Talk: Mathematical analysis and fast numerical methods for space- fractional diffusion

Speaker: Prof. Wang Hong

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Time: 10:10 a.m. - 10:50 a.m.

Abstract:

Fractional diffusion equations provide an adequate and accurate description of transport processes that exhibit anomalous diffusion, which cannot be modeled properly by second-order diffusion equations. In the past few decades fractional differential equations have been used in increasingly more applications. However, fractional differential equations raise mathematical and numerical difficulties that have not been encountered in the context of second-order differential equations.

Computationally, because of the nonlocal property of fractional differential operators, the numerical methods for fractional diffusion equations often generate dense coefficient matrices. Consequently, these methods often require computational work of $O(N^3)$ to invert per time step and memory of $O(N^2)$ for where N is the number of unknowns. Mathematically, fractional differential equations exhibit mathematical properties that have fundamental differences from those of second-order differential equations.

In this talk we go over the development of faithful and efficient numerical methods for space-fractional partial differential equations, without resorting to any loss compression, but rather by exploring the structure of the coefficient matrices. These methods have computational cost of $O(N\log_2^N)$ per time step and memory of $O(N)$, while retaining the same accuracy and approximation property of the underlying numerical methods. We will also address those mathematical issues that are characteristic for fractional differential equations and report our recent progress in this direction.