Shaping Electromagnetic Fields for Optical Trapping and Binding

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Optical traps can be built simply from constructive and destructive interference of two or more coherent light beams. For example, interference of several identical plane waves distributed with an n-fold symmetry lead to periodic or aperiodic arrays of traps [1]. Figure 1 displays such a set of traps. Interference between an intense electromagnetic field impinging on mesoscopic particles and fields scattered by such particles generate ensembles of self distributed traps [2]. This leads to assemblies of the type of the one shown in Figure 2. Other kinds of interference made with two or more beams presenting a variety of complex amplitude distributions lead to atypical intensity landscapes presenting endless configuration possibilities for trap potentials [3]. The design of various trap shapes can then be manipulated at will through such interference, in order to control trap strength or also to command optical forces which channel polarizable dielectric particles. Besides, one can simply take advantage of free space wave propagation to form interference by illuminating a diffractive pattern with a plane wave or with a spherical wave.

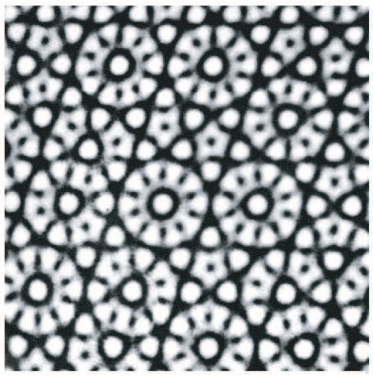

Figure 1: Five-fold symmetry array of optical traps.

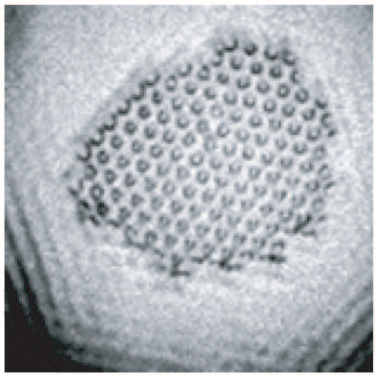

Figure 2: Dielectric particles assembled with gradient and binding forces.

The scope of this paper is to review and discuss several uncommon optical trap designs, such as those using Talbot imaging, a periodic diffractive structure, speckle patterns, or multiple beam interference. Experimental results emphasize the capability of the Talbot effect to generate three-dimensional optical lattices with the advantage of creating stiff traps with strong gradient forces. Several schemes of self-organization representing interesting means for trapping will also be described and discussed.

Mechanisms involved in those trapping procedures do not require the use of bulky high numerical aperture optics and are under test to produce new regimes of optical trapping. Most of the investigated designs account for the possibility of creating large arrays of traps.

REFERENCES

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