Optical trapping with Super-Gaussian beams

Melanie McLaren, Thulile Khanyile, Patience Mthunzi and Andrew Forbes*
National Laser Centre, Council for Scientific and Industrial Research, PO Box 395 Pretoria, 0001 South Africa
Author e-mail address: aforbes1@csir.co.za

Abstract: We outline the possibility of optical trapping and tweezing with Super-Gaussian beam profiles. We show that the trapping strength can be tuned continuously by adjusting the order of a Super-Gaussian beam, approaching that of a perfect Gaussian and perfect flat-top beam at the two extremes.
OCIS codes: (140.3300) Laser Beam Shaping;

1. Introduction and Results

Super-Gaussian (SG) beams have been studied extensively to date [1], and have found application in several fields, notably as means to extract high powers from laser resonators, in laser materials processing, and in non-linear applications of laser light. Importantly they have a continuously tunable order parameter (p) that transforms the electric field, $u(r)$, from a perfect Gaussian ($p = 2$) to a perfect flat-top beam ($p \to \infty$)

$$u(r) = \exp\left[-\left(\frac{r}{w}\right)^{p}\right]. \qquad (1)$$

This tuning towards higher values of p results in steeper intensity gradients near the edges of the beam, as well as flatter intensities at the centre of the beam, as shown in Fig. 1. A consequence of this is that the intensity gradient, and therefore the trapping strength, can also be tuned through control of p without the need for power adjustment of the laser (the conventional means to adjust the trapping strength).

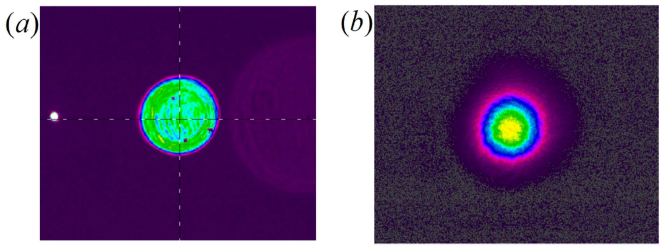

Fig. 1. Experimental images of (a) a circular SG beam of order 50 (flat-top beam), and (b) a SG beam of order 2 (Gaussian).

We show that the trapping strength can be varied as a function of the order parameter, and demonstrate successful trapping with a SG beam.

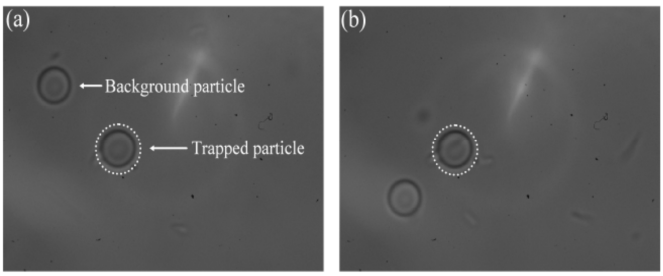

Fig. 2. Experimental images of optical trapping with a SG beam.

2. References

[1] Fred M. Dickey and Scott C. Holswade "Gaussian beam shaping)" in *Laser Beam Shaping: Theory and Techniques*, F.M. Dickey, ed. (Marcel Dekker, New York 2000).