Title: **Introduction to the Mathematical theory of diffusion via PDEs**

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Abstract:

The course is intended to present the students with the basic concepts of the mathematical theory of diffusion formulated in terms of PDEs as well as some lines of current research where the researcher is active. It begins by a brief review of the heat equation and its connection to Physics and Probability, and continues with linear parabolic equations with variable coefficients. The novel direction of nonlocal interactions leads to the topic of fractional diffusion, in vogue in recent years.

We then present the main nonlinear models, like the porous medium equation, the fast diffusion equation, and the p-Laplacian equation. These equations have interesting functional analysis in the form of a priori estimates, interesting geometries in the form of free boundaries, and interesting asymptotics, where scalings, entropies and functional inequalities play a big role.

As the whole the course should offer a window to a peculiar world with a surprising number of concepts, theories, phenomena, applications and connections suited for many linesof further study..