Mathematics 664
Mathematical Theory of the Navier-Stokes Equations

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Title: Mathematical Theory of the Navier-Stokes Equations.

Course description: In these lectures I will introduce the basics of the mathematical of the Navier-Stokes equations of viscous incompressible fluids. These equations appear in a wide range of physical and biological applications, varying from oceanic and atmospheric dynamics, to combustion theory any body-fluid transport. From the mathematical point of view, these equations have been identified among the most challenging problems in Applied Analysis. On the other hand, from the computational point of view they are prohibitively expensive to simulate, and out of reach even for most powerful state-of-the-art computers.

In this course we will focus on the analytical properties of the solutions of these equations. Students who are interested in attending the course are expected to have a background in Real Analysis (and some basics of Functional Analysis). The rest of the course will be, to a large extend, self-contained.

Proposed topics to be covered:

1. Deriving the Navier-Stokes and Euler equations from basic physical principles. Introducing the appropriate Functional Spaces.
2. Steady state solutions to the Navier-Stokes equations and their regularity.
3. Time dependent weak solutions.
4. Global regularity of strong solutions for the two-dimensional case.
5. Short time existence of strong solutions in the three-dimensional case.
6. Time Analyticity and Gevrey regularity.
7. Long-time behavior of solutions, global attractors, determining modes, nodes and other degrees of freedom (if time allows)
8. Inertial Manifolds (if time allows).
Textbooks:


Other References:


