TWO-LASER OPTICAL TWEEZERS AS A MICRO-VISCOMETER

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We present a new configuration of the holographic optical tweezers setup. A typical one consists of a laser, SLM (Spatial Light Modulator) and high numerical aperture microscope objective. However, in our version two lasers of different wavelengths are used in order to generate non-interfering trapping beams. The primary, stronger source is Nd:YAG (1064nm, 4W) an d is connected to the electronic shutter. Therefore, it periodically 'blinks' with a well-controlled frequency. The auxiliary, weaker source is a solid-state laser diode (980nm, 0.5W) working in a continuous mode.
A standard polystyrene bead (Ø4.5μm) is placed between two traps – a blinking and a constant one. As a result, the bead performs an oscillatory movement from one trap to the other. Moving through the medium, the particle experiences a drag force which influences its trajectory. A fast video camera (up to 5000fps) is used for tracing the bead's position with high precision and measuring the amplitude of oscillations. We propose a method of determining viscosity of the fluid from bead's trajectory. The numerical computations followed by the experimental results are presented.
Moreover, the analogous technique can be used for measuring the stiffness of the weaker (non-blinking) trap. Quantitative and precise estimation of trap stiffness is a difficult problem in optical trapping. There are several well-developed methods [1,2] such as power spectrum analysis [3], equipartition theorem, autocorrelation or so-called drag force method but most of them require high trapping efficiency, i.e. powerful laser beam. For a weak trap they tend to fail or experience a significant accuracy loss [4,5]. We show that our blinking trap technique brings an improvement in the weak trap regime and provides a reasonable estimate of trap stiffness.

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