Sound waves levitate and move objects

Contact-free manipulation could help to protect samples from contamination.

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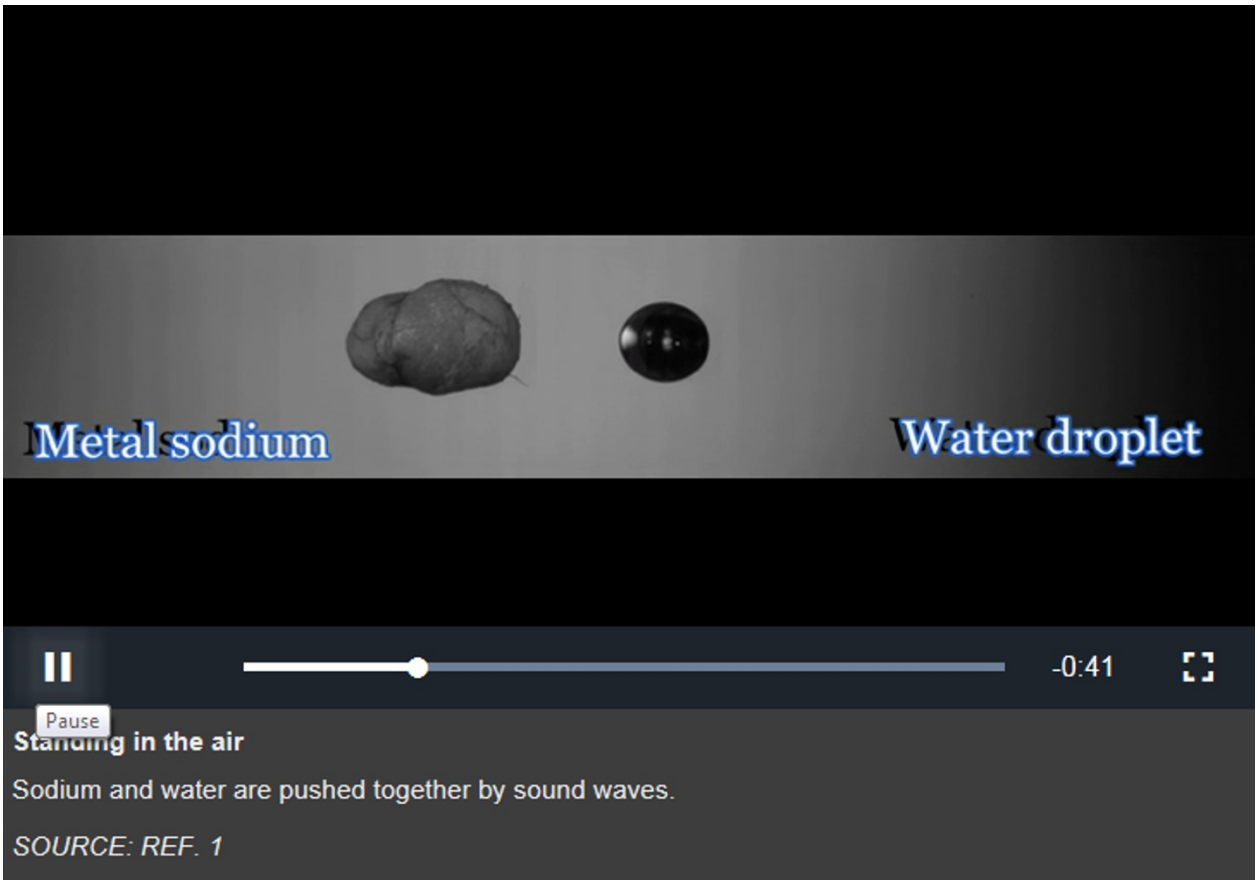


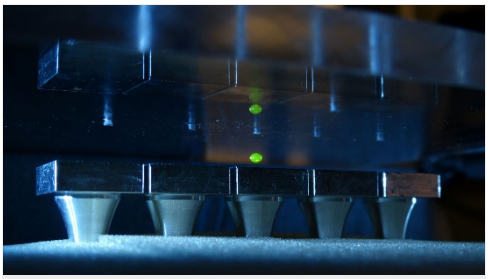
Water droplets, coffee granules, fragments of polystyrene and even a toothpick are among the items that have been flying around in a Swiss laboratory lately — all of them kept in the air by sound waves. The device that achieves this acoustic levitation is the first to be capable of handling several objects simultaneously. It is described today in the *Proceedings of the National Academy of Sciences*[1].

Typically, levitation techniques make use of electromagnetism; magnetic forces have even been used to levitate frogs[2]. It has long been known that sound waves could counter gravity, too, but so far the method has lacked practical application because it could do little more than keep an object in place.

To also move and manipulate levitating objects, Dimos Poulikakos, a mechanical engineer at the Swiss Federal Institute of Technology (ETH) in Zurich, and his colleagues built sound-making platforms using piezoelectric crystals, which shrink or stretch depending on the voltage applied to them. Each platform is the size of a pinky nail.

The platforms emit sound waves which move upward until they reach surface lying above, where they bounce back. When the downward-moving reflected waves overlap with the upward-moving source waves, the two ‘cancel out’ in the middle, at so-called node points. Objects placed there remain stuck in place because of the pressure of sound waves coming from both directions (see picture below).

By adjusting the position of the nodes, the researchers can tow the objects between platforms. The platforms can be arranged in different ways to adapt to various experiments. In one demonstration involving a T-shaped array of platforms, the researchers joined two droplets introduced at separate locations then deposited the combined droplet at a third location.



Dimos Poulikakos

A liquid droplet is levitated in the space between sound-emitting platforms (bottom) and a sound-reflecting surface (top).

Hands-free reactions

The system could be used to combine chemical reactants without the contamination that can result from contact with the surface of a container. Sound waves are already used in the pharmaceutical industry to obtain accurate results during drug screening[3]. Yet Poulikakos's method is the first to offer the possibility of precisely controlling several items simultaneously.

Poulikakos suggests that the system could be used to safely try out hazardous chemical reactions. "We had fun demonstrating the idea by colliding a lump of sodium with some water, which is obviously an aggressive reaction," he says.

Peter Christianen, a physicist who works on electromagnetic levitation at Radboud University in Nijmegen, the Netherlands, says that he's impressed with the invention. "I really like it; this is a very versatile platform — almost anything you want to manipulate, you can."

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References

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2. Berry, M. V. & Geim, A. K. *Euro. J. Phys.* **18**, 307–313 (1997).
3. Ekins, S., Olechno, J. & Williams, A. J. *PLoS ONE* **8**, e62325 (2013).