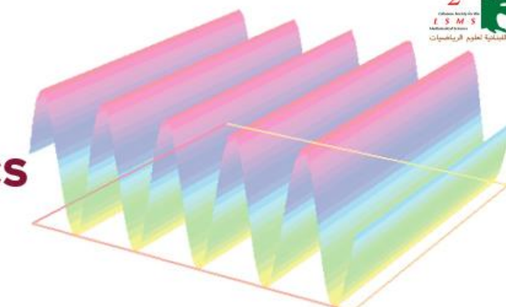
AMERICAN UNIVERSITY of BEIRUT
CENTER FOR ADVANCED MATHEMATICAL SCIENCES

AMERICAN UNIVERSITY of BEIRUT
FACULTY OF ARTS & SCIENCES
Department of Mathematics

CAMS WORKSHOP ON INVERSE PROBLEMS AND COMPUTATIONAL MATHEMATICS

WEDNESDAY, JUNE 5, 2024

COLLEGE HALL, AUDITORIUM | ZOOM



Time Evolution Graph, S. Moufawad, 2024

Titles & Abstracts

Faouzi Triki (Grenoble Alpes University, France)

Title: Recovering point sources for the inhomogeneous Helmholtz equation

Abstract: The presentation is related to the inverse point source problem for the Helmholtz equation. It consists of recovering the locations and amplitudes of a finite number of radiative point sources from the knowledge of a single boundary measurement. A new Hölder type stability estimate for the inversion under the assumption that the point sources are well separated will be exposed. The proof of the stability is based on a combination of Carleman estimates and a technique for proving uniqueness of the Cauchy problem.

Sophie Moufawad (American University of Beirut, Lebanon)

Title: Direct and Inverse Problem for Gas Diffusion in Polar Firn

Abstract: Simultaneous use of partial differential equations in conjunction with data analysis has proven to be an efficient way to obtain the main parameters of various phenomena in different areas, such as medical, biological, and ecological. In the ecological field, the study of climate change (including global warming) over the past centuries requires estimating different gas concentrations in the atmosphere, mainly CO_2. The mathematical model of gas trapping in deep polar ice (Firns) consists of a parabolic partial differential equation that is almost degenerate at one boundary extreme. In this work, we consider all the coefficients to be constants, except the diffusion coefficient that is to be reconstructed. We present the theoretical aspects of existence and uniqueness for such direct problem and build a robust simulation algorithm. Consequently, we formulate the inverse problem that attempts to recover the diffusion coefficients using given generated data, by defining an objective function to be minimized. An algorithm for computing the gradient of the objective function is proposed and its efficiency is tested using different minimization techniques available in MATLAB's optimization toolbox.

Toufic El Arwadi (Beirut Arab University, Lebanon)
Title: Analysis of a contact problem for a viscoelastic Bresse model
Abstract: We study a Signorini for the viscoelastic Bresse beam (curved beam). We show the existence of a unique weak solution for the system. Later we show that the system is exponentially stable without any constraint on the physical parameters. A numerical scheme is introduced and analyzed. Finally, some numerical experiments are performed to demonstrate the decay of the discrete energy and the numerical convergence.

Mirza Karamehmedovic (Technical University of Denmark, Denmark)
Title: On localization and the landscape function for regular Sturm-Liouville operators
Abstract: Localization is an emergent wave phenomenon that occurs in quantum dynamics, electrodynamics, and several other fields, where certain eigenfunctions concentrate at small subsets of the problem domain. We here consider localization in dimension one, specifically estimating the localization effect in eigenfunctions of regular Sturm-Liouville operators. Moreover, there is evidence that the so-called landscape function can indicate where low-frequency eigenfunctions localize. We characterize the landscape function in terms of low-frequency eigenfunctions of the regular Sturm-Liouville operator. Joint work with F. Triki.

Ali Wehbe (Lebanese University, Lebanon)
Title: On the asymptotic behavior of solutions of distributed systems
Abstract: In this talk we will introduce the notion of stabilization of distributed systems with different types of damping. Then, we study the asymptotic behavior of solutions of wave/wave transmission problems with local internal damping or with boundary damping. Finally, we give some numerical simulations.

Omar Lakkis (University of Sussex, United Kingdom)
Title: Aposteriori error estimates and adaptive methods for Galerkin methods for the wave equation
Abstract: Aposteriori error analysis for Galerkin finite element methods have proven very successful tool in developing mathematically rigorous adaptive mesh refinement algorithms for elliptic and parabolic equations. Progress for the wave equation has picked up only in recent years. I will review in the first part of the talk the state of the art in this field. In the second part, I will present recent work of mine and coauthors, especially in connection to

practical schemes such as the Leapfrog method and local time step variants that are used in acoustics, geophysics, imaging and engineering.

Ahmad Sabra (American University of Beirut, Lebanon)

Title: **Inverse Problems in Imaging and Non-imaging Optics**

Abstract: **Imaging Optics deals with optical systems whose goal are to create an image at a target set. In non-imaging optics, we are rather interested in the characteristics of the radiation leaving the system such as direction, and intensity. We present in this talk several inverse problems in Geometric Optics with models that are of interest in physics and Optical engineering ant that involve solving systems of non-linear differential equations.**

Hagop Karakazian (American University of Beirut, Lebanon)

Title: **Recovering the Polytropic Exponent in the Porous Medium Equation: An Asymptotic Approach**

Abstract: **The Porous Medium Equation is given by $u_t = \Delta u^\gamma$ with polytropic exponent $\gamma>1$. An inverse problem for PME (subject to a homogeneous Dirichlet boundary condition) would be to recover γ from one or more measurements of the solution u at different time instances. In this talk, we present a method for recovering γ from the knowledge of u at a given large time T. Our work is based on an asymptotic inequality satisfied by $u(T)$. We also present an upper bound for the error between the exact and recovered γ. Finally, we show a summary of numerical tests done in two and three dimensions.**

This is joint work with Toni Sayah and Faouzi Triki.