Axial Localization Improvements when Trapping Aerosol Droplets using an Annular Beam

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Abstract: We demonstrate that annular beam traps lead to an increased size range and improved axial trapping of aerosols in comparison to Gaussian beam traps. These methods are extended to consider ionic liquid samples.

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1. Optical trapping using an annular beam

In this work we quantify the improvements that can be achieved by using an annular beam trap, formed by blocking the centre of a Gaussian beam [1]. These improvements include an increase in the range of trappable particles, both in terms of the refractive index contrast between the trapping medium and particle, with particular applications in aerosol trapping where this contrast is large, and also an increase in the size range of trappable salt water aerosol droplets. In addition annular beams show improved axial localization and an increase in axial:lateral trap stiffness ratio. These improvements show excellent agreement with theoretical models of these systems [2], using a modification of Mie-Debye spherical aberration theory [3,4].

2. Micro-viscosity measurements in ionic liquids

Using a combination of high-speed camera tracking and back focal plane interferometry we have extended this work to include an investigation into the trapping of both ionic liquid droplets, defined as organic salts with a melting point below 100 °C, and of tracer particles in ionic liquid samples. These methods have allowed us to monitor micro-viscosity changes under a variety of different conditions in these novel media.

Fig 1. An example power spectrum for a 2.35 μm melamine tracer particle trapped in ethylammonium nitrate.

3. References

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