

The Clay Institute Millennium Prize Problem in Mathematical Fluid Dynamics

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Abstract

Modern mathematical fluid mechanics has been developing well over three centuries with profound applications in many branches of engineering sciences. Rigorous theory of fluid dynamics however gained impetus only in the 1930s starting with J. Leray and then by E. Hopf and O. A. Ladyzhenskaya in the 1950s. These works have identified the solvability of three dimensional Navier-Stokes equations with reasonable initial data as a profound open problem. At the turn of this millennium the Clay Institute identified seven outstanding problems in mathematics (with \$1M award for resolution of each of the problems), one of which was the above problem in the solvability of three dimensional fluid dynamics. In this talk we will give an exposition of this mathematical problem and its probabilistic/stochastic counterpart. We will also discuss some of the other famous mathematical problems currently actively researched in modern nonlinear partial differential equations literature such as the Einstein field equations of general relativity and geometric PDEs such as the Ricci flow which has been at the heart of the resolution of one of the Clay Institute Millennium problems, namely the Poincare Conjecture, in order to compare the mathematical challenges and opportunities.