Ultrasonic Imaging

Ultrasound which was first used by Paul Langevin in 1917 to detect submarines is now deployed in a vast array of medical diagostic and therapeutic tools. The breadth and sophistication of this expansion has been so great that we can only give a brief overview. Ultrasound with a frequency in the neighborhood of $5-20kHz$ is particularly effective in causing microbubble growth because the microbubbles ubiquitous and numerous in most aqueous liquids have a size of the order of $10\mu m$ and these microbubbles also happen to have a resonant frequency in that kHz range.

Ultrasound is most widely used for medical imaging at low acoustic pressures of the order of $1MPa$ and, in this range, the development and exploitation of ultrasound contrast agents has opened up great opportunities for new diagnostics and therapies (see, for example, Blomley *et al.* (2001), Crum *et al.* (2009). Of great interest are the microbubble contrast agents, usually gas-filled microbubbles about $3\mu m$ in diameter that are injected intravenously and, when excited with ultrasound at or near their resonant frequency, cause them to be several thousand times more reflective than normal body tissue. Not only does this open up improved imaging opportunities but it also raises the possibility of exploiting other non-linear ultrasound phenomenon such as the production of harmonics, rectified diffusion, microstreamimg and Bjerknes' forces.