Title:	Optical and Thermal Nonlinearities in Laser Trapping of Metallic/Metal-Dielectric Hybrid Nanoparticles and Laser Beam Shaping with a Spatial Light Modulator: Theories and Experiments
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Abstract:	In recent years, there is an impetus to explore the intriguing physics of nonlinear optical and thermal forces acting on particles of varying sizes under femtosecond pulsed excitation. The immense peak power of ultra-short pulses introduces optical (for example, optical Kerr effect) and thermal nonlinearities that promise to hold the capacity to fine-tune the nature and the magnitude of trapping forces, and thereby control the trapping dynamics. Such nonlinear phenomena become more fascinating for particles made of materials with plasmonic characteristics, especially due to the distinctive size- dependent plasmonic resonance features inherent to nanoparticles, quite different from their bulk counterparts. On the other hand, laser beam shaping techniques are gaining increased attention in modulating optical forces with structured light, and controlling of gradient and scattering forces with the aid of such structured light is thought-provoking. This thesis focuses on the theoretical and experimental investigations of the effects of optical and thermal nonlinearities in laser trapping under femtosecond pulsed excitation, and additionally, on the application of shaped laser beams in optical trapping and manipulation. Following an introduction to the motivation behind this work and an overview of the methodologies used, in the first part of the thesis, theoretical results describing the effects of optical nonlinearity on trapping of silver nanoparticles, silver-polystyrene core-shell type nanoparticles, and dielectric/metal-dielectric multi-layered type nanoparticles will be discussed. Further, the effects of the surrounding medium (having high Kerr nonlinearity) on beam propagation and trapping will be presented. In the subsequent section, theoretical results describing the effects of optical and thermal nonlinearities on the trapping dynamics of polystyrene particles of varying sizes at distinct axial trapping planes will be discussed. In the second part of the thesis, generation and propagation of Bessel beams using a spatial light modulator will be presented. Further, combining beam shaping with an optical tweezers apparatus, the trapping efficiency of distinct concentric annular beams will be discussed. The presentation will conclude with a discussion on the future prospects of this research, with an emphasis on the possible applications in nanoscale optical trapping and manipulation.
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