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Influence of a rigid boundary on the resonance of an ultrasound contrast agent

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Recent experimental studies showed that the behavior of an Ultrasound Contrast Agent (UCA) is strongly modified when located close or targeted to a vessel wall. Asymmetrical oscillations can occur and the frequency response differs from those of free UCA. To design new techniques for diagnostic or therapeutic applications with UCA, it is important to have a better knowledge of the acoustic behavior and the dynamics of UCA in vessels. We used a finite element model (FEM) to focus on how the resonance frequency is affected by a boundary.
A FEM had been first developed with COMSOL Multiphysics to calculate the pressure field scattered by two types of spherical objects (air microbubble or UCA with a viscoelastic shell) immersed in an unbounded liquid. The results obtained with the FEM being coherent with analytical models, a rigid boundary was then added to study its influence on the frequency responses of both objects.
We observed a decrease of the resonance frequency of both objects when they are close to the boundary. This behavior is in good agreement with experimental results found in literature. The model has been used to perform parametrical studies (distance to the wall, UCA radius, shell parameter...).