Mini-Workshop on Mathematical Analysis and Related Topics

Abstract

January 27, 2022

Invited Speakers

Trushin Igor (Shinshu University, Japan)
Yong-Gwan Ji (Inha University, South Korea)
Hyeonbae Kang (Inha University, South Korea)
Daisuke Kawagoe (Kyoto University, Japan)
Takashi Nakazawa (Osaka University, MMDS, Japan)
Grigori Rozenblum (Chalmers Univ. Technology, Sweden; St. Petersburg, University, Sirius University, Russia)

Program

This workshop will start at **10:00 JST (UTC +9), 27 January 2022**
(9 am Beijing, 4 am Saint Petersburg, 2 am Stockholm, 1 am London, 8 pm New York)

10:00-10:50 Takashi Nakazawa (Osaka, MMDS)

Title: Shape Optimization for Complex Flows

Abstract: Complex flow (Turbulence, Non-Newtonian fluid, Compressible flow) are playing an important role in engineering/industry, and has been always regarded as target for shape optimization problem. So far, Model-Based approach is studying to design a fluidic machinery but is quite difficult from Its spatial and temporal complex behavior. The author is adopting Data-Drive approach to solve shape optimization problem, successfully suppressing time fluctuation part of Turbulence.

11:00-11:50 Trushin Igor (Shinshu)

Title: Inverse Scattering Problems on Quantum Graphs

Abstract: Inverse scattering problem for a Sturm-Liouville operator on the metric graph consisting of a finite number of half-lines joined with either a loop or a finite number of finite intervals is investigated. The scattering matrix, part of the negative eigenvalues and corresponding normalizing coefficients are taken as a scattering data. The main goal of this research is to reconstruct the coefficients of Sturm-Liouville operator on the basis of the given scattering data. We have deduced Marchenko equation which allowed us to prove the uniqueness theorems, provided a reconstruction procedure for the coefficients on the half-lines and investigated the conditional stability of the inverse scattering problem.

The research was done jointly with Prof. K. Mochizuki

11:50-14:00 Lunch break

14:00-14:30 Daisuke Kawagoe (Kyoto)

Title: On polynomial compactness of the elastic Neumann-Poincaré operator on $C^{1,\alpha}$ boundaries in three dimensions

Abstract: The elastic Neumann-Poincaré (eNP) operator is a boundary integral operator that appears naturally when we solve classical boundary value problems for the Lamé system using layer potentials. It is known that the eNP operator is polynomially compact on $C^{1,\alpha}$ curves in two dimensional case, while it is on C^{∞} surfaces in the three dimensional case. This gap motivates us to prove its polynomial compactness on $C^{1,\alpha}$ surfaces. In this talk, we prove it by discussing the commutator of the surface Riesz transforms, which are singular integral operators of non-convolution type and play a crucial role in the previous work.

14:40-15:10 Yong-Gwan Ji (Inha)

Title: Spectral properties of the Neumann-Poincaré operator on m-fold rotational symmetric domains

Abstract: We consider the Neumann-Poincaré operator on m-fold rotational symmetric domains. It is proved that if we deform a bounded domain by m-th root transformation, then spectrum of the deformed domain, which has m-fold rotational symmetry, contains the spectrum of the original one.

15:10-15:40 Coffee break

15:40-16:30 Hyoenbae Kang (Inha)

Title: Quantitative analysis of field concentration and spectrum of the Neumann-Poincaré operator

Abstract: In a composite consisting of inclusions and a matrix with material properties of high contrast, some inclusions are located closely, and huge stress occurs in between them. Stress is a kind of field concentration and another is field enhancement to be used for imaging. In the perspective of applications, it is important to understand this field concentration in a quantitatively precise manner. It turns out that the mathematical problem for the field concentration is quite challenging since it can not be properly handled using standard elliptic PDE theory. Many significant results have been produced in this field of mathematics in the last thirty years or so, and still several outstanding problems are being produced and remain open to be solved. The purpose of this talk is to review some recent important developments and to discuss its connection to the spectral theory of the Neumann-Poincaré operator.

16:40-17:30 Grigori Rozenblum (Chalmers, St. Petersburg, Sirius)

Title: Spectral properties of zero order pseudodifferential operators and applications to the NP operator in 3D elasticity.

Abstract: It is known that the Neumann-Poincaré operator K in 3D elasticity is a zero order pseudodifferential operator on a closed surface. For a homogeneous isotropic body, it is known that the essential spectrum of consists of 3 points determined by the Lamé constants λ, μ of the material. Therefore, the eigenvalues of K can converge only to these three points. We discuss a new method for the study of eigenvalues of such, polynomially compact, pseudodifferential operators and, in particular, find their asymptotics. The formulas for the asymptotic coefficients are rather irrational, however for the two-sided asymptotics of eigenvalues these coefficients are shown to be linear combinations of the Euler characteristic and the Willmore energy of the surface with coefficients determined by the Lamé constants. Some results are obtained for the eigenvalues of the NP operator for the case when the material of the body is non-homogeneous - when the essential spectrum may consist of intervals.

Organizers

Kazunori Ando (Ehime University)
Yoshihisa Miyanishi (Shinshu University)

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