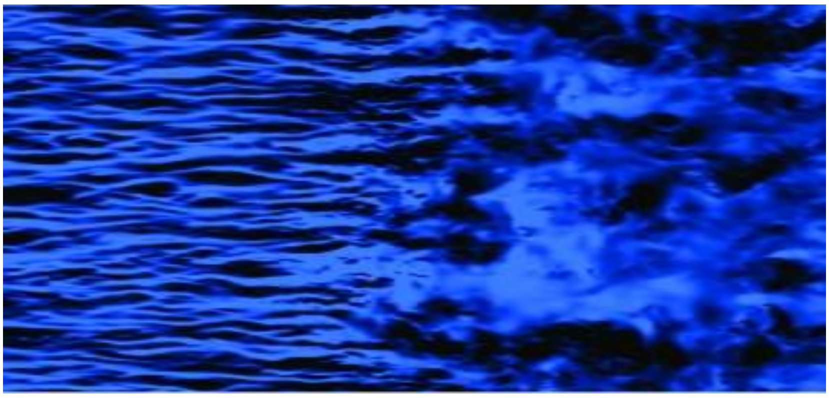
OIST SEMINAR

Date: April 18th, 2014 (Fri)
Time: 2:00 pm – 3:00 pm
Venue: Seminar room C210
Speaker: Prof. Emile Touber (Imperial College London)

Dense-gas shock-refraction properties



Abstract

Dense gases refer to single-phase vapours featuring large heat capacities, relatively to their molecular weights. Examples of such vapours are hydrocarbons, perfluorocarbons or siloxanes. Owing to their large heat capacities, dense vapours are of practical interest in energy-conversion cycles such as Organic Rankine Cycles (ORCs), which operate on low-temperature heat sources (e.g. solar, biomass, geothermal). Contrary to standard steam or gas turbines, the expansion process in ORCs is performed in only one or two stages, with parts of the expansion process occurring in close vicinity to the thermodynamic critical point. The proximity to the critical point leads to a significant reduction in the sound speed, making the expander flow highly supersonic and inevitably causing the formation of shock waves inside the expander. Some salient real-gas effects on the refraction properties of a normal shock wave will be presented. In particular, the effect of the so-called D'yakov-Kontorovich ``instability'' on the amplification of plane acoustic and entropy waves interacting with the shock surface will be discussed, in the limit of small-amplitude perturbations. Results at zero-incidence angle indicate that intense acoustic and entropy modes can arise if the D'yakov--Kontorovich instability criteria is satisfied, with intensities up to ten times greater than in an ideal gas. Interestingly, these modes are characterised by strong density fluctuations but weak pressure fluctuations, a specificity which is rooted in the significant role played by inter-molecular forces. Entropy modes are found to specially benefit from this effect, with amplification factors hundred times greater than those of an ideal gas, a scenario which could be of particular concern to dense-gas turbines.

Contact information: Fluid Mechanics Unit & Continuum Physics Unit
Kaori Egashira: (Tel) 098-966-8683 (e-mail) e-kaori@oist.jp