Microbubble dynamics in a viscous compressible liquid subject to ultrasound

Qianxi Wang
University of Birmingham, UK

This talk is concerned with microbubble dynamics in a viscous compressible liquid subject to ultrasound. The topic is associated with important applications in medical ultrasonics and ultrasound cleaning. The compressible effects are modelled using the weakly compressible theory of Wang & Blake (J. Fluid Mech. 730, 245-272, 2010 and 679, 559-581, 2011), since the Mach number associated is small. The viscous effects are approximated using the viscous potential flow theory of Joseph & Wang (J. Fluid Mech., 505, 365-377, 2004), because the flow field is characterized as being an irrotational flow in the bulk volume but with a thin viscous boundary layer at the bubble surface. Consequently, the phenomenon is modelled using the boundary integral method, in which the compressible and viscous effects are incorporated into the model through including additional terms in the dynamic boundary condition at the bubble surface. The numerical results are shown in good agreement with the experiments of Versluis et al. (Phys. Rev. E 2010, 82, 026321), for the development of shape modes after dozens cycles of oscillation. The model is accurate, highly efficient, stable for many cycles of oscillation and grid-free in the flow domain. Our computations show that when subject to an acoustic wave a microbubble initially oscillates spherically. Beyond a critical threshold of the acoustic pressure amplitude, nonspherical surface modes generate after several cycles of oscillation. The threshold decreases as the acoustic frequency is equal to the natural frequency of the bubble. As the pressure amplitude increases, non-spherical shape modes develop earlier. A shape mode can be activated if the driving acoustic frequency is equal to the natural frequency of the shape mode.

e: q.x.wang@bham.ac.uk