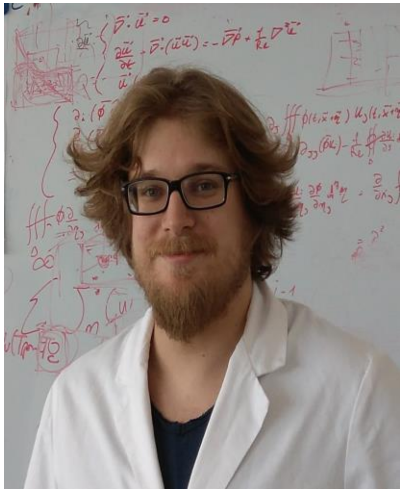
Center for Particulate Products and Processes (CP3)

Seminar:

12:00 – 1:00 pm; Friday, March 9, 2018
ME 2054 (Ford Seminar Room)



Numerical simulation and coarse graining of momentum, heat and mass transfer in dense gas-particle suspensions

Dr. Federico Municchi
School of Mechanical Engineering, Purdue

Abstract: Accurate prediction of dispersed multiphase flows is a central topic in many areas of science and engineering, from oil&gas applications to the study of river beds and blood flows. However, due to the large number of relevant spatio-temporal scales involved, it is generally not possible to resolve the fine details of the fluid-particle system and approximate (generally unclosed) models are often employed that describe systems with dynamic properties varying at some larger scales. There are generally termed as "unresolved" models. One example is the Particle Unresolved Euler-Lagrange (PU-EL) model, where the fluid flow is described at length scales larger than the characteristic particle diameter and particles (or group of particles named "parcels") are tracked separately. This method is very appealing since it allows to track the thermal and chemical history of each particle as well as resolving intra-particle phenomena. Another popular method is the Two Fluid Euler Euler (TF-EE) method, where the particle and fluid phases are modeled as interpenetrating continua. Such method has been recently extended to model even larger systems by mean of a Filtered Two Fluid Euler Euler (FTF-EE) formulation, where inhomogeneous structures like clusters and anisotropic drag laws are taken into account in the constitutive laws of the dispersed phase.

In this contribution, it is shown how these models are build starting from a fully resolved formulation of the dispersed multiphase problem. The method of volume averaging is then employed to show how closures for PU-EL models can be derived from Particle Resolved Direct Numerical Simulation (PR-DNS) of dense gas-particle suspensions. Such procedure is termed "coarse-graining" and involves statistical analysis of PR-DNS data. Specifically, a library for fluid-particle data processing (CPPPO) is described together with the relevant PR-DNS algorithms implemented in OpenFOAM. Focus is drawn on latest results for homogeneous and wall-bounded suspensions and a brief description of FTF-EE models and their implementation in OpenFOAM is provided.