

CONTACT Institut de Mécanique des Fluides de Toulouse  
Groupe d'Etude des Milieux Poreux (GEMP)  
1er étage (bureau 211), bâtiment Nougaro  
Allée du Professeur Camille Soula, Toulouse, FR  
Tél : +33 (0)534322882 Mail : yohan.davit@imft.fr

RESEARCH I'm broadly interested in: (1) *mathematical and physical biology*; (2) *multiscale physics*; (3)  
INTERESTS *transport phenomena in porous media*; and (4) *three-dimensional imaging techniques*.

During my master's thesis, I worked on the rheology of confined suspensions and its application to blood flows through capillaries. We used a finite volume formulation to model the flow of a suspension of non-deformable non-Brownian hard spherical particles confined between two walls in a shear flow. We studied its effective viscosity, that is the viscosity of an homogeneous equivalent fluid inducing the same averaged stress on the boundaries. For concentrations above 25%, we found that this viscosity meets a minimum when the inter-wall distance is around five times the sphere radius, which is reminiscent to the Fahraeus-Lindqvist effect for blood flows. We also showed that this minimum is not due to a migration effect but to the change of hydrodynamic interactions.

My PhD research has focused on multiscale analysis of transport phenomena in porous media with biofilms. Biofilms are complex consortia of micro-organisms (primarily bacteria, fungi, archaea, and protists, although others may be present) that are aggregated on surfaces and coated within an extracellular polymeric matrix. In porous media (e.g., subsurface soil or rocks), biofilm growth within the pore space can induce substantial modifications to mass and momentum transport dynamics on a much larger scale. In order to understand and model these interactions, we have applied a multidisciplinary approach to tackle problems with imaging the spatial distribution of microbes within opaque porous structures and modeling the transport phenomena in such heterogeneous systems.

As a postdoctoral researcher, I worked on cell-based models of biological tissues (Chaste project), discrete-to-continuum homogenization and hybrid discrete-continuous models. I also pursued my research on biofilm imaging in porous media and, more generally, on biofilms.

KEYWORDS Physics and mathematics for life sciences, Multiscale analysis, Transport in porous media, Biofilms, Fluid dynamics, Microfluidics, Modeling, X-ray tomography.

---

## Education & Positions

- DEC. 2012 **Chargé de recherche**, *CNRS - Institut de Mécanique des Fluides*, Toulouse, FR.
- 2011-NOW **PostDoc**, *University of Oxford - Mathematical Institute*, Oxford, UK.  
TITLE **A framework for hybrid discrete/continuous multiscale modelling of biological tissues.**  
D. Gavaghan, H. Byrne, J. Pitt-Francis, J. Osborne
- 2007-2010 **Ph.D.**, *Institut de Mécanique des Fluides*, Toulouse, FR.  
THESIS TITLE **Multiscale analysis of transport phenomena in porous media with biofilms.**  
Advisors: G. Debenest, M. Gerino.
- 2006-2007 **M.S., Physics for life sciences**, *University Joseph Fourier*, Grenoble.  
THESIS TITLE **Rheology of confined suspensions.**  
Advisor: P. Peyla.
- 2004-2007 **M.S., Engineering**, *French "Grande Ecole" ENSPG/Phelma*, Grenoble.
- 2002-2004 **Preparatory school to french "Grandes Ecoles"**, *PCSI/PC\**, Lycée Paul Cézanne.

