MISSOURI S&T University of Science & Technology

Department of Mathematics and Statistics

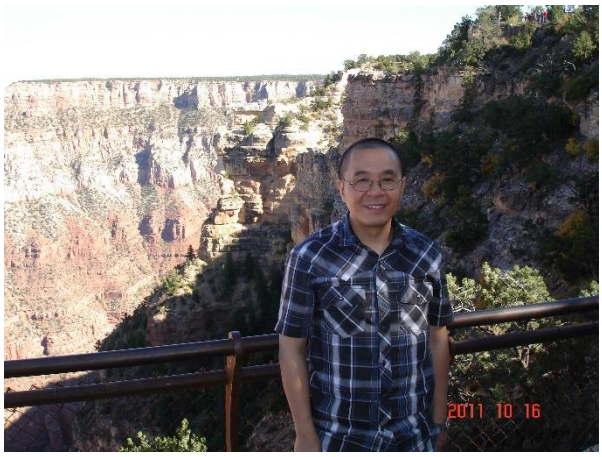
MICAMS Seminar

Friday, March 10, 4:00 – 5:00 pm

Rolla G5

Coffee and refreshments at 4:00 followed by the lecture at 4:15

Structure-preserving, operator splitting numerical schemes for reaction-diffusion system in the energetic variational approach



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Abstract: A few positivity-preserving, energy stable numerical schemes are proposed and analyzed for certain type reaction-diffusion systems involving the Law of Mass Action with the detailed balance condition. The energetic variational formulation is applied, in which the reaction part is reformulated in terms of reaction trajectories. The fact that both the reaction and the diffusion parts dissipate the same free energy opens a path of an energy stable, operator splitting scheme for these systems. At the reaction stage, equations of reaction trajectories are solved by treating all the logarithmic terms in the reformulated form implicitly due to their convex nature. The positivity-preserving property and unique solvability can be theoretically proved. Moreover, the energy stability of this scheme at the reaction stage can be proved by a careful convexity analysis. Similar techniques are used to establish the positivity-preserving property and energy stability for the standard semi-implicit solver at the diffusion stage. As a result, a combination of these two stages leads to a positivity-preserving and energy stable numerical scheme for the original reaction-diffusion system. It is the first time to report an energy-dissipation-law-based operator splitting scheme to a nonlinear PDE with variational structures. Several numerical examples are also presented.

Biographical Sketch: Dr. Cheng Wang is a professor in Department of Mathematics at the University of Massachusetts Dartmouth (UMassD). He obtained hid Ph.D degree from Temple University in 2000, under the supervision of Prof. Jian-Guo Liu. Prior to joining UMassD in 2008 as an assistant professor, he was a Zorn postdoc at Indiana University from 2000 to 2003, under the supervision of Roger Temam and Shouhong Wang, and he worked as an assistant professor at University of Tennessee at Knoxville from 2003 to 2008. Dr. Wang's research interests include development of stable, accurate numerical algorithms for partial differential equations and numerical analysis. He has published more than 110 papers with more than 5000 citations. He also serves in the Editorial Board of "Numerical Mathematics: Theory, Methods and Applications".