ReactiveFronts

PhD or Post-doctoral joint-position at the Institut de Mécanique des Fluides de Toulouse and the Observatoire des Sciences de l'Univers de Rennes.

Lagrangian analysis and stochastic modeling of flow and transport properties of brain microvascular networks.

Keywords: Biofluid Mechanics, Microcirculation, Stochastic modeling, Transport in disordered media.

Academic context: This position is part of a collaboration between two interdisciplinary projects funded under the European Research Council *Consolidator* grant scheme (http://erc.europa.eu/consolidator-grants): BrainMicroFlow awarded to Sylvie Lorthois (http://brainmicroflow.inp-toulouse.fr) and ReactiveFronts awarded to Tanguy Le Borgne. BrainMicroFlow focuses on modeling the structure and function, including flow and transport properties, of brain microcirculation at various scales, while ReactiveFronts focuses on the interplay between flow heterogeneity and reactive mixing processes in porous media.

Scientific context: The cerebral microvascular system is essential to a large variety of physiological processes in the brain, including blood delivery and blood flow regulation as a function of neuronal activity (neuro-vascular coupling). It plays a major role in the associated processes leading to disease (stroke, neurodegenerative diseases) but the comprehension of the basic mechanisms involved is still largely incomplete. 1D non-linear network models taking into account the complex blood rheology have proved useful to study blood flow at large scale in anatomically accurate human vascular network. They demonstrated a tremendous heterogeneity of blood flow in these networks [1,2], suggesting the emergence of broad transit-time distributions. From Lagrangian theoretical studies of anomalous transport in heterogeneous media [3,4], we expect that these distributions, possibly associated with correlations in the velocity fields, strongly impact the efficiency of mass transfer processes, e.g. oxygen delivery, in brain microvascular networks.

Project summary: Our first goal is to extend the above Lagrangian approaches to investigate how the complex topological organization of brain microvascular networks and the rheology of blood govern the interplay between flow heterogeneity and transport processes in the brain. In particular, the relative contributions of capillary network complexity and flow topology under arteriole injection and venule draining will be studied by comparison between networks with different capillary networks of controlled disorder, from simple generic ones to anatomical networks. Our second goal is to develop and parameterize effective stochastic models incorporating the observed Lagrangian statistics in order to capture the emergent non-Fickian transport properties of both intravascular and diffusible molecules. These methods will be used to understand how the vascular alterations observed in Alzheimer Disease, such as diffuse capillary occlusions, may affect both blood distribution and the efficiency of transfer processes, with applications for improving diagnosis and/or therapeutic strategies.

Profile: Strong background in physics or fluid mechanics. Demonstrated motivation for work at the interface between disciplines, in a collaborative environment. Experience in stochastic modeling of transport phenomena in porous media welcomed. A Master Degree or, alternately, a PhD in Physics, Fluid Mechanics or related disciplines is required, as well as fluency in English and willingness to learn French.

Academic supervisors: Sylvie Lorthois, Directeur de Recherches CNRS (IMFT), in collaboration with Tanguy Le Borgne, Professor (Observatoire des Sciences de l'Univers de Rennes).

Administrative aspects: The PhD position is funded for 3 years (Gross salary: ~ 21 000 €/year; Net salary, including social security: ~ 17 000 €/year). The PhD will be awarded by *Université de Toulouse*, Doctoral School "Mechanics, Energetics, Civil and Process Engineering" (www.ed-megep.fr). The employer is the *Centre National de la Recherche Scientifique* (www.cnrs.fr), the largest fundamental research organization in Europe, and, after 1.5 years, *Université de Rennes I.* Alternately, a 2 years post-doctoral position can be proposed (Gross salary, depending on experience: ~ 30 to 40 000 €/year; Net salary, including social security: ~ 24 to 34 000 €/year). Position will be open until filled.

References: [1,2] Lorthois et al. Neuroimage 2011a, 2011b **[3]** Kang et al PRL 2011 **[4]** Le Borgne et al PRL 2008

For more information or to apply, please submit your curriculum vitae, copies of recent transcripts, a cover letter describing previous research experience and interests, and contact information of two references, with *ERC BrainMicroFlow PhD6* or *ERC BrainMicroFlow PDRA6* in the subject line, to: Sylvie Lorthois (lorthois@imft.fr) and Tanguy Le Borgne (tanguy.le-borgne@univ-rennes1.fr)