---

## Prizes and scholarships

- SCHOLARSHIP **PhD ministerial research fellowship.**
- SCHOLARSHIP **CIES teaching fellowship.**
- AWARD **PhD thesis award Léopold Escande and Novélisé 2013.**

---

## Services

- REVIEWER *Advances in Water Resources, Journal of Theoretical Biology, Biotechnology & Bioengineering, Bulletin of Mathematical Biology, Transport in Porous Media, Water Resources Research, Journal of Porous Media, New Journal of Physics, Special Topics & Reviews in Porous Media*
- POPULAR SCIENCE *Amandine, Yohan, and Nicolas. De la science au pluralisme scientifique. Plume, 12:7-8, 2010*
- ORGANIZING COMMITTEE *Chaste cell-based workshop, Organizing committee, Department of Computer Science, 4-6 January 2012*
- PROGRAMME COMMITTEE *Workshop on Cell Based and Individual Based Modelling - CBIBM, International Conference on Computational Science, 10th-12th June 2014, Cairns Australia.*
- SCIENTIFIC COMMITTEE *New Trends in Transport Phenomena (NTTP), May 1-2, 2014, Ontario, Canada.*

---

## Teaching experience

- 2011 **Tutor**, *University of Oxford*, Oxford,  $\approx$  35 hours.
- CLASSES *Mathematical Ecology and Biology, Mathemaical Physiology*

- 2007-2010 **CIES tutor**, French "Grande Ecole" ENSEEIHT, Toulouse,  $\approx$  100 hours.  
 LECTURE Transport in porous media.  
 CLASSES Transport in porous media (COMSOL), Introduction to MATLAB, Transfer in hydrology.
- 2007-2010 **CIES tutor**, French "Grande Ecole" ENSAT, Toulouse,  $\approx$  100 hours.  
 CLASSES Optimization (mathematics).
- 2007-2010 **CIES training**, *The art of clown for teaching, When to work for a better work, Communication basics, Teaching ethics, Introduction to didactic.*

## Journal publications

Y. Davit and P. Peyla. Intriguing viscosity effects in confined suspensions : A numerical study. *Europhysics Letters*, 83:64001, doi: 10.1209/0295-5075/83/64001, 2008.

Y. Davit, G. Debenest, B. D. Wood, and M. Quintard. Modeling non-equilibrium mass transport in biologically reactive porous media. *Advances in Water Resources*, 33:1075–1093, 2010.

Y. Davit, G. Iltis, G. Debenest, S. Veran-Tissoires, D. Wildenschild, M. Gerino, and M. Quintard. Imaging biofilm in porous media using x-ray computed microtomography. *Journal of Microscopy*, 242(1):15–25, 2010.

Y. Davit, M. Quintard, and G. Debenest. Equivalence between volume averaging and moments matching techniques for mass transport models in porous media. *International Journal of Heat and Mass Transfer*, 53:4985–4993, 2010.

Y. Davit and M. Quintard. Comment on “frequency-dependent dispersion in porous media”. *Physical Review E*, 86:013201, 2012.

Y. Davit, B. D. Wood, G. Debenest, and M. Quintard. Correspondence between one- and two-equation models for solute transport in two-region heterogeneous porous media. *Transport In Porous Media*, 95:213–238, 2012.

Y. Davit, H. Byrne, J. Osborne, J. Pitt-Francis, D. Gavaghan, and M. Quintard. Hydrodynamic dispersion within porous biofilms. *Physical Review E*, 87:012718, 2013.

G. R. Mirams, C. J. Arthurs, M. O. Bernabeu, R. Bordas, J. Cooper, A. Corrias, Y. Davit, S. J. Dunn, A. G. Fletcher, D. G. Harvey, M. E. Marsh, J. M. Osborne, P. Pathmanathan, J. Pitt-Francis, J. Southern, N. Zemezemi, and D. J. Gavaghan. Chaste: An open source c++ library for computational physiology and biology. *PLoS Comput Biol*, 9(3):e1002970, 03 2013.

D. Wildenschild, M. L. Rivers, M. L. Porter, G. C. Iltis, R. T. Armstrong, and Y. Davit. Using synchrotron-based x-ray microtomography and functional contrast agents in environmental applications. *Soil–Water–Root Processes: Advances in Tomography and Imaging.*, Special Publication 61, 2013.

C. Soulaine, Y. Davit, and M. Quintard. A two–pressure model for slightly compressible single phase flow in bi-structured porous media. *Chemical Engineering Science*, 96:55–70, 2013.

