Inverse Problems for PDEs

Laboratoire de Mathématiques de Reims, 02 - 03 June 2015

Invited Speakers

Habib Ammari (ENS - Paris)

Mourad Choulli (IECL - Metz)

Michel Cristofol (LATP - Marseille)

David Dos Santos Ferreira (IECL - Nancy)

Houssem Haddar (CMAP Polytechnique - Paris)

Guanghui Hu (WIAS- Berlin)

Yavar Kian (CPT - Luminy, Marseille)

Eric Soccorsi (CPT - Luminy, Marseille)

Program

Tuesday 02 June

14:30 - 15:20   Habib Ammari

Mathematics for imaging

In this talk, we will suggest schemes for electrical sensing of objects by weakly electrical fish and for echolocation by bats. We will present recent results for shape identification and classification in electro-sensing using pulse form and waveform signals. We will also introduce an efficient and novel approach based on frequency-dependent shape descriptors for shape perception and classification in echolocation. Finally, we will apply the developed bio-inspired approaches in biomedical imaging in order to enhance the resolution, the robustness, and the specificity of tissue property imaging modalities.

15:30 - 16:20   Guanghui Hu

Shape identification in inverse medium scattering with a single far-field pattern

Consider time-harmonic acoustic scattering problems in two and three dimensions. We prove that bounded penetrable obstacles with corners or edges with an arbitrary angle scatter every incident wave nontrivially. Moreover, if such a penetrable obstacle is a convex polyhedron or polygon, then its shape can be uniquely determined by the far-field pattern over all observation directions incited by a single incident plane or point source wave. This is a joint work with J. Elschner.

16:30 - 17:00   Coffee Break

17:00 - 17:50   Mourad Choulli

A multi-dimensional Borg-Levinson theorem

My talk concerns a stability estimate related to the multi-dimensional Borg-Levinson theorem of determining a potential from spectral data: the Dirichlet eigenvalues and the normal derivatives of the eigenfunctions on the boundary of a bounded domain. The estimate is of Hölder type, and we allow finitely many eigenvalues and normal derivatives to be unknown. We also show that if the spectral data is known asymptotically only then we still have Hölder stability. This is a joint work with Plamen Stefanov.

18:00 - 18:50   Houssem Haddar

On the Transmission Eigenvalue Problem for Maxwell's Equations

We consider the transmission eigenvalue problem for Maxwell's equations corresponding to non-magnetic inhomogeneities. This problem arises naturally in the study of the inverse scattering problem from inhomogeneous media. Transmission eigenvalues correspond with frequencies for which one can construct nearly non-scattering incident wave. Their study has gained an important interest in recent years due to their link with practical inversion algorithms and also due to stimulating mathematical challenges behind this non linear/non selfadjoint eigenvalue problem.
We shall address in this talk the case of Maxwell's Equations with contrast that changes sign inside the scatterer. We demonstrate how a surface integral formulation of the eigenvalue problem can help revealing the Fredholm nature of the problem and understanding the structure of these transmission eigenvalues.
This formulation also allows the use of standard numerical libraries to numerically approximate these (possibly complex) eigenvalues.
This is a joint work with Fioralba Cakoni and Shixu Meng from the University of Delaware.

Wednesday 03 June

09:00 - 09:50   **Eric Soccorsi**

A Borg-Levinson theorem in periodic cylindrical domains

We consider the Dirichlet Laplacian in a 3D infinite cylindrical domain associated with a smooth bounded cross section, which is perturbed by a bounded real-valued and periodic electric potential. This operator admits a fiber decomposition. We prove uniqueness and stability in the inverse problem of determining the electric potential from the asymptotic behaviour of the spectral data of any fiber operator.
This is joint work with Otared Kavian (Versailles) and Yavar Kian (Marseille).

9:55 - 10:15   **Coffee Break**

10:15 - 11:05   **Michel Cristofol**

New Kind of Observations in an Inverse Parabolic Problem

In this talk, I analyze the inverse problem of determining the reaction term $f(x, u)$ in reaction-diffusion equations of the form $\partial_t u - D\partial_{xx} u = f(x, u)$, where f is assumed to be periodic with respect to $x \in \mathbb{R}$. Starting from a family of exponentially decaying initial conditions $u_{0,\lambda}$, I will show that the solutions u_λ of this equation propagate with constant asymptotic spreading speeds w_λ. The main result shows that the linearization of f around the steady state 0, $\partial_u f(x, 0)$, is uniquely determined (up to a symmetry) among a subset of piecewise linear functions, by the observation of the asymptotic spreading speeds w_λ.

11:10 - 12:00   **Yavar Kian**

A multidimensional Borg-Levinson theorem for magnetic Schrödinger operators with partial spectral data

Let H be the Dirichlet realization of the magnetic Schrödinger operator $(-i\nabla + A)^2 + V$ on a bounded domain $\Omega \subset \mathbb{R}^n$, $n \geq 2$, with $A \in W^{1,\infty}(\Omega, \mathbb{R}^n)$, and $V \in L^\infty(\Omega)$. We associate to H the full boundary spectral data given by the set $\left\{\left(\lambda_k, \partial_\nu \varphi_{k|_{\partial\Omega}}\right) : k \geq 1\right\}$, where $\{\lambda_k : k \in \mathbb{N}^*\}$ is the non-decreasing sequence of eigenvalues of H $\{\varphi_k : k \in \mathbb{N}^*\}$ an associated Hilbertian basis of eigenfunctions and ν the unit outward normal vector to $\partial\Omega$. We will consider the multidimensional Borg-Levinson theorem of determining both the magnetic field dA and the electric potential V from partial knowledge of the boundary spectral data of H.

12:05 - 12:55   **David Dos Santos Ferreira**

Geometric aspects of the Calderón problem

In this talk I will present the geometric version of the Calderón problem, and explain how the problem of finding the conformal factor in a certain conformal class of metrics with a fixed Euclidean direction relates to tomographic issues on the geodesic ray transform. This is based on joint works with Kenig, Salo and Uhlmann in the case of simple transversal metrics and joint work with Kurylev, Lassas and Salo in the general case.