Optical micromanipulation – transfer of linear and angular momentum of light

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The way light can apply forces to a microscopic object is easily understood as an exchange of momentum between the light beam and the object. This applies both to linear momentum and to angular momentum exchange. Methods based on these phenomena promise high flexibility and an opportunity for driving these objects in microfluidic devices or inside a biological cell or developing methods that enable manipulation of large biological objects in vivo and combining it with optogenetics. Optical drive of micron scale devices promises the ability to carry out measurements and operations on microscopic systems in a flexible way.

The use of the angular momentum of light enables introduction of controlled rotation of microscopic objects. Quantitative measurements of this rotation are possible through a measurement of the change of polarisation state of light after passing through the object. The transfer of the angular momentum can then be used for several applications in biology and medicine. One of such application is microrheology of complex fluids that exhibit both viscous and elastic behaviours. The use of orbital angular moment presents further advantages in creating highly controllable devices as for example bio-analogues.