Post-doctoral position at LMA/CINaM/IUSTI Marseille

Structural organization of red blood cell suspensions under flows in health and sickle cell disease

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The reduced red blood cell (RBC) deformability in patients with sickle cell disease induces an increase in blood viscosity and leads to painful vaso-occlusive crises. RBC deformability influences their spatial organization under flow and the resulting rheology of blood. So far the micro/macro link is not well understood due to the lack of experimental techniques giving access to the microstructure of RBC suspensions. Indeed, blood is an opaque RBC suspension so the use of optical methods is limited to measurements in 2D confined flows and/or in diluted suspensions, that are not physio-pathologically representative.

The Post-doc project aims to characterize the microstructure of RBC suspensions in health and sickle cell disease. Our laboratories have developed in the last years original *in vitro* set-ups designed to measure the structural organization of particulate suspensions under shear flow (confined or not) by optical or ultrasonic means [1][2] (see Fig. 1). These set-ups will be used to probe the microstructure in sheared suspensions of healthy RBCs, artificially rigidified RBCs, and RBCs from sickle cell patients. In parallel, a new device combining a microfluidic chip and high-frequency ultrasound (80 MHz) will be developed to simultaneously measure the structuration of concentrated RBCs under flow. With this new ultrasonic technique we will enlighten the role of RBC properties on suspension microstructure and rheology, in both confined and unconfined flows. This will pave the way to a better understanding of the hemorheological alterations in sickle cell disease.

This interdisciplinary project brings together three CENTURI groups with complementary skills: E. Franceschini (LMA), quantitative ultrasound investigation of microstructure; E. Helfer (CINaM), red blood cells in confined flow; L. Bergougnoux (IUSTI), rheology of complex fluids.

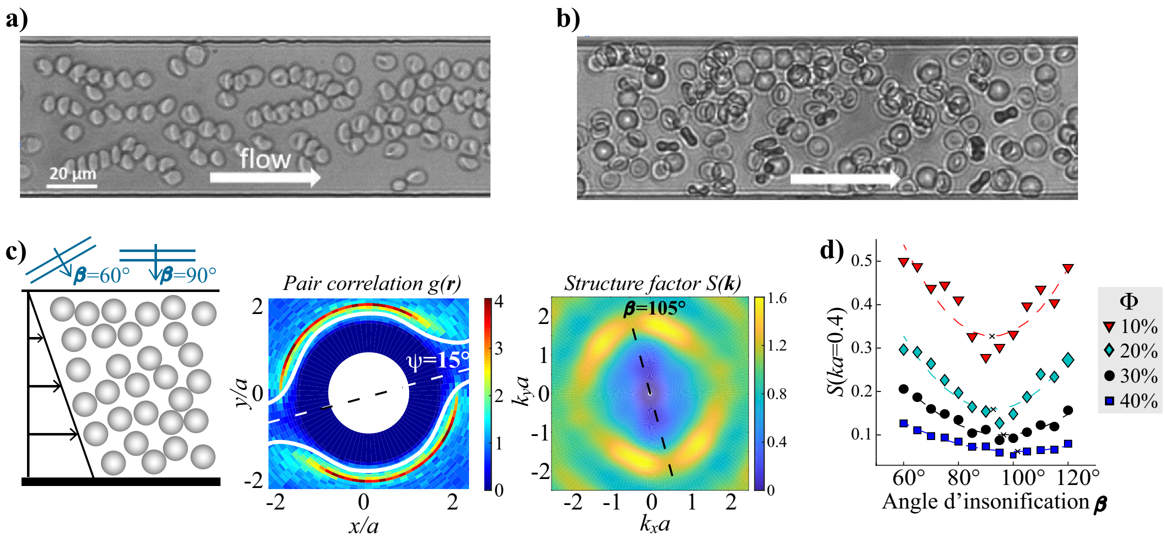

Figure 1. (a) RBCs self-organize under confined flow while (b) rigidified RBCs do not, see Ref. [1]. (c) Sketch of ultrasonic insonification of sheared suspension at two angles to probe the spatial arrangement of particles. One way to characterize this arrangement is the spatial pair correlation function $g(r)$, or the structure factor $S(\mathbf{k})$. As detailed in Ref [2], the main angular position of regions depleted in particles (blue regions) can be detected by ultrasound scattering. (d) Structure factors $S(k)$ measured by ultrasound as a function of insonification directions β on suspensions of disaggregated RBCs for different volume fractions Φ. These ultrasonic anisotropic signatures highlight the presence of regions depleted in cells.

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Profile : Highly motivated candidates with a PhD degree in biophysics, physics, fluid mechanics and/or acoustics with strong experimental skills. Ability to work in an interdisciplinary environment involving several research teams, and expertise in programming (Matlab or Python) are required.
The deadline for application is the 16th April https://centuri-livingsystems.org/recruitment/

[1] Iss C, Midou D, Moreau A, Held D, Charrier A, Mendez S, Viallat A, Helfer E. *Self-organization of red blood cell suspensions under confined 2D flows*. Soft Matter 15:2971 (2019)
[2] Lombard O, Rouyer J, Debieu E, Blanc F, Franceschini E. *Ultrasonic backscattering and microstructure in sheared concentrated suspensions*, J. Acoust. Soc. Amer. 147(3):1359 (2020)