Jules DICHAMP

Postdoctoral Fellow

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French nationality
Born on March 9, 1992

Education

2014 – 2018 **Doctoral thesis**, *Institut de Mécanique des Fluides de Toulouse (IMFT), France.*
From full tissue imaging to *in silico* modelisation of vascular imaging: a new vision of adipose tissue, under the supervision of F. Plouraboué (IMFT) and L. Casteilla (STROMALab). Nominated for the Paul Escande price (University price).

2013 – 2014 **Master research degree in fundamental and applied mathematics**, *Master 2 de recherche at Université Paul Sabatier (UPS) of Toulouse, France, concurrently to last year at INSA.*
Theory of partial differential equations, dispersive non-linear and elliptical equations.

2013 (6 months) **ERASMUS exchange semester**, *Hamburg Universität, Germany.*

2010 – 2014 **Enginnering master degree**, *Institut National des Sciences Appliquées (INSA) de Toulouse, France.*
Speciality in mathematics and modelisation: numerical methods for partial differential equations, functional analysis, optimization.

Experiences

2018 – 2019 (current position) **Postdoctoral fellow**, *IfADo, Dortmund – in collaboration with INRIA, Paris.*
Drug induced liver damage. *In vitro* to *in vivo* hepatotoxicity prediction. Multiscale spatiotemporal modeling of liver lobule detoxification (Dirk Drasdo's group).

2018 (1 month) **Invited student, Stanford University**, *Palo Alto, United States.*
Invited by Daniel Tartakovsky to work on applicability regimes of homogenized bioheat equations.

2015 (1 month) **Invited student, Imperial College**, *London, England.*
Invited by Pierre Degond to work on numerical particle methods with shape deformations applied to diffusion and porous medium equations.

2014 (5 months) **Internship at IMFT**, *Institut de Mécanique des Fluides de Toulouse (31), France.*
Parametrical study of thermal exchanger with homogeneous Robin boundary conditions (Supervisor: F. Plouraboué and F. de Gournay).

2013 (2 months) **Internship at IMT**, *Institut de Mathématiques de Toulouse (31), France.*
Demonstration of existence and unicity of equations of ferromagnetism by a Galerkin method (Supervisor: D. Sanchez).

Research interests

Key words **Blood flow modelisation, transport (heat, oxygen), convective exchangers, numerical particle methods, image analysis**.
I'm interested in simulation of blood flow over full tissue using porous network methods and the heat exchanges between vascular vessels on idealised models of convective exchangers. I also work on numerical methodological aspects using several families of new numerical particle methods (SPH like) adapted on diffusion for further applications to oxygen transport.

Work in progress

From whole-organ imaging to in-silico blood flow modeling: a new multi-scale network analysis to revisit tissue functional anatomy.
This work concerns 3D imaging of a full imaged inguinal adipose tissue. We proceed with the full reconstruction and vectorization of the vascular network (1.7 million vessels) using image processing methods. A graph formalism of the network is then used and blood flow modeling is performed. As adipose tissue's vascular network is organized in dense aggregates of vessels weakly connected between each other (called lobules), we further take advantage of a graph clustering algorithm to derive flow information at the scale of lobules. We thus can provide functional description of the tissue's anatomy as composed of micro-environments of various sizes and relations to blood flow. In particular, we show that a central area close to the lymph node, which is known for its specific browning regionalized potential (i.e. ability of performing thermogenesis at a higher intensity), is also related to blood flow intensity from several graph metrics.

Work in progress

Linearly Transformed Particle method for diffusion and porous medium equations.
SPH methods (Smoothed Particle Hydrodynamics) have several interesting aspects: they are mesh-less so designed for complex geometry, easily parallelisable, quick to develop and can naturally account for free boundary conditions. However, their convergence depends on the distance between particles over their size ratio. This problem can be corrected by remapping particles on a grid but such methods are expensive and introduce numerical diffusion. Recently, the LTP (Linearly Transformed Particle) was introduced for pure advection and aggregation equations and whose convergence does not depend on the previously introduced ratio neither on any remapping. In this method, not only do we compute position of particles at each time step as it is done in SPH methods, but we also compute deformation of the shape of each particle which depends on the Jacobian of the flow. In this work, we wish to adapt those methods to diffusion and porous equation and study their convergence from a numerical and theoretical point of view.

