

Negative Optical Force: Tractor Beam, Light Escalator, and Interface

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Recently tractor beam which can pull the object has been receiving intensive attention. In this presentation, we will first unveil the fundamental physics and origin of the general pulling force by using multiple beams and even a single gradientless beam. Nevertheless that cannot be called a “tractor beam” *per se*, as long as the light pulling effect is ultrasensitive to the object’s material and size, a perturbation of which will ruin pulling effect. We therefore investigate the universality condition for Bessel beam to be a material-independent and size-independent tractor beam in dipolar regime. These universal pulling effects and conditions are discussed in association with insight on modified far-field scattering, scattering resonances, and induced polarizabilities. It is still too stringent to achieve pulling light with nonparaxial Bessel beam in practice. Hence we propose another schematic to transform normal plane waves into a light escalator, which can change the sign of the optical force on the object and gear it up and down using light. A non-magnetic levitating “train” can thus be possible then like Fig.1. A liquid interface is also presented and experimentally verified to be efficient to make a plane wave into a “tractor beam” based on linear photon momentum transfer.

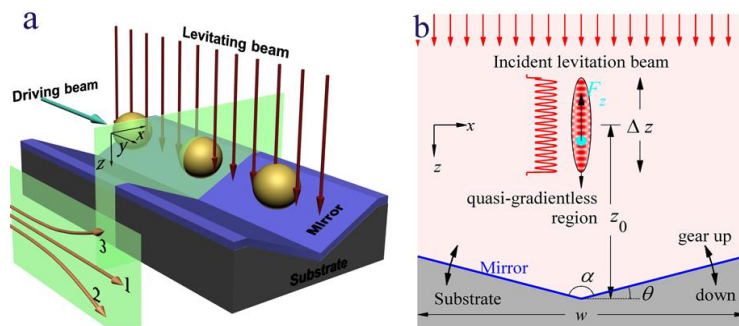


Fig.1 A telescope-based escalator (a) and its levitating/descending region (b).