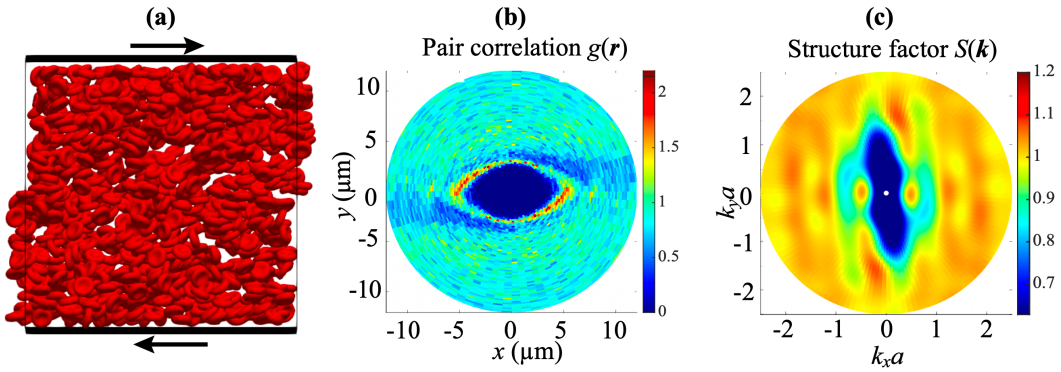
2-year Post-doctoral position at LMA/IUSTI Marseille

Microstructure of Blood Cell Suspensions probed by Ultrasounds

Blood is a dense suspension of deformable red blood cells in a Newtonian fluid, the plasma. The loss of deformability of red blood cells in patients with sickle cell disease induces an increase in blood viscosity and leads to alterations in blood flow. The link between **blood cell properties, microstructure and blood rheology** is still poorly understood, although it is crucial to better **understand the alterations of blood rheology in sickle cell disease**. Since blood is an opaque suspension of red blood cells, optical imaging methods are impossible to access the blood microstructure (i.e. the spatial organisation of the blood cells within the flow).

The Post-doc objective is to **probe by ultrasound the microstructure of red blood cell suspensions** in order to better **understand the role of cellular properties on the microstructure** (from a fundamental point of view), and to **detect alterations of the cell deformability** (from an application point of view). In a first step, ultrasonic and optical measurements will be jointly performed on a Couette flow device on transparent model suspensions of soft particles, using the optics as a reference measurement. The ultrasound/optical confrontation will allow the validation of the ultrasonic tool to characterize the microstructure of the suspensions. In a second step, we will study the ultrasonic signatures of sheared suspensions of normal and artificially rigidified red blood cells. The determination of the microstructure by ultrasound will then be coupled to 3D numerical simulations of red blood cell suspensions, in order to elucidate the physical mechanisms underlying the microstructure anisotropy and its changes with the cell deformability.

The work will be carried out at the Laboratory of Mechanics and Acoustics LMA-Marseille in the Waves and Imaging team and at IUSTI-Marseille in the Complex Fluids & Solids SOFT axis under the direction of Emilie Franceschini (LMA) and Laurence Bergougnoux (IUSTI). The project will benefit from the collaborations with F. Blanc and E. Lemaire from INPHYNI (rheology of suspensions) and S. Mendez (simulations of microstructure) from IMAG.



Anisotropic microstructure of sheared red blood cell suspensions obtained by numerical simulation. **(a)** Image of the numerical simulation showing red blood cells in a shear flow. **(b)** Pair correlation function $g(\boldsymbol{r})$ giving the probability of finding a neighboring cell in the xy plane with respect to a given reference cell. **(c)** Structure factor $S(\boldsymbol{k})$ linked to the Fourier transform of $g(\boldsymbol{r})$ allowing access to the microstructure by ultrasound.

Profile: We are looking for a highly motivated candidate with strong experimental skills and having a PhD in acoustics/physics/fluid mechanics. Matlab or python programming skills are also required. The position is funded for two years, preferably beginning in the fall of 2023, although earlier or later appointments are possible.

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References

[1] Lombard O., Rouyer J., Debieu E., Blanc F., Franceschini E., Ultrasonic backscattering and microstructure in sheared concentrated suspensions, J. Acoust.Soc. Amer. 147(3), 1359-1367 (2020)
[2] Blanc F., Lemaire E., Meunier A., Peters F. Microstructure in sheared non-brownian concentrated suspensions, Journal of rheology 57(1), 273-292 (2013)