Ultrasound propagation in nanofluids

Funding : Le Havre University doctoral grant (3 years, gross salary 1684.93 E / month).
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Supervision : F. Luppé and P. Maréchal : Laboratoire Ondes et Milieux Complexes, Le Havre, France

The problem

Nanofluids are disordered suspensions of (nano)particles (1 to 100 nm) in host fluids. They are used in the industry as well as in the biomedical field [1], and their possible application as metamaterials has been shown recently [2].

For particles size between 100 and 1000 nm and low concentration, characterizing an aquous colloidal suspension (concentration, polydispersity estimates) may be achieved by measuring the frequency dependent attenuation coefficient of an ultrasonic compressional wave that travels through [3]. This coefficient is the imaginary part of the wavenumber of the coherent wave that is given by a multiple scattering theory [4]. As the particles size diminishes and the concentration increases, the non ideal nature of the host fluid must be taken into account by including the waves conversion phenomena (compression / shear / thermal waves) [5-7] in the multiple scattering model.

The models used [4,5] are based on the asymptotic expansion of the squared wavenumber of the coherent wave, around that in the absence of particles, in powers of the concentration. Knowledge of the concentration, however, is not sufficient to explain why the expansion may be limited at order 2 or 3 (or whatever) in order to obtain a satisfying agreement between theory and experiment.

The PhD project aims in defining precisely, and increasing if possible, the validity domain of the model [5], adapting it to the resolution of the inverse problem that consists in the characterization of a nanofluid with possible polydispersion, and in exploring the possible applications of the formulas that provide the properties of the other coherent waves (shear, thermal) that emerge from the multiple scattering process.

The work will be done at the LOMC (Le Havre), in collaboration with Doctor Valerie J. Pinfield, of the Chemical Engineering Department of Loughborough university in England (the candidate should be ready to spend some time there).

Candidate profile

Solid background in wave propagation and scientific programming (Fortran and/or Matlab). Oral and written english.

The candidate should show a real interest in both equations and experiments.

Contact

francine.luppe@univ-lehavre.fr

References

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