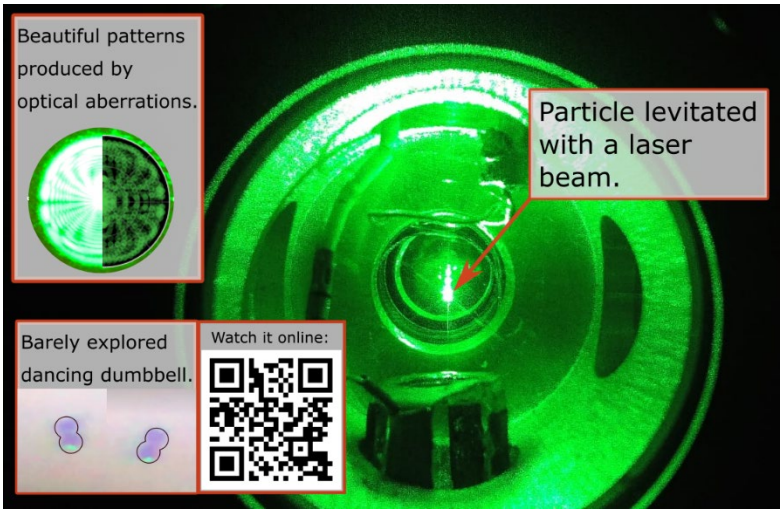
Optical Levitation



Background: Using optical manipulation it is possible to very precisely trap and manipulate micro- and nano-metric particles in air, water and vacuum. This has grown to be an indispensable tool in biophysics, nanophysics and fundamental physics research. In particular, the dynamics of particles in easily manipulable optical potentials can help predict the dynamics of similar particles in other environments. This is especially interesting in vacuum where it is possible to reach the underdamped regime and test theoretical predictions [1]. Furthermore, a trapped particle can also be used as a light source to visualize spherical aberration [2].

Problem description: Trapped dumbbells in air have sometimes been found to dance from side to side. You will in this project trap and study the dynamics of such trapped dumbbells both in air and in different levels of vacuum, with the goal to increase our understanding of the dynamics of a trapped dumbbell.

The project can further be expanded to include studies of optical aberrations in different lenses, including yet unexplored astigmatism. The patterns can be compared to simulations to calculate the magnitude of different optical aberrations.

Procedure: Experimental work divided as: building your own optical trap, gathering and analyzing data and (possibly) programing.

Group size: One or two groups of 3 students.

Target group: F, GU-Fysik.

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Bibliography

[1] Rondin, L. et al. Direct measurement of Kramer's turnover with a levitated nanoparticle. Nature Nanotech 12, 1130–1133 (2017). https://doi.org/10.1038/nnano.2017.198
[2] Marmolejo, J. et al. "Visualization of spherical aberration using an optically levitated droplet as a light source," Opt. Express 28, 30410-30422 (2020)