2019 CHAPTER

ICMC SUMMER MEETING
ON DIFFERENTIAL EQUATIONS

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SESSIONS:

- ✓ Boundary Perturbations of Domains for PDEs and Applications
- ✓ Computational Dynamics in the Context of Data
- ✓ Dispersive Equations
- ✓ Elliptic Equations
- ✓ Evolution Equations and Applications
- ✓ Fluid Dynamics
- ✓ Linear Equations
- ✓ Nonlinear Dynamical Systems
- ✓ Ordinary/Functional Differential Equations
- ✓ Poster Session

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Semilinear elliptic equations with terms concentrating on oscillatory boundaries

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In this work we study concentrating integrals properties through two applications, both in Lipschitz domains of $\mathbb{R}^2$, where we analyze semilinear elliptic problems posed in a oscillating region with reaction terms concentrated in a neighborhood of an oscillatory boundary when a small parameter goes to zero: an oscillating boundary domain which tends to a fixed limit domain; and a thin region with a oscillatory boundary. In both cases under some conditions we prove the upper and lower semicontinuity of the family of solutions from these problems, showing that the solutions of our perturbed equation can be approximated with one limit equation defined in a fixed domain, which also captures the effects of all relevant physical processes that take place in the original problem.

Neumann Laplacian in nonuniformly collapsing strips

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We consider the Neumann Laplacian in the region below the graph of $\varepsilon g(x)$, for a (possibly unbounded) positive smooth function $g : [a, \infty) \to \mathbb{R}$. As $\varepsilon \to 0$ such region collapses to $[a, \infty)$ and (under suitable technical conditions) an effective operator is found, which has Robin boundary conditions at a. Then we recover, in the case of unbounded g, such effective operators through uniformly collapsing regions; in such approach, we have (roughly) got norm resolvent convergence for g diverging less than exponentially.

On the effects of small boundary perturbation on the fluid flow

Igor Pažanin, Eduard Marušić-Paloka, University of Zagreb, Croatia

It is well-known that only a limited number of the fluid flow problems can be solved (or approximated) by the solutions in the explicit form. To derive such solutions, we usually need to start with (over)simplified mathematical models and consider ideal geometries on the flow domains with no distortions introduced. However, in practice, the boundary of the fluid domain can contain various small irregularities (rugosities, dents, etc.) being far from the ideal one. Such problems are challenging from the mathematical point of view and, in most cases, can be treated only numerically. The analytical treatments are rare because introducing the small parameter as the perturbation quantity in the domain boundary forces us to perform tedious change of variables. Having this in mind, our main goal is to present recent analytical results on the effects of a slightly perturbed boundary on the fluid flow through a channel filled with a porous medium. We start from a rectangular domain and then perturb the upper part of its boundary by the product of the small parameter ε and arbitrary smooth function. The porous medium flow is described by the Darcy-Brinkman model which can handle the presence of a boundary on which the no-slip condition for the velocity is imposed. Using asymptotic analysis with respect to ε, we formally derive the effective model in the form of the explicit formulae for the velocity and pressure. The obtained asymptotic approximation clearly shows the nonlocal effects of the small boundary perturbation. The error analysis is also conducted providing the order of accuracy of the asymptotic solution. We will also comment on our recent results concerning the problem of a reactive solute transport, MHD flow and time-dependent setting.