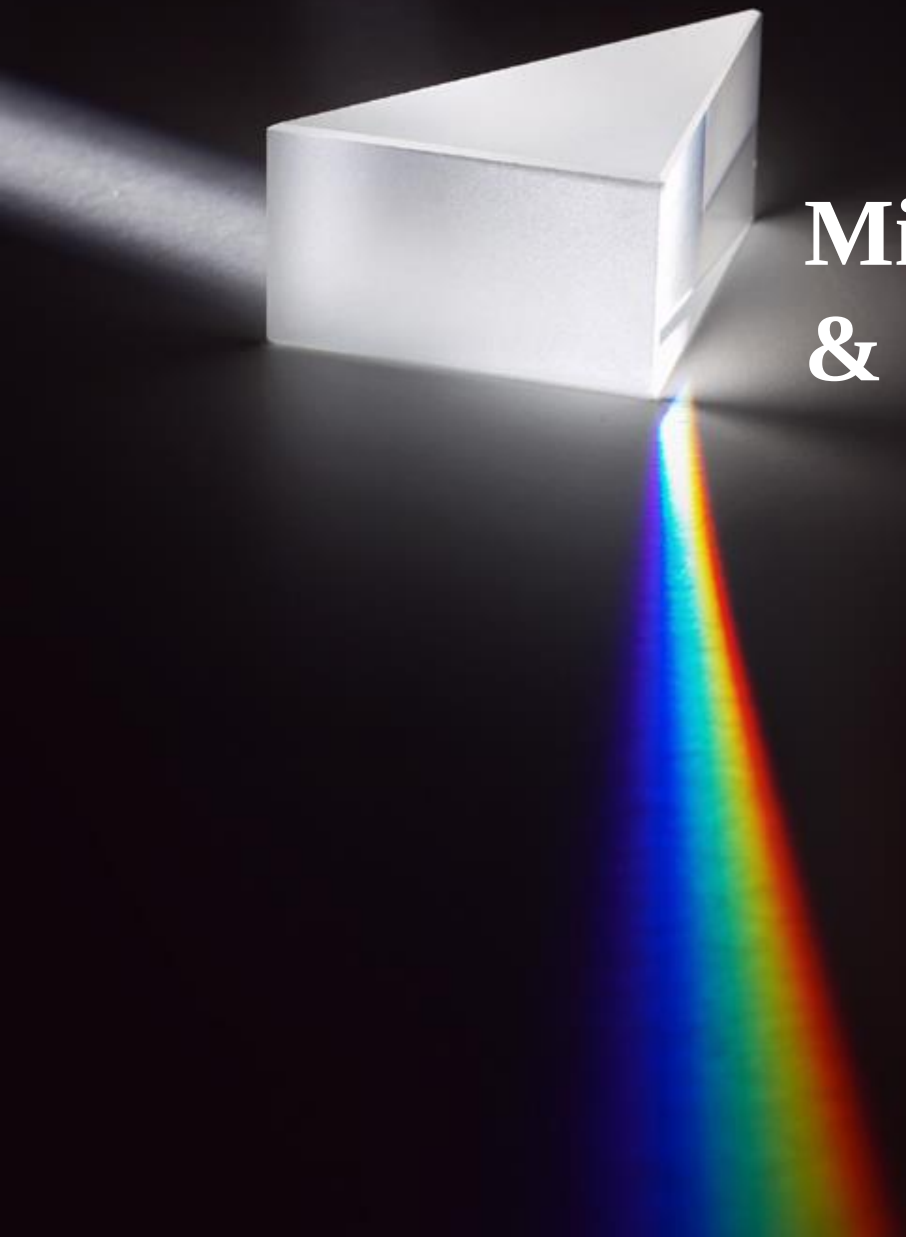

Microrheology & Optical Tweezers

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Optic-Fall2023 Dr. S.Reihani

Microrheology:

- the study of the flow and deformation behavior of complex fluids and soft materials at the microscale
- the use of particles(much smaller than the characteristic length scale of the material), such as colloidal beads or nanorods, as probes to track the local flow and deformation of the material
- By tracking the Brownian motion or the response of these particles to external forces we can study about complex dynamics and rheological properties like such as viscoelasticity, shear thinning, and non-Newtonian behavior at a very small scale

Techniques in Microrheology:

1. Particle Tracking Microrheology (PTM):
- tracking the Brownian(thermal) motion of colloidal particles to study local viscoelastic properties.

2. Fluorescence Recovery After Photobleaching (FRAP):
- fluorescently labeled material is photobleached, then the recovery of fluorescence due to molecular diffusion or flow is monitored.