Y. Davit, J. M. Osborne, H. Byrne, J. Pitt-Francis, and D. J. Gavaghan. Validity of the cauchy-born hypothesis applied to 2-D discrete models of biological tissues. *Physical Review E*, 87:042724, 2013.

Y Davit, CG Bell, HM Byrne, LAC Chapman, LS Kimpton, GE Lang, KHL Leonard, JM Oliver, NC Pearson, RJ Shipley, SL Waters, JP Whiteley, BD Wood, and M Quintard. Homogenization via formal multiscale asymptotics and volume averaging: how do the two techniques compare? *Advances in Water Resources*, 2013.

## Theses and others

Y. Davit. Rheology of confined suspensions. *Master's thesis*, 2007.

Y. Davit. Multiscale analysis of transport phenomena in porous media with biofilms. *PhD thesis*, 2010.

M. Baines, B. Bhattacharya, Y. Davit, L. Dyson, M. Edgington, S. Modhara, C. Please, J. Siggers, A. Smith, and M. Tindall. Spatial and temporal dynamics of signalling pathways. *Mathematics in Medicine Study Group Report*, 2011.

## Conference proceedings

Y. Davit, G. Debenest, S. Sauvage, and M. Quintard. Relationship between local non-equilibrium models for mass transport in two-phase porous media. In *Proceedings of 3rd International Conference on Approximation Methods and Numerical Modelling in Environment and Natural Resources, MAMERN, Pau*, 2009.

S. Sauvage, S. Delmotte, Y. Davit, K. Dedieu, S. Navel, F. Mermillod-Blondin, J. Gibert, B. Montuelle, J.-M. Sanchez-Perez, and M. Gerino. Modelling interactions between physical habitat properties and biodiversity in the subsurface aquatic sediment to test the role of organisms in bio-degradation processes. In *Proceedings of HydroEco 2009: 2nd International Multidisciplinary Conference on Hydrology and Ecology, Vienna*, 2009.

Y. Davit, G. Debenest, and M. Quintard. Multiple-scale analysis of transport in porous media with biofilms. In *Proceedings of Porous media and its applications in science, engineering, and industry*, 2010.

Y. Davit, G. Debenest, and M. Quintard. 3-D imaging of biofilm in porous media using x-ray microtomography. In *Proceedings of Porous media and its applications in science, engineering, and industry*, 2010.

G. Iltis, Y. Davit, R. T. Armstrong, B.D. Wood, and D. Wildenschild. Imaging microbial biofilm in three-dimensional opaque porous media with x-ray tomography. In *Interpore 2011, 3rd International Conference on Porous Media & Annual Meeting of the International Society for Porous Media, Bordeaux, France, March 28-31*, 2011.

## Invited conferences

G. Iltis, Y. Davit, B. Wood, and D. Wildenschild. *In situ* imaging of biofilm within opaque porous media. In *AGU Fall Meeting, San Francisco*, 2010.

Y. Davit. In *Conference on Biofilm-Induced Mineralization, Montana State University, Bozeman, MT*, August 6-10, 2012.

Y. Davit. In *Oxford Conference on Challenges in Applied Mathematics, University of Oxford*, 2013.

## Invited seminars

Y. Davit, G. Debenest, M. Quintard, S. Sauvage, and M. Gerino. Transport de masse en milieu poreux en présence de biofilms : Un problème multi-échelles. In *IMFT*, 2008.

Y. Davit, G. Debenest, M. Quintard, S. Sauvage, and M. Gerino. Biofilms en milieux poreux : Un problème multi-échelles. In *Workshop IMFT/ECOLAB*, 2008.

Y. Davit, G. Debenest, M. Quintard, S. Sauvage, and M. Gerino. Biofilms in porous media. In *2nd IMPaCT-FERMAT Meeting, University of Twente*, 2009.

Y. Davit. Multiscale analysis of biological tissues. In *Group Meeting of the Computational Biology Group, Department of Computer Science, University of Oxford*, 2011.

