PURDUE UNIVERSITY

Department of Mathematics

Outstanding Alumnus Seminar

Thursday, September 24, 2015
4:30 p.m.
BRNG 2290

Refreshments will be served at 4:00 p.m. in the MATH Library Lounge

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Exponentially Convergent Numerical Methods for the Inversion of Laplace Transforms and Their Applications

We will begin with a short history of the discoveries of Fourier and Laplace transforms in the beginning of 19th centuries. These transforms have been contributed deeply and widely in the development of mathematics as well as a variety of applied sciences and engineering.

When I was a graduate student in this department, Profs. Jim Douglas and Juan Santos were interested in the propagation of seismic waves in porous media saturated by multi-phase fluids. It is known that waves in such media depend on the frequency. The governing equations are of integro-differential form, and thus it was very natural for us to solve the problem in the frequency domain. Then the time snaps are computed by an inverse Fourier transform, such as the FFT (Fast Fourier Transform). This approach led us to develop the so-called "frequency-domain methods" for wave propagations [DSSB93, DSS94, FS94, SDS93, GSS01], which generated many interesting mathematical problems and applied to various fields. Moreover, these procedures provided "naturally parallel algorithms", which are embarrassingly fast.

Later, Vidar Thome´e suggested to apply such idea in solving parabolic problems together with Ian Sloan, using inverse Laplace transforms instead. Indeed, parabolic problems are as- sociated with analytic semigroups while hyperbolic problems are associated only with C_0 – continuous semigroups. This enabled us to use deformed contours in the inversion of Laplace transforms [SST00, SST03], the idea of which influenced several computational mathematicians to investigate on faster methods in the direction, such as exponentially convergent methods [LS09, LFPS06, WT07, Wei10, LS09, GMV11, TW14].

In this talk, we will review the development of the exponentially convergent methods with analysis and applications.