Post-doctoral position at LMA/IUSTI Marseille

Ultrasound for probing the microstructure in sheared concentrated suspensions

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Complex fluids are ubiquitous in nature and in industry: biological fluids (blood, mucus), erosion sludge or industrial pastes. From a theoretical point of view, the characterization of these media is confronted firstly to the huge variety of particle size and shape that compose them, and secondly to the coupling between the macroscopic and microscopic scales: the flow is controlled by the spatial distribution of the particles (*i.e.*, the microstructure of the suspension), but the macroscopic flow back-acts and modifies this microstructure. From an experimental point of view, it is crucial to develop tools to investigate the microstructure of concentrated suspensions. The use of optical methods is limited to diluted suspensions or transparent concentrated suspensions (by using an iso-index technique) that are not representative of natural or industrial conditions.

Our goal is to develop an ultrasonic tool for measuring the microstructure of concentrated suspensions of particles. The principle is based on the experimental measurement of the structure factor, which is related to the Fourier transform of the pair correlation function. We have recently observed the anisotropic ultrasonic signature caused by the modification of the microstructure in sheared concentrated suspensions [1] (see Figure 1). This study was limited to a low frequency regime (where the wavelength λ is larger than the particle size a) and should be extended to higher frequencies (λ≈a) to characterize by ultrasound the microstructure.
The aim of the post-doctoral fellow will be to carry out ultrasonic and optical measurements on concentrated suspensions sheared in the same Couette flow device (Fig. 1a), using the optics as a reference measurement. The suspensions will consist of rigid spheres of PMMA (with diameter around 100µm) in a suspending fluid having the same refractive index as the particles, which will enable the optical determination of the pair correlation function. The ultrasound/optical confrontation will allow the validation of the ultrasound tool to characterize the microstructure of concentrated suspensions, and will make it possible to consider in the future the characterization of the microstructure of opaque suspensions with deformable particles (red blood cells), for which the rheology is still poorly understood.

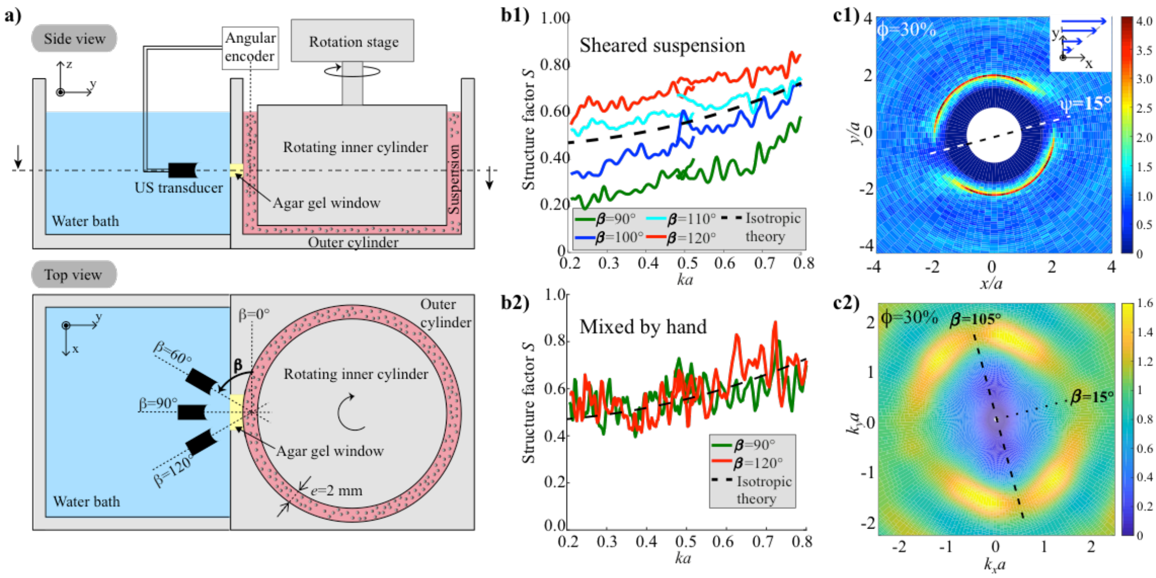

Figure 1. **(a)** Schematic diagram of a Couette device combined with a single-element ultrasonic transducer **(b1) and (b2)** Examples of ultrasonically measured structure factors for different insonification angles β (b1) for a sheared suspension and (b2) for a suspension homogeneously mixed by hand. **(c1)** Pair correlation function from computer simulations of Blanc et al. [2] for a sheared suspension of volume fraction 30%. **(c2)** Corresponding structure factor [1].

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Profile : Highly motivated candidates with a PhD degree in physics, fluid mechanics and/or acoustics with a strong experimental skills. The post-doc position is funded for one year and will start in September/October 2020 at the Institute of Mechanics and Engineering (laboratories LMA/IUSTI Marseille) under the supervision of Emilie Franceschini and Laurence Bergougnoux.

[1] Blanc, Lemaire, Meunier, Peters, *Microstructure in sheared non-brownian concentrated suspensions*, Journal of rheology 57 (2013)
[2] Lombard, Rouyer, Debieu, Blanc, Franceschini, *Ultrasonic backscattering and microstructure in sheared concentrated suspensions*, J. Acoust. Soc. Amer. 147 (2020)