

# Instability and sensitivity of the flow around a rotating circular cylinder

Luca Brandt

Royal Inst. of Tech. Sweden

2:30-3:30 pm

Friday, January 30

319 Akerman Hall

**ABSTRACT:** The aim of the talk is to present a theoretical framework based on the use of the adjoint stability operator to identify the instability mechanisms as well as the sensitivity of the flow to external forcing. The two-dimensional flow around a rotating circular cylinder at  $Re = 100$  is considered. The flow is characterized by two instability modes: at low rotation rates, the classic von Karman vortex street is observed to be distorted by the cylinder rotation while at high cylinder rotation, a low-frequency instability has been recently found. The instability mechanisms for the first and second shedding mode are analysed: The region in the flow with a role of 'wave-maker' in the excitation of the global instability is identified by considering the structural sensitivity of the unstable mode. This approach is compared with the analysis of the perturbation kinetic energy production, a classic approach in linear stability analysis. Multiple steady state solutions are found at high-rotation rates, explaining the quenching of the second shedding mode. Turning points in phase space are associated to the movement of the flow stagnation point. In addition, a method to examine which structural variation of the mean flow has the largest impact on the instability features is proposed. This has relevant implications for the passive control of instabilities. Finally, numerical simulations of the flow are performed to verify that the structural sensitivity analysis is able to provide correct indications on where to position passive control devices, e.g. small obstacles, in order to suppress the shedding modes.

**BIOGRAPHY:** Luca Brandt took his master degree in Mechanical Engineering with honor in 1997 at the University of Rome la Sapienza. After, he was a graduate student at the Department of Mechanics at KTH, (supervisor Prof. Dan Henningson) where he is now Associate Professor. He has been involved in numerous international collaborations (about 10 different institutions in Europe); In particular, he spent 9 months at the Hydrodynamics Laboratory (LadHyX) of Ecole Polytechnique. His main research interests are in hydrodynamic stability, receptivity, transition to turbulence and flow control. He has performed large-scale numerical simulations, theoretical and experimental investigations. In 2006 he was awarded the Goran Gustafsson Fellowship for young researchers. In 2008, he won the "Special Researcher" Position from the Swedish Research Council (VR) in Mechanics.