Full Mueller matrix single particle scatterometer

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We describe a setup for measuring the full angular Mueller matrix profile of a single mm- to µm-sized sample, and verify the experimental results against a theoretical model. The scatterometer has a fixed or levitating sample, illuminated with a laser beam whose full polarization state is controlled. The scattered light is detected with a combination of wave retarder, linear polarizer, and photomultiplier tube that is attached to a rotational stage. The first results are reported.

Measuring scattering properties of different targets is important for material characterization, remote sensing applications, and for verifying theoretical results. Furthermore, there are usually simplifications made when we model targets and compute the scattering properties, e.g., ideal shape or constant optical parameters throughout the target material. Experimental studies can help us in understanding the link between the observed properties and computed results.

Experimentally derived Mueller matrices of particles can be used as input for larger-scale scattering simulations, e.g., radiative transfer computations. This method allows us to bypass the problem of using idealized model for single-particle properties. There are publicly available studies of the scattering properties of particles, e.g., the Granada light scattering database. With our scatterometer, we aim to offer similar material for single, small (down to µm-scale) targets. While other sources usually offer ensemble- and orientation-averaged particle properties, we will be able to measure individual particles with controlled or known orientation.
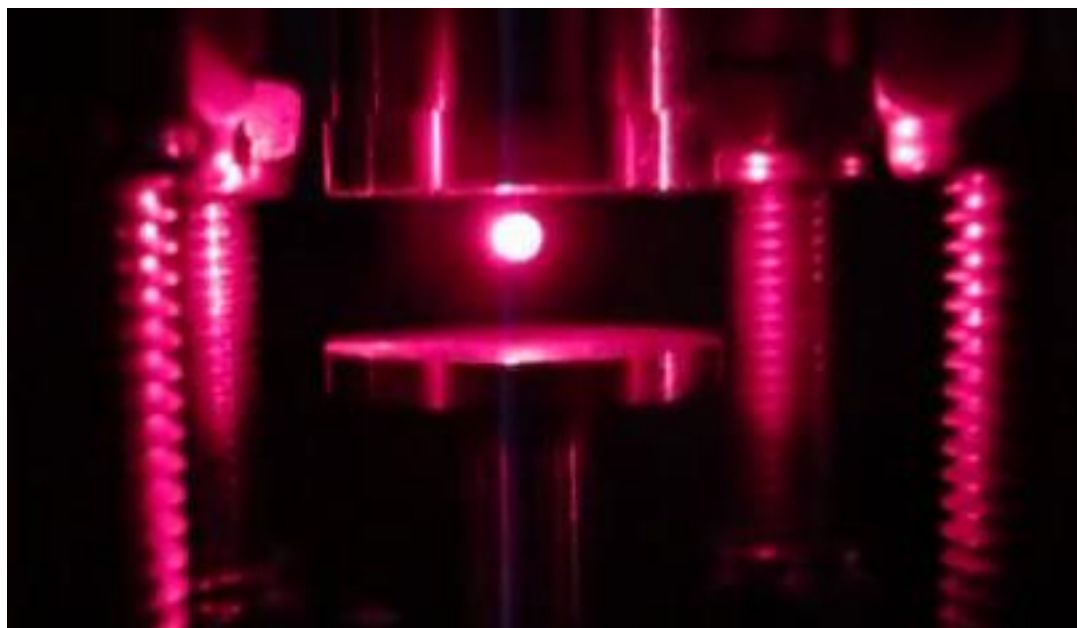

Figure: Single-amplifier ultrasonic levitator with a 3 mm glass sphere trapped in the upper node of the standing ultrasound wave.

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