

[HOME](#)[ISSUES](#)[MORE ▾](#)[Home > Applied Physics Letters > Volume 106, Issue 1 > 10.1063/1.4905130](#)

&lt; PREV

NEXT &gt;

 No Access

Submitted: 31 October 2014

Accepted: 24 November 2014

Published Online: 05 January 2015

# Particle manipulation by a non-resonant acoustic levitator

Appl. Phys. Lett. **106**, 014101 (2015); <https://doi.org/10.1063/1.4905130>Marco A. B. Andrade<sup>1, a)</sup>, Nicolás Pérez<sup>2</sup>, and Julio C. Adamowski<sup>3</sup>[View Affiliations](#)[View Contributors](#)

Topics ▾

 PDF

We present the analysis of a non-resonant acoustic levitator, formed by an ultrasonic transducer and a concave reflector. In contrast to traditional levitators, the geometry presented herein does not require the separation distance between the transducer and the reflector to be a multiple of half wavelength. The levitator behavior is numerically predicted by applying a numerical model to calculate the acoustic pressure distribution and the Gor'kov theory to obtain the potential of the acoustic radiation force that acts on a levitated particle. We also demonstrate that levitating particles can be manipulated by controlling the reflector position while maintaining the transducer in a fixed position.

We would like to thank the Brazilian funding agencies Petrobras/ANP, FAPESP, CNPq, and CAPES and the Uruguayan funding agencies CSIC and ANII.

## REFERENCES

1. E. H. Brandt, *Nature* **413**, 474–475 (2001).  
<https://doi.org/10.1038/35097192>, [Google Scholar](#), [Crossref](#)

---

2. A. Scheeline and R. L. Behrens, *Biophys. Chem.* **165**, 1 (2012).  
<https://doi.org/10.1016/j.bpc.2012.03.008>, [Google Scholar](#), [Crossref](#)

---

3. S. Santesson, J. Johansson, L. S. Taylor, L. Levander, S. Fox, M. Sepaniak, and S. Nilsson, *Anal. Chem.* **75**, 2177 (2003).  
<https://doi.org/10.1021/ac026302w>, [Google Scholar](#), [Crossref](#)



in chemical analysis," *Anal. Bioanal. Chem.* **378**, 1704 (2004).

<https://doi.org/10.1007/s00216-003-2403-2>, [Google Scholar](#),  
[Crossref](#)

---

5. R. J. K. Weber, C. J. Benmore, S. K. Tumber, A. N. Taylor, C. A. Rey, L. S. Taylor, and S. R. Byrn, *Eur. Biophys. J.* **41**, 397 (2012).

<https://doi.org/10.1007/s00249-011-0767-3>, [Google Scholar](#),  
[Crossref](#)

---

6. C. J. Benmore and J. K. R. Weber, *Phys. Rev. X* **1**, 011004 (2011).

<https://doi.org/10.1103/PhysRevX.1.011004>, [Google Scholar](#), [Crossref](#)

---

7. V. Vandaele, A. Delchambre, and P. Lambert, *J. Appl. Phys.* **109**, 124901 (2011). <https://doi.org/10.1063/1.3594245>, [Google Scholar](#), [Scitation](#),  
[ISI](#)
- 

8. J. R. Gao, C. D. Cao, and B. Wei, *Adv. Space Res.* **24**, 1293 (1999).

[https://doi.org/10.1016/S0273-1177\(99\)00736-X](https://doi.org/10.1016/S0273-1177(99)00736-X), [Google Scholar](#),  
[Crossref](#)

---

9. W. J. Xie, C. D. Cao, Y. J. Lü, Z. Y. Hong, and B. Wei, *Appl. Phys. Lett.* **89**, 214102 (2006). <https://doi.org/10.1063/1.2396893>, [Google Scholar](#),  
[Scitation](#), [ISI](#)
- 

10. D. Koyama and K. Nakamura, *IEEE Trans. Ultrason. Ferroelectr. Freq. Control* **57**, 1152 (2010). <https://doi.org/10.1109/TUFFC.2010.1527>,  
[Google Scholar](#), [Crossref](#)
- 



---

Natl. Acad. Sci. U. S. A. **110**, 12549 (2013).

