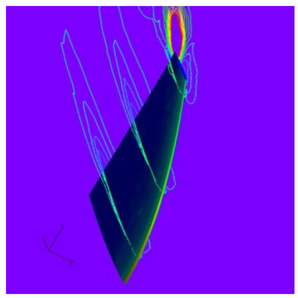
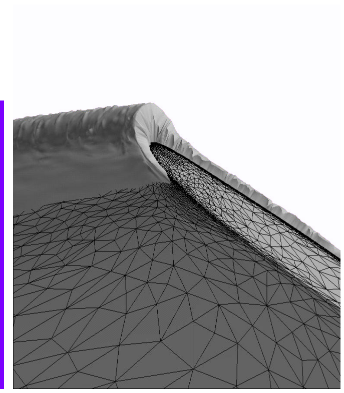
MC2 postdoctoral position - ANR CARPEiNTER

Modeling icing using cartesian grids, penalisation and level sets





Ice accretion on aerodynamic bodies is a serious and not yet totally mastered meteorological hazard due to supercooled water droplets (liquid water droplets at a temperature below the dew point) that impact on surfaces. Ice accretions have several negative effects, especially performance degradations. We intend to study icing effects on wind turbines and aircraft wing sections. A realistic ice accretion simulation is achieved if the three contributing factors: the flow field, the water droplet trajectories, and the thermodynamic ice accretion process, are accurately modeled.

In this postdoctoral position we propose to model icing on moving geometries by an innovative paradigm that is based on cartesian grids, penalization and level sets. The use of cartesian grids bypass the meshing issue in complex geometries and moreover allows extensions to higher order accuracy in a natural and simple way. Penalization is an efficient alternative to explicitly impose boundary conditions so that the body fitted meshes can be avoided, making multi fluid/multi physics flows easy to set up and simulate. Level sets describe the geometry in a non-parametric way so that geometrical and topological changes due to physics and in particular icing are straight forward to follow.

A vortex method for the simulation of incompressible flow interaction with rigid bodies is currently used by some members of the team. The method is based on a penalization technique where the system is considered as a single flow. The bodies around which the flow is computed are modeled using the so-called penalization method or Brinckman-Navier-Stokes equations in which the bodies are considered as porous media with a very small intrinsic permeability. Level set functions are used to capture interfaces and compute rigid motions of the solid bodies. Following this methodology the candidate will develop the thermodynamic module based on mass and heat transfer balance at the aerodynamic surface using partial differential equations and four compatibility relations to close the system.

This work will be done in collaboration with ETS (Ecole de Technologie Supérieure - Université du Québec) from Montreal Canada. This university is known for it strong partnership with aeronautic and wind turbine industries. Also, as a CLUMEQ member, ETS will house a tightly coupled cluster of approximate 20,000 processing elements with large storage capabilities.

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Required Knowledge and background:
Scientific computing, Multi-physics modelling.

Keywords : icing modelling, cartesian grids, penalization, level set.