SORS:Equilibrium and stability of fusion plasmas via three-dimensional Magneto-Hydrodynamics

Speaker: Dr. Joaquim Loizu from Princeton Plasma Physics Laboratory

Abstract: Controlled nuclear fusion could provide our society with a clean, safe, and virtually inexhaustible source of electric power production. Magnetic fusion has proven to be capable of producing large amounts of fusion reactions by confining magnetically the fusion fuel at sufficiently high density and temperature, thus in the plasma state. Similarly to neutral fluids, plasmas often exhibit instabilities and turbulent behaviour. This limits the performance of magnetic fusion devices such as tokamaks and stellarators.

The general theory to describe the macroscopic equilibrium and stability of magnetically confined fusion plasmas is the so-called Magneto-Hydrodynamics (MHD) theory. Two-dimensional MHD, typically enough to describe devices with certain continuous symmetries, has been shown to be a very powerful tool to understand which regimes of operation are optimal in terms of performance and stability. However, three-dimensional MHD, still not fully understood, has become necessary to describe future fusion devices which are designed to have no continuous symmetries.

In this talk, I will summarize the concepts of plasma, magnetic fusion, and MHD theory. Then I will describe a recently developed theory, referred to as Relaxed-MHD, which is capable of describing the equilibrium and stability of three-dimensional magnetically confined fusion plasmas. In particular, I will describe a state-of-the-art numerical code that implements this theory and I will show some examples of computed plasma equilibria.

Bio: Joaquim Loizu graduated in Physics at the Ecole Polytechnique Fédérale de Lausanne, carrying out his master thesis project at the Center for Bio-Inspired Technology, Imperial College London, on the theoretical and numerical study of the biophysics of light-sensitive neurons.

In 2009, he started his PhD studies with Prof. Paolo Ricci at the Centre de Recherches en Physique des Plasmas, the major plasma and fusion laboratory in Switzerland. His thesis focused on the theory of plasma-wall interactions and their effect on the mean flows and turbulence in magnetized plasmas. During his PhD, he developed first-principle analytical theories and performed both kinetic and fluid numerical simulations.

In 2014, he joined the Max-Planck-Princeton Center for plasma research as a Postdoctoral Research Fellow. His main research line is currently focused on the macroscopic equilibrium and stability of magnetically confined fusion plasmas. He is currently at the Princeton Plasma Physics Laboratory working with Dr. Stuart Hudson and Prof. Amitava Bhattacharjee on three-dimensional magnetohydrodynamics.