<https://doi.org/10.1073/pnas.1301860110>, [Google Scholar](#), [Crossref](#)

---

12. D. Foresti and D. Poulikakos, Phys. Rev. Lett. **112**, 024301 (2014).

<https://doi.org/10.1103/PhysRevLett.112.024301>, [Google Scholar](#),  
[Crossref](#)

---

13. T. Hoshi, Y. Oachi, and J. Rekimoto, Jpn. J. Appl. Phys., Part 1 **53**,  
07KE07 (2014). <https://doi.org/10.7567/JJAP.53.07KE07>,

[Google Scholar](#), [Crossref](#)

---

14. S. A. Seah, B. W. Drinkwater, T. Carter, R. Malkin, and S. Subramanian,  
IEEE Trans. Ultrason. Ferroelectr. Freq. Control **61**, 1233 (2014).

<https://doi.org/10.1109/TUFFC.2014.3022>, [Google Scholar](#), [Crossref](#)

---

15. W. J. Xie and B. Wei, Appl. Phys. Lett. **79**, 881 (2001).

<https://doi.org/10.1063/1.1391398>, [Google Scholar](#), [Scitation](#), [ISI](#)

---

16. C. A. Rey, U.S. patent 4,284,403 (18 August 1981). [Google Scholar](#)

---

17. C. A. Rey, D. R. Merkley, G. R. Hammarlund, and T. J. Danley, Metall.  
Mater. Trans. A **19**, 2619 (1988). <https://doi.org/10.1007/BF02645792>,

[Google Scholar](#), [Crossref](#)

---

18. A. Haake and J. Dual, Ultrasonics **40**, 317 (2002).

[https://doi.org/10.1016/S0041-624X\(02\)00114-2](https://doi.org/10.1016/S0041-624X(02)00114-2), [Google Scholar](#),  
[Crossref](#)



19. T. Kozuka, K. Yasui, T. Tuziuti, A. Towata, and Y. Iida, Jpn. J. Appl. Phys., Part 1 **46**, 4948 (2007). <https://doi.org/10.1143/JJAP.46.4948>, [Google Scholar](#), [Crossref](#)
- 
20. A. Grinenko, C. K. Ong, C. R. P. Courtney, P. D. Wilcox, and B. W. Drinkwater, Appl. Phys. Lett. **101**, 233501 (2012). <https://doi.org/10.1063/1.4769092>, [Google Scholar](#), [Scitation](#), [ISI](#)
- 
21. L. P. Gor'kov, Sov. Phys.-Dokl. **6**, 773 (1962). [Google Scholar](#)
- 
22. M. A. B. Andrade, N. Pérez, F. Buiochi, and J. C. Adamowski, IEEE Trans. Ultrason. Ferroelectr. Freq. Control **58**, 1674 (2011). <https://doi.org/10.1109/TUFFC.2011.1995>, [Google Scholar](#), [Crossref](#)
- 
23. A. Stindt, M. A. B. Andrade, M. Albrecht, J. C. Adamowski, U. Panne, and J. Riedel, Rev. Sci. Instrum. **85**, 015110 (2014). <https://doi.org/10.1063/1.4861197>, [Google Scholar](#), [Scitation](#), [ISI](#)
- 

© 2015 AIP Publishing LLC.

**APL Energy**

**Open, quality research for the energy communities**

[LEARN MORE](#)



AUTHOR

LIBRARIAN

ADVERTISER

---

## General Information

ABOUT

CONTACT

HELP

PRIVACY POLICY

TERMS OF USE

FOLLOW AIP PUBLISHING:



Website © 2022 AIP Publishing LLC.

Article copyright remains as  
specified within the article.

**Scitation**