3. Multiple Particle Tracking (MPT):
- involves simultaneously tracking the motion of multiple particles within a sample, allows for the study of collective behavior and interactions between particles

4. Active Microrheology:
- uses external forces, such as optical or magnetic tweezers, to exert controlled stresses. . By measuring the response of the particles to these forces, researchers can probe the local viscoelastic properties

5. Dynamic Light Scattering (DLS):
- used to measure the size and motion of particles in suspension by analyzing the fluctuation in scattered light

Applications of Microrheology:

1. Biological and Soft Matter Systems:

- Study mechanical properties of biological systems such as cells, tissues, and biopolymers in fields like tissue engineering, drug delivery, and understanding cellular mechanics

2. Complex Fluids and Polymers

- properties of complex fluids and polymers such as emulsions, colloids, gels, and polymer melts for industrial products like cosmetics, food, pharmaceuticals producs

3. Quality Control in Manufacturing

- analyze the flow and deformation behavior of materials during the manufacturing process of paints, inks, adhesives, and coatings

Applications of Microrheology:

4. Drug Development:
- research and development of drug formulations, gels, and drug delivery systems to optimize drug viscosity, stability, and release kinetics.

5. Material Science and Nanotechnology:
- investigate the rheological properties of nanomaterials, such as nanoparticles, nanotubes, and nanocomposites in fields like electronics and aerospace.

6. Environmental and Geological Studies:
- in studying the rheological properties of complex environmental and geological fluids such as muds, sludges, and soil suspensions to understand natural processes, pollution control, and geological fluid dynamics.

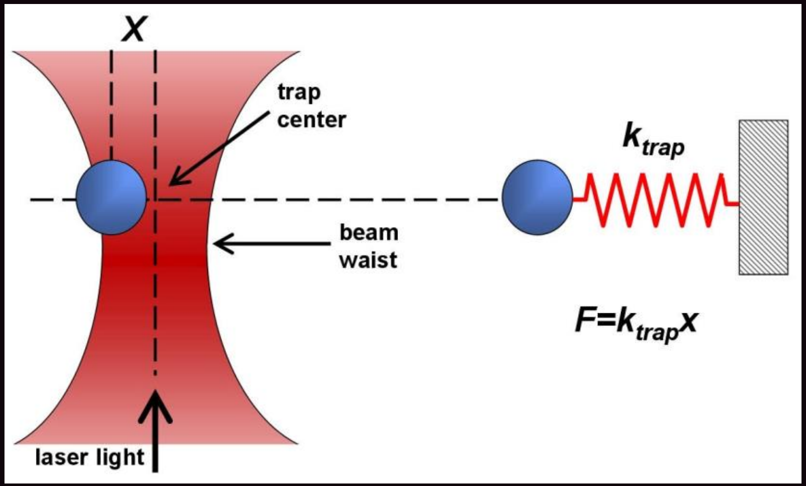
History of Optical Tweezers:

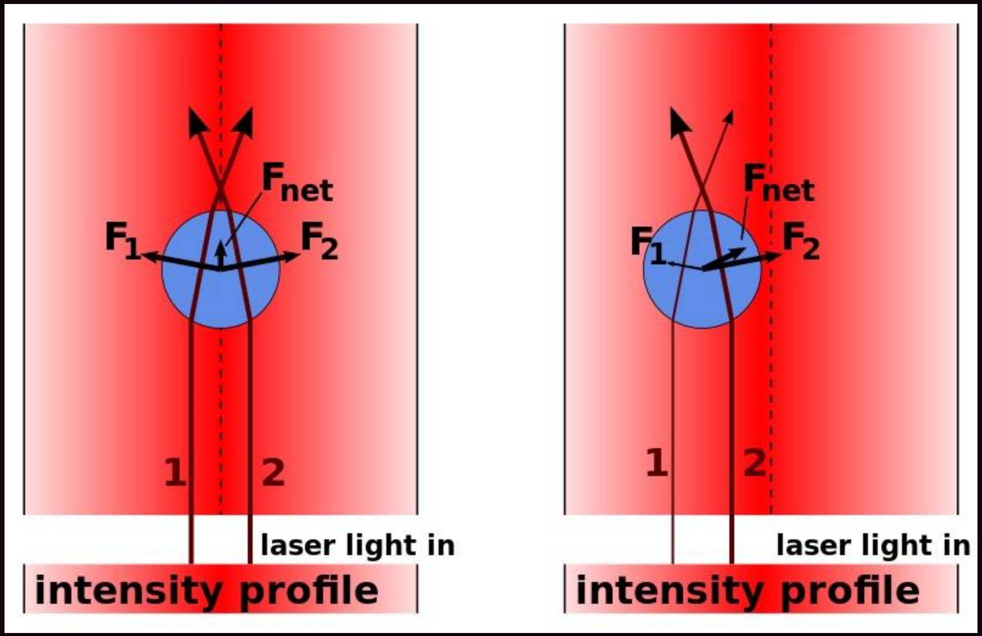
- the early 1970s
- Arthur Ashkin, a physicist at Bell Laboratories
- using the radiation pressure of light to trap and manipulate small dielectric particles
- In the late 1980s that Ashkin and his team successfully demonstrated the first practical optical tweezers
- In 1986, Ashkin and co-workers published a seminal paper
- Optical tweezers is a powerful tool for studying the mechanical properties and biological functions of living cells, viruses, and other microorganisms
- the Nobel Prize in Physics in 2018

