Acoustic wave scattering and analysis of internal fields of rigid materials

José Renato Alcarás, Alexandre Souto Martinez
FFCLRP/USP e INCT-SC

The sound wave scattering aims to understand the propagation nature of scattered and incident sound waves, for different structures and geometries of the scattering centers that form a disordered environment. In the literature, in general, we obtain only information regarding the acoustic scattering in regions distant from the scattering centers (far-field approximation), for some incident waveforms and scattering particles. In order to understand the undulatory behavior in regions close to and within the scattering center, our study provides an analytical description of the acoustic radiation fields in these regions. The scattering materials are considered to be viscoelastic (which exhibit viscous and elastic behavior when subjected to external forces), as they are feasible in the modeling of biological cells and polymers in general. So far, we have in hand the equations that govern the propagation of pressure waves, as well as the boundary conditions for a single scattering by a spherical particle. Starting from first principles and calculations based on optical scattering, we obtained analytical expressions for the limiting case in which the scattering particle is rigid, for the field in all regions; in particular, we find the results well established in the far field approximation. We emphasize that the known results do not take into account the means of propagation, being limited to the geometric aspects of the scattering (equivalent to diffraction in optics). Our treatment of the problem allowed us to go beyond the diffraction regime and to account for the effects of the constituent materials, which are evident in the distant field approach, both for spheres and for cylinders. Although not negligible, this portion was never considered in experimental results, we believe that due to normalization procedures. We will present these results and propose new experiments where these effects can be detected.