# Scientific Computing



# Fractional derivative modeling of “anomalous” behaviors of soft matter

**Prof. Wen Chen from Hohai University, China, will visit SC between Sep. 26 and Oct. 10. In connection with Prof. Chen's visit, he will give a guest lecture on Wednesday, September 26, in Bakrommet, 13:15-14:00.**

## Fractional derivative modeling of “anomalous” behaviors of soft matter


**Professor Wen Chen**

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Total number of participants: 17
Number of different nationalities represented: 2
Total number of speakers: 1
Total number of talks: 1

Soft matter (e.g., human tissues, polymers, colloids, emulsions, foams, living organisms, rock layers, sediments, plastics, glass, rubber, oil, soil, DNA) has become an important bridge between physics and diverse disciplines. The frequency scaling power law of fractional order appears universal in physical behaviors of soft matter and is considered “anomalous”, compared with those of the ideal solids and fluids, where the various standard gradient laws of physics, mechanics and chemistry (e.g., Hookean elasticity, Newtonian viscosity, Fickian diffusion, Fourier heat conduction, Darcy’s law, etc) are broken. For instance, a fractional frequency power law is the universal dielectric response in soft matter, and the same is also true for dissipative acoustic propagation through soft matter. The standard mathematical modeling approach using partial time-space derivatives of integer order can not accurately describe such arbitrary frequency power law attenuations, except of ideal solids and fluids, while the fractional derivatives are instead found an irreplaceable modeling approach.

In particular, anomalous diffusion equation has been recognized as a master equation to describe frequency power scaling of various physical processes (e.g., transport, relaxation, dissipation). However, all such models are phenomenological in nature, and the underlying fundamental physical mechanism, however, is largely obscure.

The fractional derivative equations are also known to be computationally expensive, since they are non-local in nature and the numerical discretization will produce a dense matrix equation. Therefore, the development of corresponding fast numerical techniques is also a pressing yet perplexing problem.

In this talk, I will give a survey of the current status and future trend of the mathematical and numerical modeling of soft matter, involving basic problems and possible solutions. Our recent works will also be summarized. In particular, this talk will discuss the following issues:

- “Anomalous” behaviors of soft matter and their common features ；
- Modeling approaches （fractional calculus and Hausdorff derivative for partial differential equation modeling; Levy statistics, fractional Brownian motion, stretched Gaussian, nonextensive Tsallis entropy for statistical modeling ） ；
- Some opening issues in numerical solution of fractional and fractal derivative model equations of soft matters.

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| **What** | |
| **When** | Sep 26, 2007<br>from 01:15 PM to 02:00 PM |
| **Where** | Bakrommet at Simula |
| **Contact Name** | Xing Cai |
| **Add event to calendar** | vCal<br>iCal |