Y. Davit. Multiscale analysis of transport phenomena in biofilms and porous media. In *Group Meeting of the Center for Mathematical Biology, University of Oxford*, 2011.

## Other seminars, conferences and posters

Y. Davit, G. Debenest, M. Gerino, and M. Quintard. A one-equation non-equilibrium model for mass transport in biologically mediated porous media: a numerical study. In *AGU Fall Meeting, San Francisco (Poster)*, 2008.

Y. Davit, K. Dedieu, Y. Aspa, S. Sauvage, F. Julien, M. Gerino, G. Debenest, and M. Quintard. Role of interactions between benthic fauna and biofilms on bio-physical functioning of the sub-surface zone: a column-modeling approach. In *The Second Nereis Park Conference "Bioturbation: An update on Darwin's last idea", Renesse (Poster)*, 2008.

P. Peyla, Y. Davit, and C. Verdier. Viscosity of confined suspensions. In *APS meeting, New Orleans*, 2008.

P. Peyla, Y. Davit, and C. Verdier. Dimensional effect on viscosity of a confined suspension. In *The XVth International Congress on Rheology, Monterey*, 2008.

Y. Davit, G. Debenest, M. Gerino, and M. Quintard. Imaging biofilms in porous media using X-ray computed microtomography. In *AGU Fall Meeting, San Francisco*, 2009.

Y. Davit, G. Debenest, and M. Quintard. Biofilms en milieux poreux : Modèles de transport et imagerie. In *Journée d'Etude des Milieux Poreux, JEMP, Paris*, 2009.

Y. Davit, G. Debenest, S. Sauvage, and M. Quintard. Relationship between local non-equilibrium models for mass transport in two-phase porous media. In *3rd International Conference on Approximation Methods and Numerical Modelling in Environment and Natural Resources, MAMERN, Pau*, 2009.

S. Sauvage, S. Delmotte, Y. Davit, K. Dedieu, S. Navel, F. Mermillod-Blondin, J. Gibert, B. Montuelle, J.-M. Sanchez-Perez, and M. Gerino. Modelling interactions between physical habitat properties and biodiversity in the subsurface aquatic sediment

to test the role of organisms in bio-degradation processes. In *HydroEco 2009: 2nd International Multidisciplinary Conference on Hydrology and Ecology, Vienna (Poster)*, 2009.

M. Quintard, Y. Davit, and G. Debenest. Multiple-scale analysis of transport in porous media with biofilms. In *Third international conference in porous media and its applications in science, engineering, and industry, Montecatini, Italy*, 2010.

Y. Davit, G. Debenest, and M. Quintard. 3-D imaging of biofilm in porous media using x-ray microtomography. In *Third international conference in porous media and its applications in science, engineering, and industry, Montecatini, Italy*, 2010.

Y. Davit, G. Debenest, and M. Quintard. Biofilms en milieux poreux : une analyse multi-échelles. In *Journées de la Matière Condensée, Troyes, France*, 2010.

D. Wildenschild, G. Iltis, R. Armstrong, Y. Davit, J. Connolly, R. Gerlach, and B. Wood. Current status of imaging microbial biofilms in three-dimensional opaque porous media using x-ray microtomography. In *DOE-Subsurface Biogeochemical Research Programs 6 Annual Meeting, Washington DC*, April 26-28, 2011.

G. Iltis, J. Connolly, Y. Davit, R. Gerlach, B.D. Wood, and D. Wildenschild. Pore-scale imaging of biofilm grown under varying flow rates. In *AGU Fall Meeting, San Francisco (Poster)*, 2012.

G. Iltis, Y. Davit, J. Connolly, R. Gerlach, and D. Wildenschild. Visualizing biofilms in porous media using synchrotron based x-ray computed microtomography. In *Brookhaven National Laboratory, Young Researcher Symposium (Poster)*, 2013.

R. Guibert, Y. Davit, M. Quintard, and G. Debenest. Effective properties of real biofilm shell. In *AIChE conference*, 2013.