Program Topic for Internships

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Topic 1： Numerical methods for Compressive Sensing

Compressed sensing plays an important role in many science and engineering applications, for instance, imaging, sensor network, MRI and Astronomy. Various type of mathematics modeling and numerical algorithms are proposed and studies during the past decades including of random sampling, sparse tensor expression and recovery.

Topic 2: Numerical solution for Option Pricing

Since the Chicago Board Options Exchange started to operate in 1848, the trading of options has grown to tremendous scale and plays an important role in global economics. Various type of mathematical models for the prices of different kinds of options are proposed during the last decades, and the valuation of options has been topic of active research. Based on the Black-Scholes model for American options, numerical solutions including operator splitting methods, penalty methods, high order compact schemes with local mesh refinement, Modulus-based matrix splitting methods are considered and analyzed.

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Topic 1：Uncertainty Quantification

"uncertainty is anywhere", UQ aims to include uncertainty in mathematical models and quantify its effect on output of interest used in decision making. UQ has a variety of applications, including hydrology, fluid mechanics, data assimulation, and weather forecasting.

Topic 2: Multiscale analysis for the PNP Equations

Electrostatic interaction in aqueous solution including charged interfaces is of interest in a wide range of areas such as biological macromolecules, colloidal suspensions and nanoparticle assembly. The structure of screened ions near charged surfaces, so-called the electric double layer, controls many macroscopic properties of the system such as the zeta potential and colloidal renormalized charges, and is affected by such as the interfacial chemistry, the surface charge distribution, and the ionic specificity. A deep understanding of correlation effects and its relation with interfacial properties are then considered to be great meaningful in many applications. A multiscale computational formulations of the Poisson-Nernst-Planck (PNP) equations will be studied to describe the multiscale ionic transfer phenomena, coupled with electro capillary effects, in electrically charged periodic porous media.

Topic 3: Multiscale analysis for materials with dynamic internal structure

In various modern applications, including biomimetic and energy related materials, nanomanipulation, self-organization in material systems, cell mechanics, polymer engineering, material aging and other studies, the vital physical phenomena are often determined by localized kinetic processes occurring at the macroscopic scales of time. Examples of such basic phenomena include grain boundary dynamics, diffusion, capillary phenomena, entropy-driven protein unfolding, and similar processes. The long-term nature of these phenomena implies inapplicability of the MD/FE coupling approaches for studying overall macroscopic properties of the relevant material structure. Interesting opportunities arise from a joint usage of the discrete non-deterministic and continuum finite element modeling of the elastic, heat and mass transfer processes in material systems.