

WANG Li-Lian
Assistant Professor
Division of Mathematical Sciences
School of Physical and Mathematical Sciences
B.S. (XiangTan); Ph.D (Shanghai)



Research Interests: **Numerical Analysis and Scientific Computing**
Spectral and spectral-element methods; Numerical methods
for unbounded domains and complex geometries; High-order
adaptive methods for wave and electromagnetic scattering

Email: lilian@ntu.edu.sg
<http://www.ntu.edu.sg/home/lilian/>
Tel: (65) 6513 7669
Fax: (65) 6316 6984

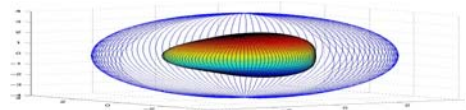
Development of high-order adaptive computational methods

Mathematical modeling of practical problems oftentimes leads to partial differential equations in unbounded domains and/or in complex geometries. In practice, high-order methods become highly demanded in the simulations. We are currently working on developing several efficient numerical approaches (a) effective domain truncation techniques coupled with efficient spectral approximation techniques in bounded domains with particular applications to wave scattering problems; (b) direct methods using orthogonal polynomials and/or functions in unbounded domains; (c) Orthogonal rational approximations based on the mapping techniques.

We have established a set of approximation results in certain functional spaces, which are useful for the analysis of numerical methods for a wide range of problems in bounded and unbounded domains. We are also interested in the development of high-order triangular spectral-element methods for complex geometries, and apply them to the simulations of incompressible flow and electromagnetic wave propagations with rough scatterings. Our approach is based on the use of rational orthogonal approximation and has a couple of appealing features, when compare with the existing spectral-element methods. It is highly flexible, easy to implement, and very accurate. As a result, it can provide an insight into the flow and wave propagation structures. Our research also concerns the construction of adaptive spectral methods for time-dependent problems. Unlike the finite element methods, spectral methods are implemented on the fixed grid points. We are using map techniques to redistribute the grid points to where they are most needed.

Applications to CFD, CEM, finance and information processing

The most important task and issue is to apply the developed methods to a wide spectrum of applications in fluid dynamics, electromagnetism, financial engineering and information processing such as signal and image processing. The main mathematical ingredients include mathematical modeling (PDEs), efficient algorithm design, simulation and visualizations, which integrate a wide range of knowledge crossing out several disciplines.



Elongated wave scattering

Selected publications:

1. Generalized Laguerre interpolation and pseudospectral method for unbounded domains, B. Guo, L. Wang and Z. Wang, *SIAM J. Numer. Anal.* 43 2567-2589 (2006)
2. Spectral approximation of the Helmholtz equation with high wave numbers, J. Shen and L. Wang, *SIAM J. Numer. Anal.* 43 623-644 (2005)
3. Jacobi approximations in non-uniformly Jacobi-weighted Sobolev Spaces, B. Guo and L. Wang, *J. Approx. Theor.* 128, 1-41 (2004)
4. Error analysis for mapped Legendre spectral methods, J. Shen and L. Wang, *SIAM J. Numer. Anal.* 42, 326-349 (2004)
5. Jacobi interpolation approximations and their applications to singular differential equations, B. Guo and L. Wang, *Adv. Comp. Math.* 14 227-276 (2001)