Invitation à la soutenance publique de thèse de
Thomas GILLIS
Master ingénieur civil en mathématiques appliquées
Pour l’obtention du grade de Docteur en sciences de l’ingénieur et technologie
« Accurate and efficient treatment of solid boundaries for the
Vortex Particle-Mesh method »
qui se déroulera
le lundi 24 juin 2019 à 17h
Auditoire BARB 91
Place Sainte Barbe, 1
1348 Louvain-la-Neuve

Jury members :
Prof. Grégoire Winckelmans (UCLouvain), supervisor
Prof. Philippe Chatelain (UCLouvain), supervisor
Prof. Thomas Pardoen (UCLouvain), chairperson
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The Vortex Particle-Mesh method has been gaining popularity for many advection-dominated flow simulations, such as wake studies at high Reynolds numbers and external aerodynamics. However, the handling of inner solid boundaries remains an open challenge as the formulation of the boundary condition for the vorticity is not as straightforward as in a classical velocity-pressure formulation. This complexity is further increased since the method relies on a non-body-conforming Cartesian mesh; hence the obstacle may intersect the grid at arbitrary locations. In such a setting, several numerical techniques have been proposed for immersing the geometry into the Cartesian mesh. In this work, we investigate two approaches aimed at addressing this problem: the iterative penalization technique and the Immersed Interface treatment. The iterative penalization enforces the body contribution by adding an additional source term to the Navier-Stokes equations. It results in a non-intrusive way to handle immersed boundaries; yet it leads to inaccurate results. On the contrary, the Immersed Interface treatment is sharp and accurate, as it handles the interface discontinuities on the grid through the evaluation of jumps so as to maintain the order of convergence of the finite difference stencil used. We apply the Immersed Interface tool to the Vortex Particle-Mesh method and prove its accuracy and efficiency on 2D and 3D benchmarks. This method is more intrusive than the iterative penalization approach, yet it is less computationally expensive. It also enables the computation of wall quantities, which are mandatory for fluid-structure interaction applications. Our approach is the first of its kind that enables a flexible, accurate and efficient treatment of solid boundaries for the Vortex Particle-Mesh framework.