**Aleksandar Donev** (New York University):

**Mini Course on Fluctuating Hydrodynamics**

**Abstract:**

I will discuss fluctuating hydrodynamics (FHD) from both a mathematical, physical, and also computational perspective. For illustration purposes I will use as an example the simplest FHD equation describing a collection of Brownian walkers, often called the Dean-Kawasaki equation in physics, but I will also discuss the fluctuating momentum (Stokes) equation in relation to diffusion of a colloidal particle in a liquid. In the first part, I will focus on trying to understand what fluctuating hydrodynamics is, where it comes from, and what it means both mathematically and physically. One approach is to think of FHD as coming from Large Deviation Theory (LDT) for particle systems, however, this does not allow for genuinely nonlinear FHD, which I will argue is physically-important. Another approach, which I will advocate for, is related to LDT and comes from work with Pep Espanol (UNED, Madrid), and thinks of FHD as a coarse-grained Markovian approximation of the microscopic dynamics. In the second part, I will present some finite-volume schemes for numerically solving the equations of FHD including multispecies mixtures of charged and uncharged potentially reactive species, and explain the importance of discrete fluctuation-dissipation balance. Then, in the third part, I will discuss suspensions as a complex fluid and explain how FHD can be used to model them more efficiently, but also to extend the applicability of classical fluid dynamics to smaller and smaller scales, going down to describing individual ions in an electrolyte solution. I will adjust the topics based on the audience's interest as we go along.