid body in an incompressible viscous fluid that fills the whole space $\mathbb{R}^3$. When the small rigid body shrinks to a "massless" point in the sense that its density is constant, we prove that the solution of the fluid-rigid body system converges to a solution of the Navier-Stokes equations in the full space. To achieve this, I will introduce a technique that utilizes L^p-L^q estimates of the fluid-structure semi-group and a fixed-point argument to obtain a uniform estimate of velocity of the rigid body. I then will present the construction of the test function and the process of passing to the limit. This is a joint work with Pei Su (Charles University).

- **Alex Imba (Universidad Técnica Federico Santa María)**. *Carleman estimates for transmission waves with variable jumps.*

  In this work, we present new Carleman estimates for a wave equation where the main coefficient is variable and has a jump discontinuity on a strictly convex interface. We also prove Lipschitz stability for the recovery of a spatially dependent potential by boundary measurements.

  Work in collaboration with: Lucie Baudouin (LAAS-CNRS), Alberto Mercado (UTFSM), and Axel Osses (U. CHILE).

- **Johana Jimenez (Universidad Autónoma de Barcelona)**. *Limit cycles for continuous and discontinuous perturbations of two cubic ischronous centers.*

  A *limit cycle* of a differential system is a periodic orbit that is isolated in the set of all periodic orbits of the system. One of the main open problems in the qualitative theory of planar differential systems is the study of the limit cycles that can bifurcate from a center, or from its periodic orbits. These problems have been studied intensively in these last decades and are closely related to the Hilbert's 16th problem. In this work we consider two reversible cubic isochronous centers and we study both continuous and discontinuous perturbations inside the general class of cubic polynomial differential systems. In the continuous case we provided the maximum number of small and medium limit cycles which bifurcate from the center and from the periodic orbits surrounding the center, respectively, either when both of reversible cubic isochronous centers are perturbed inside the class of all continuous cubic polynomial differential systems or when the parameters of one of the reversible cubic centers are perturbed. In the discontinuous case we study the small limit cycles for six families of discontinuous piecewise differential systems formed from the two reversible cubic isochronous centers. The main tool used for proving our results is the averaging theory up to seven order.

- **David Llerena (Paris-Saclay)**. *Sobre la existencia, regularidad y unicidad de soluciones de las ecuaciones micropolares estacionarias.*

  En esta presentación hablaremos de ciertos resultados respecto a las ecuaciones micropolares estacionarias, las cuales están compuestas de 3 variables: la velocidad, la presión y la velocidad de microrotación. Primero, presentaremos la existencia de soluciones para dicho sistema mediante un argumento de compacidad, lo cual no permite deducir información con respecto a la unicidad de la solución. Sin embargo, es posible deducir que dichas soluciones son regulares. Por otro lado, considerando el problema de la unicidad e insipirados en la teoría de las ecuaciones de Navier-Stokes estacionarias, probamos un resultado del tipo Liouville para estas ecuaciones. En efecto, si suponemos que la velocidad verifica cierto control de integrabilidad adicional, es posible deducir la unicidad de la solución trivial. Es importante observar que no suponemos ningún control adicional sobre las otras variables, lo cual es la novedad de nuestro trabajo.

- **Randy Llerena (Viena)**. *Configuraciones óptimas en un problema con dos fronteras libres.*

  En esta charla tratamos un modelo variacional que considera al mismo tiempo energías elásticas y superficiales. Además, se considera la posibilidad de fracturas, filamentos, adhesiones y delaminaciones entre materiales. En primera instancia se presentará de forma rigurosa la formulación matemática de estos fenómenos físicos, luego, se demuestra la existencia de configuraciones mínimas aplicando el Método Directo del Cálculo de Variaciones (con la restricción de una cantidad finita de componentes conexos de las fronteras topológicas de cada material). Se presentará igualmente una extensión de este modelo al tratamiento de layers finitos. En colaboración con P. Piovano.

- **Geremy Loachamín (Universidad de Luxemburgo)**. *De la difusión anómala a la difusión clásica en una ecuación del calor no lineal.*

  En esta charla, consideramos una ecuación de tipo calor con un término de transporte no lineal y un término de difusión: primero de tipo anómalo con el Laplaciano fraccionario con parámetro $1 < \alpha < 2$ y luego de tipo clásico con el Laplaciano. Cuando $\alpha \to 2$, se muestra la convergencia uniforme de las soluciones del caso fraccionario al caso clásico. Además, se deduce rigurosamente una tasa de convergencia, estudiada numéricamente en trabajos previos para el caso lineal.

