MOTION OF OPTICALLY BOUND SPHERES IN TRACTOR BEAM

Chvátal L., Damková J., Ježek J., Oulehla J., Brzobohatý O., Zemánek P.

Institute of Scientific Instruments of the CAS, v. v. i., Královopolská 147, 612 64 Brno, Czech Republic

We investigate theoretically and experimentally the dynamics of micro-sphere pairs optically bound in field that is created by retro-reflected wide Gaussian beam. Such field falls into cathegory of passive tractor beams: its has an almost uniform intensity profile along its overall momentum direction and can exert a force on a scatterer, which is directed against this momentum, as opposed to the common radiation pressure. The particle movement in our tractor beam can be even enhanced if the spheres form an extended dimer bound with a long-range `optical binding' forces, which are mostly due to the beam interaction with field from the distant particle. We demonstrate how motion of two optically bound objects in a tractor beam depends on their mutual distance and spatial orientation. Such configuration-dependent optical forces are yet another means by which we can control matter with light. Understanding and controlling them outstrips the limits of current limitations of common sorting or delivery of colloidal matter. To determine the 3D particle positions we used holographic video microscopy technique processed with the Rayleigh-Sommerfeld back-propagation, and we based the simulation of the dynamics on forces given by the exact Mie theory for multiple sphere scattering.

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