Work in progress

Applicability regimes for macroscopic bioheat models.
Due to the high complexity of geometries in biological context, numerous models have been proposed to tackle this question. The first one being the Pennes equation that considers an thermal equilibrium between the microvascular bed and the tissue (to some extent). Others were derived from volume averaging method and porous media context. Some authors have also considered several compartments through the tissue and thus several equations at each scale. All those approaches share the idea of upscaling the micro-scale to the macro-scale. In this work, we study the applicability of such upscaling approaches using the theoretical multiple-scale expansion method in simple but relevant geometries. Using a semi-analytical method we then compare the macro-scale derived model to the micro-scale solution.

Teaching

Teaching assistant

2016 – 2018 at ENSEEIHT, Toulouse (France), **224 hours**: Hydraulic machinery, optimization, statistical hydrology, hydrogeology, laminar and turbulent boundary layer (practical work), linear elasticity (practical work), Fluent, thermal exchanges (practical work).

Projects supervising

2018, fifth year university level at INSA, Toulouse (France): implementation of a porous network like method for concentration transport with reaction on a vascular graph.
2017, fourth-year university level at UPS, Toulouse (France): parametric study of a periodic counter-current heat exchanger.
2016, fifth year university level at INSA, Toulouse (France): implementation of periodic counter-current heat exchanger, scripts and post-treatment validation.

Publications and papers submitted

2019 **Accepted – IJHMT**, J. Dichamp, F. de Gournay and F. Plouraboué. Thermal significance and optimal transfer in vessels bundles is influenced by vascular density *Int. J. Heat Mass Transfer*.

2018 **Submitted (under revision)**, J. Dichamp, P. Kennel, C. Barreau, C. Guissard, L. Teyssedre, J. Rouquette, J. Colombelli, A. Lorsignol, F. Plouraboué and L. Casteilla. From whole-organ imaging to in-silico blood flow modeling : a new multi-scale network analysis to revisit tissue functional anatomy.

2018 **Submitted (under revision)**, J. Dichamp, R. Grefeuille, C. Barreau, C. Guissard, A. Carriere, A. Lorsignol, Y. Martinez, D. Xavier, J. Rouquette, F. Plouraboué and L. Casteilla. 3D analysis of adipose lobules network in the whole fat pad reveals vasculature heterogeneity predictive of browning ability.

2016 **Publication – IJHMT**, J. Dichamp, F. de Gournay and F. Plouraboué. Theoretical and numerical analysis of counter-flow parallel convective exchangers considering axial diffusion. *Int. J. Heat Mass Transfer*, 107:154-167, 2017.

Conferences

2018 **Conference (Talk) – 8th World Congress of Biomechanics, 2018 Dublin, Irland**, J. Dichamp, P. Kennel, C. Barreau, C. Guissard, L. Teyssedre, J. Rouquette, J. Colombelli, A. Lorsignol, F. Plouraboué and L. Casteilla. Modelisation of blood perfusion into a whole reconstructed adipose tissue vascular network reveals structural and functional heterogeneities.

2018 **Conference (Talk) – 5ème Journées du GDR MécaBio 2018 Toulouse, France**, J. Dichamp, P. Kennel, C. Barreau, C. Guissard, A. Lorsignol, J. Rouquette, F. Plouraboué and L. Casteilla. Modelisation of blood perfusion into a whole adipose tissue vascular network.

2017 **Conference (Talk) – Blood Flow: Current State and Future Prospects 2017 Paris, France**, J. Dichamp, P. Kennel, C. Barreau, C. Guissard, L. Teyssedre, J. Rouquette, J. Colombelli, A. Lorsignol, F. Plouraboué and L. Casteilla. Modelisation of blood perfusion into a whole adipose tissue vascular network.

2016 **Conference (Poster) – ICTAM 2016 Montréal, Canada**, J. Dichamp, F. de Gournay and F. Plouraboué. Analysis of counter-flow convective exchangers using general Graetz modes.

2016 **Conference (Poster) – Congrés Français de thermique 2016 Toulouse, France**, J. Dichamp, F. de Gournay and F. Plouraboué. Analyse d'échangeurs convectifs contre-courant par modes de Graetz généralisés.

Contact for recommendation

PhD supervisor **Franck Plouraboué**, research director at CNRS (franck.plouraboue@imft.fr).

PhD supervisor **Louis Casteilla**, director of STROMALab laboratory (louis.casteilla@inserm.fr).

Teaching supervisor **Gérald Debenest**, professor at IMFT (debenest@imft.fr).