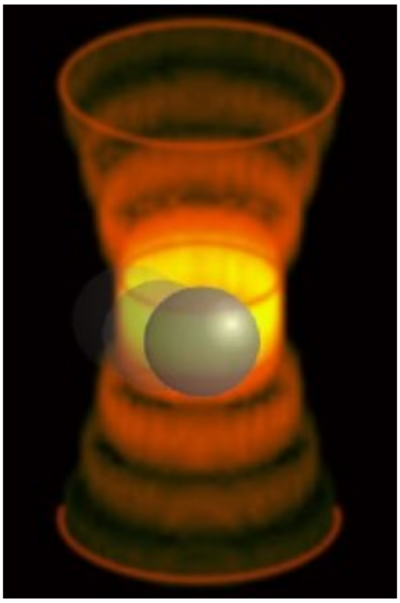
Deep Learning for Optical Tweezers

An optical tweezers is a highly-focused laser beam that can trap microscopic particles, cells and molecules.



Despite the growing interest in optical tweezers, the strategies that have been applied to achieve their scientific and technological potential have been surprisingly uniform. These strategies have been following a linear, top-down approach where, first, data analysis workflows are designed based on human intuition; then, they are tested in simulation or experiments; and, finally, they are proposed for potential applications. Unfortunately, the reliance on these strategies has brought the field to reach a point of diminishing returns. A novel, bottom-up, data-driven approach is now needed to address the open challenges of the field.

We propose to use the tools of artificial intelligence (specifically, machine learning and deep learning) to understand, design, engineer, and optimize optical tweezers. This will permit us to move from approaches relying on (and limited by) the ingenuity of human intuition to machine-learning and deep-learning approaches capable of mining new information and strategies from experimental and numerical data.

Specifically, this project aims at using deep learning to characterize the motion of a particle in an optical tweezers and to determine the conditions to generate optical potentials optimized for specific applications, such as the measurement of microscopic forces or the handling of cells.

The project will consist mostly of numerical work with deep learning using Python, but it will also be possible to compare the results to experimental results obtained in our optical trapping lab.

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References

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