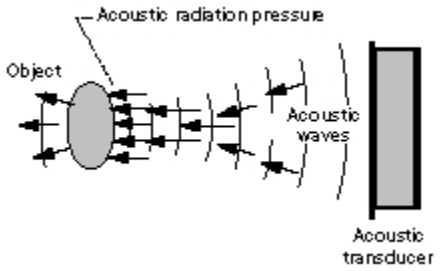
Manipulating Liquids With Acoustic Radiation Pressure

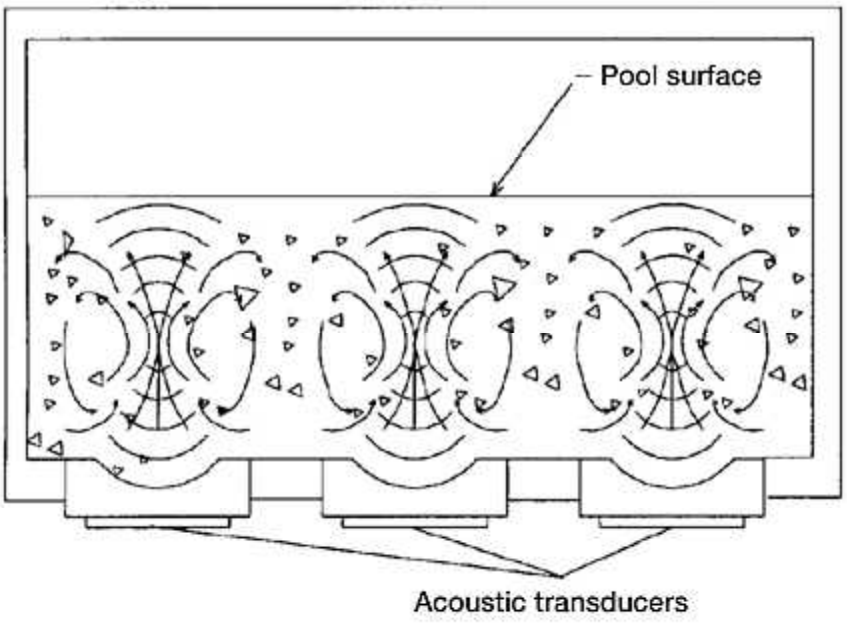
At the NASA Lewis Research Center, high-intensity ultrasound is being used to create acoustic radiation pressure (ARP) on objects in liquids. It is also being used to create liquid currents or jets called acoustic streaming.

NASA's interest in ARP includes remote-control agitation of liquid systems in space, such as in liquid space experiments and liquid propellant tanks. It can be used to eject or deploy droplets for droplet physics or droplet combustion experiments. It can also be used to manipulate bubbles, drops, and surfaces suspended in liquid experiments and propellant systems.



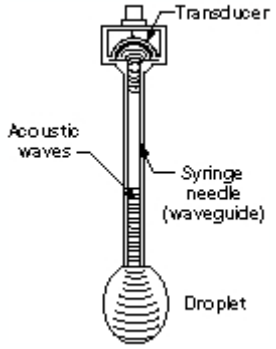
Acoustic streaming.

ARP agitation employs focus transducers to create agitating streams. The acoustic streaming can be used to suspend particles, mix liquids, and obliterate nonuniformities in temperature or concentration. Unlike conventional approaches, ARP agitation is nonintrusive, so there are no mechanical propellers, shafts, seals, or motors. Furthermore, it can be used to agitate sealed containers without external plumbing. Agitation can even be done without disturbing a liquid pool's surface.



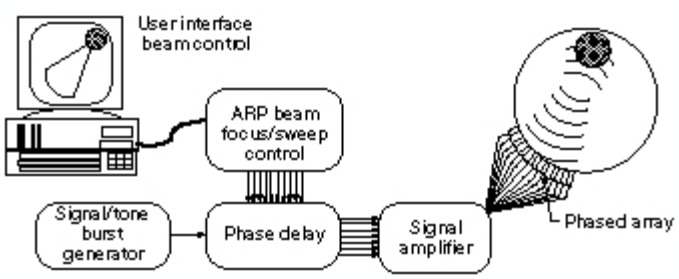
ARP agitation with focused acoustic transducers.

By introducing high-intensity sound waves into a syringe needle, one can use ARP to dispense a droplet on demand. This increases the reliability and repeatability for liquid-dispensing devices. The speed of the separation can be tightly controlled for space experiments. The device also can enhance the dispensing of coatings, adhesives, and solder pastes for the electronics industry.



ARP droplet deployment.

The ultimate in flexibility is to use a high-power acoustic phased array to generate and direct ARP. The sound beam direction and focus is controlled electronically. An interactive, real-time system lets experimenters manipulate objects anywhere in a test volume. Because the acoustic phased array can emulate simpler acoustic devices, it can serve as a general purpose system fulfilling multiple roles. This approach can also be used to control the location of bubbles and voids in spacecraft propellant tanks. In addition, ARP has potential uses in medicine, such as in repositioning detached retinas.



ARP liquid manipulation by acoustic phased arrays.

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