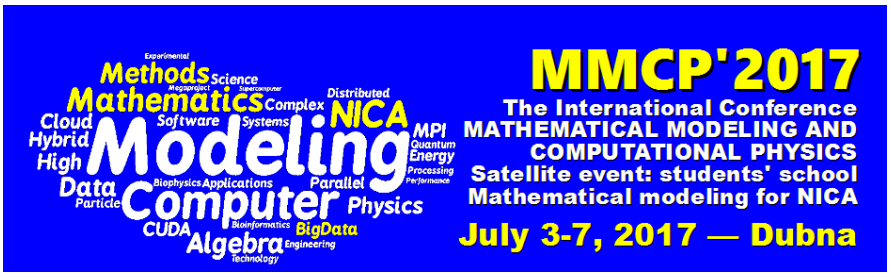

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Petrov-Galerkin Finite Element Method for Fractional Advection-Dispersion Equations

Monday 3 July 2017 11:30 (30 minutes)

First, we shall make a short introduction the concepts of fractional calculus and differential equations of fractional order that include both, steady-state and time dependent problems. This type of problems arise in mathematical modeling of asymmetric super-diffusion processes in highly heterogeneous media.

Further, we shall present variational formulations of Petrov-Galerkin type for one-dimensional fractional boundary value problems with either a Riemann-Liouville or Caputo derivative of order $\alpha \in (3/2, 2)$ in the leading term and involving both convection
and reaction terms. The well-posedness of the formulations
and sharp regularity pickup of the weak solutions are established.

A novel finite element method is developed, which employs continuous piecewise linear finite elements and "shifted" fractional powers for the trial and test space, respectively. The new approach has a number of distinct features as it allows deriving optimal error
estimates in both L^2- and H^1-norms and produces well conditioned linear systems, since the leading term of the stiffness matrix is diagonal matrix for uniform meshes. Further, in the Riemann-Liouville case, an enriched FEM is proposed to improve the convergence. Extensive numerical results are presented to
verify the theoretical analysis and robustness of the numerical scheme.

Short biography note

R. Lazarov obtained his PhD degree from Moscow State University under the supervision of Acad. A.A. Samarskii in 1972. He worked for the Bulgarian Academy of Sciences until 1991 and since then he is a professor at Texas A&M University, College Station, USA. He wrote a monograph (jointly with V.L. Makarov and A.A. Samarskii), authored and co-authored more than 150 journal papers, and advised 21 PhD students.

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