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Biomedical applications of radiation force generated in standing ultrasonic waves

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This talk presents an overview of physical basis for the action of acoustic radiation force on particles in standing waves in relation to biomedical applications. The effect itself is known since the 19th century (Kundt, 1974) and its biomedical significance was demonstrated in 1971 by Dyson et al. However, despite a long history, extensive studies of particle behavior in standing ultrasonic waves have started only during the last decade due to numerous emerging biomedical applications. The range of currently explored applications is broad: targeted drug and gene delivery, increasing sensitivity of biosensors and immunochemical tests, manipulating cells in suspensions, micro-stirring, and others.
The presentation will focus on theoretical analysis and applications of radiation force acting on particles and bubbles in the standing ultrasonic fields. Dynamics of particle motion induced by ultrasonic radiation force as a function of frequency, intensity, and other variables will be considered. The principal difference in interaction of ultrasonic standing wave field with solid particles and with bubbles due to resonant properties and high compressibility of the latter will be quantitatively analyzed. Several specific biomedical applications of the analyzed phenomena will be discussed.