- **Estefanía Loayza (Imperial College London)**. *Cálculo geodésico discreto para variedades de Riemann completas.*

  El cálculo geodésico en variedades riemannianas involucra los funcionales exponencial y logarítmico, el transporte paralelo, entre otros. Normalmente, estos funcionales están asociados con la solución de EDOs, que en la mayoría de los casos, no pueden ser resueltas de forma cerrada y lo mejor que se puede hacer es aproximarlas numéricamente. En particular, si estamos interesados en resolver problemas de optimización en variedades, necesitamos acceder a dichos funcionales múltiples veces por cada iteración del algorítmo de optimización, lo que hace que su aplicación sea muy costosa computacionalmente.

  En esta charla desarrollaremos el cálculo geodésico discreto basado en una medida de disimilitud que sea computacionalmente poco costosa. Esto nos permitirá aproximar dichos funcionales de una manera más eficiente, pero sin dejar de aprovechar las ventajas de trabajar en espacios no lineales. Nos concentraremos en las variedades rieamannianas completas, cuyas métricas pueden expresarse en términos de una métrica base (incompleta) y una función propia, tal como se describe en Gordon 1973. Se considerarán tres ejemplos para demostrar la eficacia del método propuesto.

- **María Eugenia Martinez (Lyon)**. *The soliton problem for water waves models with a varying medium.*

  We focus on the study of solitary waves for two deep water wave models: the Whitham equation and the Zakharov water wave system. In particular, we analyse the behaviour of a solitary wave when it encounters a change in the environment, for example when the bottom of the domain containing the fluid is altered.

  Zakharov water waves arises as a free surface model for an irrotational and incompressible fluid under the influence of gravity. Such a fluid is considered in a domain with a rigid bottom and a free surface. In this talk, we are interested in analysing the behaviour of the solitary wave solution of the flat-bottom problem when the bottom actually presents a change at some point, where the solitary wave enters into an interaction regime with the bottom.

  This is joint work with Claudio Muñoz (Universidad de Chile) and Frédéric Rousset (Université Paris-Sud).

- **Juan Mayorga-Zambrano (Yachay Tech)**. *Existence of positive solutions for a p-Schrödinger-Kirchhoff integro-differential equation with critical growth*

  We consider the integro-differentiable problem

$$-\left[\varepsilon^p a + b\varepsilon^\beta \left(\int_{\mathbb{R}^N} |\nabla v|^p \, dx\right)^{p-1}\right] \Delta_p v + M(x)|v|^{p-2}v = \tilde{\sigma}(v), \tag{1}$$

  for $x \in \mathbb{R}^N$ and $v \in W^{1,p}(\mathbb{R}^N)$; where $\tilde{\sigma}(s) = \lambda f(s) + |s|^{p^*-2}s$, $b \geq 0$, $a, \varepsilon, \lambda > 0$ and $\beta = p^2 - Np + N$. The dimension N and p verify $1 < p < N \leq p + 1 < p^* - 2$, where $p^* = pN/(N-p)$. We assume that M and f are continuous and verify conditions considered by Wang et al; in particular, $\mathcal{M} = \{x \in \mathbb{R}^N / M(x) = \text{ínf } M\} \neq \varnothing$. Thanks to a study of the ground state of the limit problem associated to (1), we prove, by the method of Nehari manifold, the existence of a positive ground state of (1). By a Ljusternik-Schnirelmann scheme it?s shown that, for ε small and λ big, (1) has at least $\text{cat}(\mathcal{M}, \mathcal{M}_\delta)$ positive solutions, where $\mathcal{M}_\delta = \{x \in \mathbb{R}^N / \text{dist}(x, \mathcal{M}) < \delta\}$, $\delta > 0$.

- **Katherine Morales (Télécom SudParis)**. *A probabilistic semi-supervised approach with triplet Markov Chains*

  Triplet Markov chains are general generative models for sequential data which take into account three kinds of random variables: (noisy) observations, their associated discrete labels, and latent variables which aim at strengthening the distribution of the observations and their associated labels. However, in practice, we do not have all the labels associated with the observations to estimate the parameters of such models. We propose a general framework based on a variational Bayesian inference to train parameterized triplet Markov chain models in a semi-supervised context. The generality of our approach enables us to derive semisupervised algorithms for a variety of generative models for sequential Bayesian classification.

- **Elena Ochoa (Universidad del Bío Bío)**. *Gevrey semigroup of the type III localized thermoelastic model.*

  We consider the Euler Bernoulli beam model with localized thermoelastic component following the Green and Naghdi type III theory. We prove that the corresponding semigroup is of Gevrey class 8, regardless of the size of the thermoelastic component or the position it occupies over the beam. In particular, our result implies the instantaneous smoothing effect property over the initial data, the exponential stability of the semigroup and that the exponential rate is equal to the spectral bound of its infinitesimal generator.