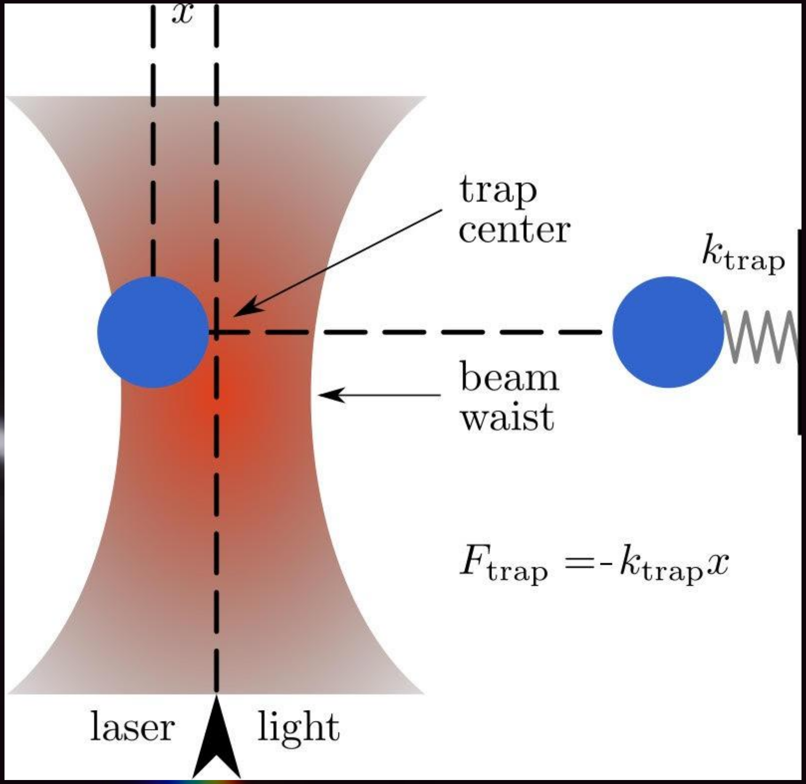
Applications of Optical Tweezers:

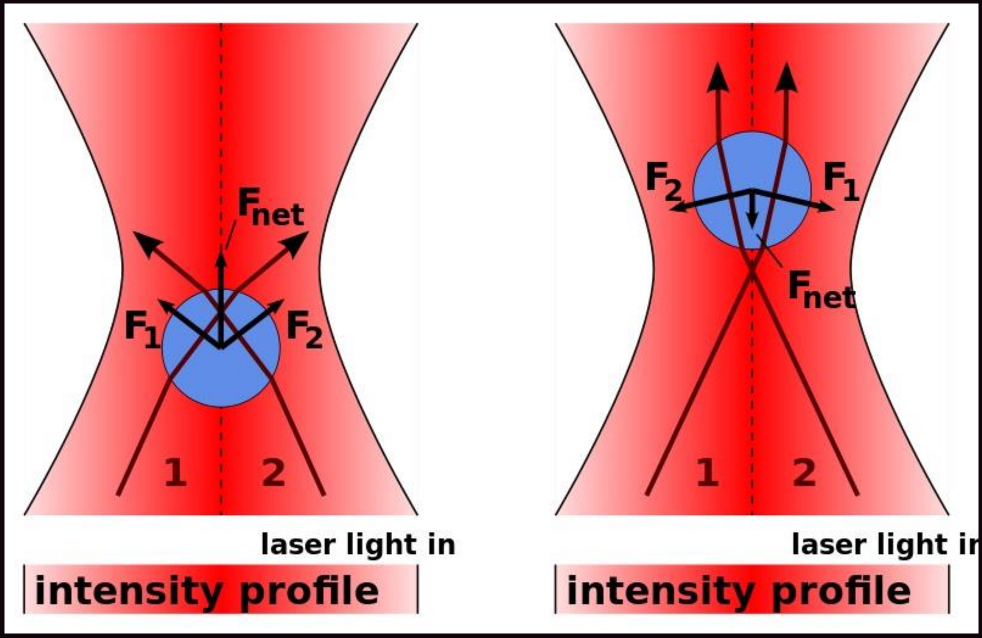
- biophysics, microbiology, nanotechnology, and colloidal science. They have been used to study the behavior of motor proteins, manipulate DNA molecules, measure forces in molecular interactions, and even trap and manipulate atoms and ions

