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Quantifiable Torques for Microfluidic Studies

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QUANTIFIABLE TORQUES FOR MICROFLUIDIC STUDIES

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Huge scientific advances have arisen from the ability to measure forces to high resolution. While Atomic Force Microscopes can reliably measure forces in solution down to around 10 pico-Newtons, force measurements well below that scale have been required to elucidate, e.g., basic mechanisms involved in the molecular motors responsible for muscle response. In this regime, non-invasive optical forces have become an invaluable tool. Just this year, the range of convincing calibration of optical forces has been extended down to 20 femto-Newtons! This opens up, for example, the possibility of studying the entropic forces involved in the statistical mechanics of DNA.

The study of torques has received less attention. It is our intention to use optical forces to push the limits of sensitivity for the measurement of torque in solution.

Our initial efforts have involved reproducing the current state of the art, an approach developed in 2004 by the Queensland group.1 We utilize a circularly polarized laser beam to transfer angular momentum to a birefringent „probe‰ particle (a micro-sphere of CaCO3) in solution. By tightly focusing the laser beam, we create strong electromagnetic gradients that allow us to trap and manipulate the probe. Our ability to quantify the torques generated by our laser beam will depend on our knowledge of three key parameters: the frequency of the laser light, the power applied to the probe particle, and changes (per photon) in the polarization state of the transmitted beam.

1. „Optical Microrheology Using Rotating Laser-Trapped Particles,‰ A. Bishop, T. Nieminen, N. Heckenberg, H. Runbinsztein-Dunlop, Phys. Rev. Lett. 92, 198104 (2004).