INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Single beam optical trap comprises a tightly focused laser beam that exerts a pico-Newton level force on suspended microscopic particles. Since last couple of decades or so such optical traps have become an important tool in areas such as biological and biomedical sciences. For proper design and efficient working of the optical traps it is important to know the various forces acting on a trapped particle using an appropriate force calculation model. Since majority of the recent applications involve trapping and manipulation of large biological particles hence for such particles force calculation model in the ray optics regime such as the ray-pencil model is more appropriate. However existing form of the ray-pencil model can compute optical forces due to plane wavefronts with cylindrically symmetric beam profiles only. On the other hand, there are optical traps that use complex beams such as vortex beams. Moreover, often the light beam used in an optical trap does not have a plane wavefront due to aberrations present. For all such cases the present form of the ray-pencil model is not sufficient. In this thesis we propose an augmentation in the ray-pencil model to be able to compute optical forces due to an arbitrary beam profile. We develop a dynamic holographic optical trap to experimentally measure the various optical forces acting on a spherical bead. We validate the proposed augmented force calculation model by comparing the numerical results with the experimental results. We also compute the optical forces on a trapped bead due to a number of vortex beams using the proposed model. We then use our holographic trap to perform trapping experiments using the vortex beams. We again find that the experimental results agree well with the theoretical predictions.