- **Cristina Sabando (Washington University in St. Louis)**. *Numerical monoids, numerical operads and applications to combinatorics.*

  In this work we consider cancellative monoids (c-monoids), in the construction of partially ordered sets (posets). In particular, we apply this general construction to the submonoids of $\mathbb{N}$. In association with a locally finite poset, the incidence algebra is classically studied. Every incidence algebra possesses two elements which are special and invariant under poset isomorphisms, the zeta function and its inverse, the Möbius function. We present and prove results using combinatorial arguments, generating functions and the Möbius function associated to posets. Recently, $^+1$-monoids were introduced for the study of ordered set partitions. Using the properties of $^+1$-monoids, we construct a new family of posets. The Möbius generating function of each of these posets is the inverse (with respect to the composition of formal power series) of its zeta generating function. Those results allow us to obtain new derivation of the Fuss-Catalan numbers with alternating signs. We extend this construction to c-monoids arising from the ordinal product of $\mathcal{L}s$-species and to c-operads. Operads are also monoids, but associated to the ordinal substitution of $\mathcal{L}s$-species. Finally, we prove that the restriction of an operad to sets whose cardinal is in a $^+1$ monoid is also an operad. That is, we prove that the law of composition of the operad restricted to a $^+1$ monoid is well defined.

- **Ronny Tonato (Grenoble)**. *Analysis of cellular interactions through Graph Neural Networks.*

  Functional analysis of cells by microscopy is currently focused on image processing, where researchers commonly employ epi-fluorescence microscopes for this kind of cell analysis. These microscopes use cell marking to visualize sub-cellular or phenotypic information. Even though neural networks have improved the efficiency of the analysis algorithms, they have not changed the way of understanding cellular analysis. This one remains centred on elementary cellular measurements, where the cells are being considered as isolated objects without considering the interactions with their neighboring cells. In this context, models based on Graph Neural Networks (GNNs) are deep learning methods capable of considering cell-cell interactions to try to quantify them and predict them.

  In this talk we will first review some definitions and notions about graphs, which will give us a better understanding of this kind of data structures used before introducing Graph Neural Network (GNN) models and how to do learning in graphs. Then, I'll present an application of my research problem that I've been working on.

- **Luis Miguel Torres (EPN)**. *TBA*

  TBA

- **Jessica Trespalacios (Chile)**. *Global Existence and Long Time Behavior in Einstein-Belinski-Zakharov Soliton Spacetimes.*

  We consider the vacuum Einstein field equations under the Belinski-Zakharov symmetries. Depending on the chosen signature of the metric, these spacetimes contain most of the well-known special solutions in General Relativity, including well-known black holes, also, under Belinski-Zakharov symmetries, the Einstein field equation can be written as a difficult system of quasilinear equations. In this talk, we present some results about the global existence of small Belinski-Zakharov spacetimes under a natural non-degeneracy condition. We also construct new energies and virial functionals to provide a description of the energy decay of smooth global cosmological metrics inside the light cone. Finally, some applications are presented in the case of generalized Kasner solitons.

  This is joint work with Claudio Muñoz.

- **Carmen Judith Vanegas (Yachay Tech)**. *First order differential operators associated to $\tilde{\Delta} = div(B\nabla)$ operator in Clifford Analysis.*

  Let $\mathcal{F}$ be a given differential operator acting with respect to spacelike variables, then a function space B is called an associated space to $\mathcal{F}$ if $\mathcal{F}$ applies B into itself. In this research work, a characterization of all the first-order differential operators with coefficients in the Clifford algebra CL_n that are associated to the space of solution functions of the partial differential equation $\tilde{\Delta}u = div(B\nabla)u = 0$ has been determined. To make this possible the equation $\tilde{\Delta}u = 0$ and some special solutions of such equation were used. The results found imply that the technique of associated spaces allows to solve certain initial value problems.

  This is joint work with Franklin Vargas.

- **Mariana Smit Vega García (Western Washington University)**. *Almgren-type monotonicity formulas.*

  In this talk, we will explore the celebrated Almgren's monotonicity formula. This beautiful result with far-reaching consequences states that if u is harmonic in the unit ball, then a certain frequency function $N(r)$ is non-decreasing. Moreover, $N(r) = k$ for all $r < 1$ if, and only if, u is homogeneous of degree k. We will then discuss some of the many applications of this formula, and recent developments connected to it. This is joint work with Blair Davey.

- **Gastón Vergara-Hermosilla (Paris-Saclay)**. *On the existence, regularity and uniqueness of some equations arising in fluid dynamics.*

  In this talk we will present some recent results about the existence, regularity and uniqueness of 3 relevants PDEs arising in fluid dynamics: the micropolar equation, the Navier-Stokes equation and its fractional generalisation. In a first part we will present the theorems and some of the background necessary to deal with them. In a second part we will sketch the proof of the results.