How Optical Tweesers work

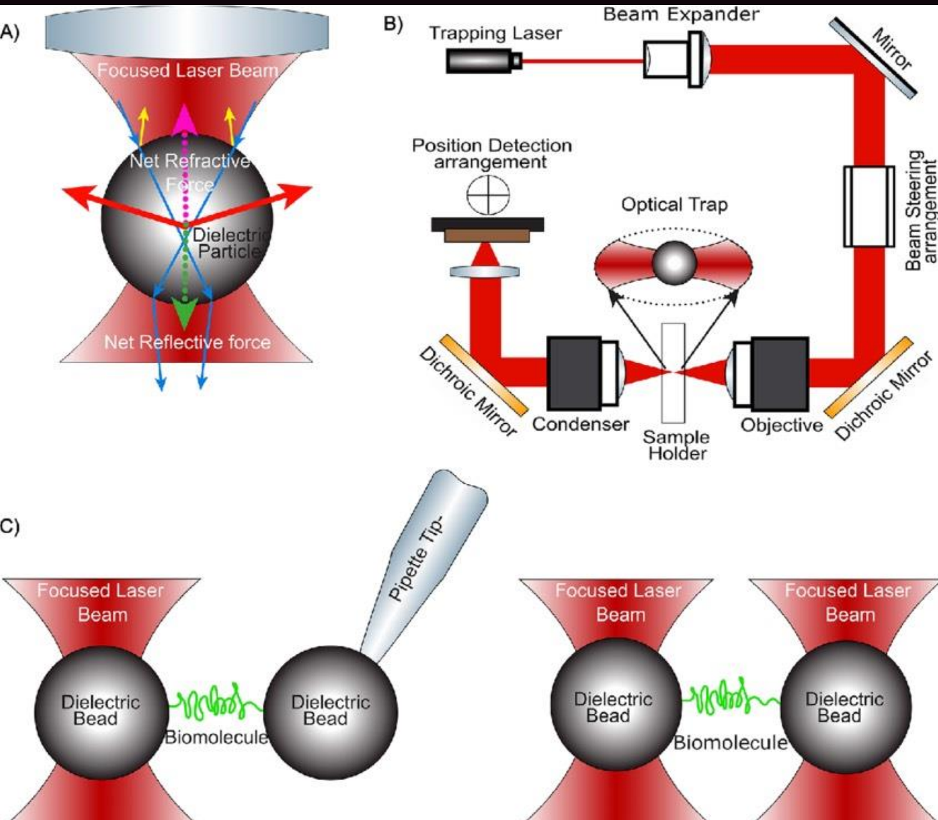


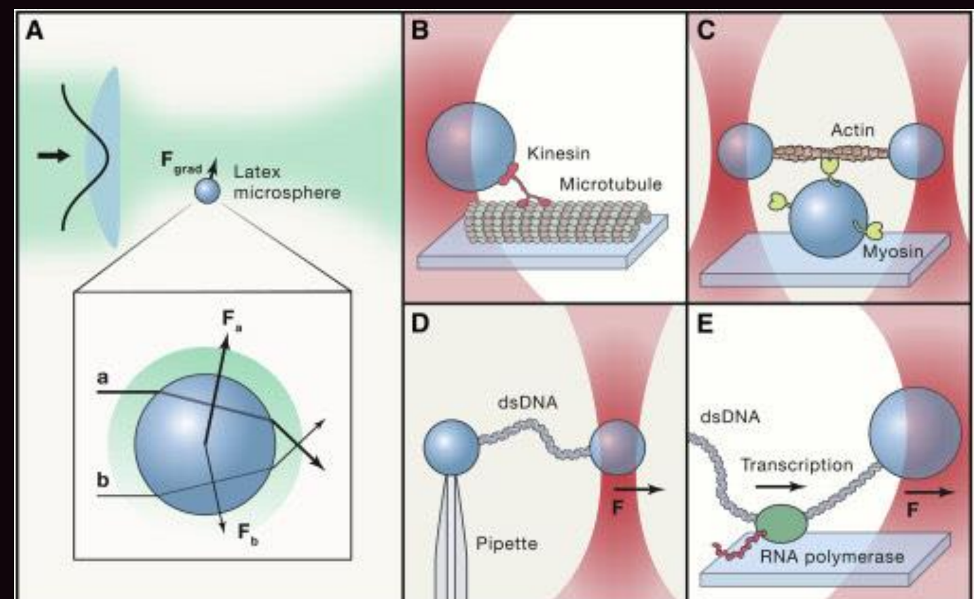




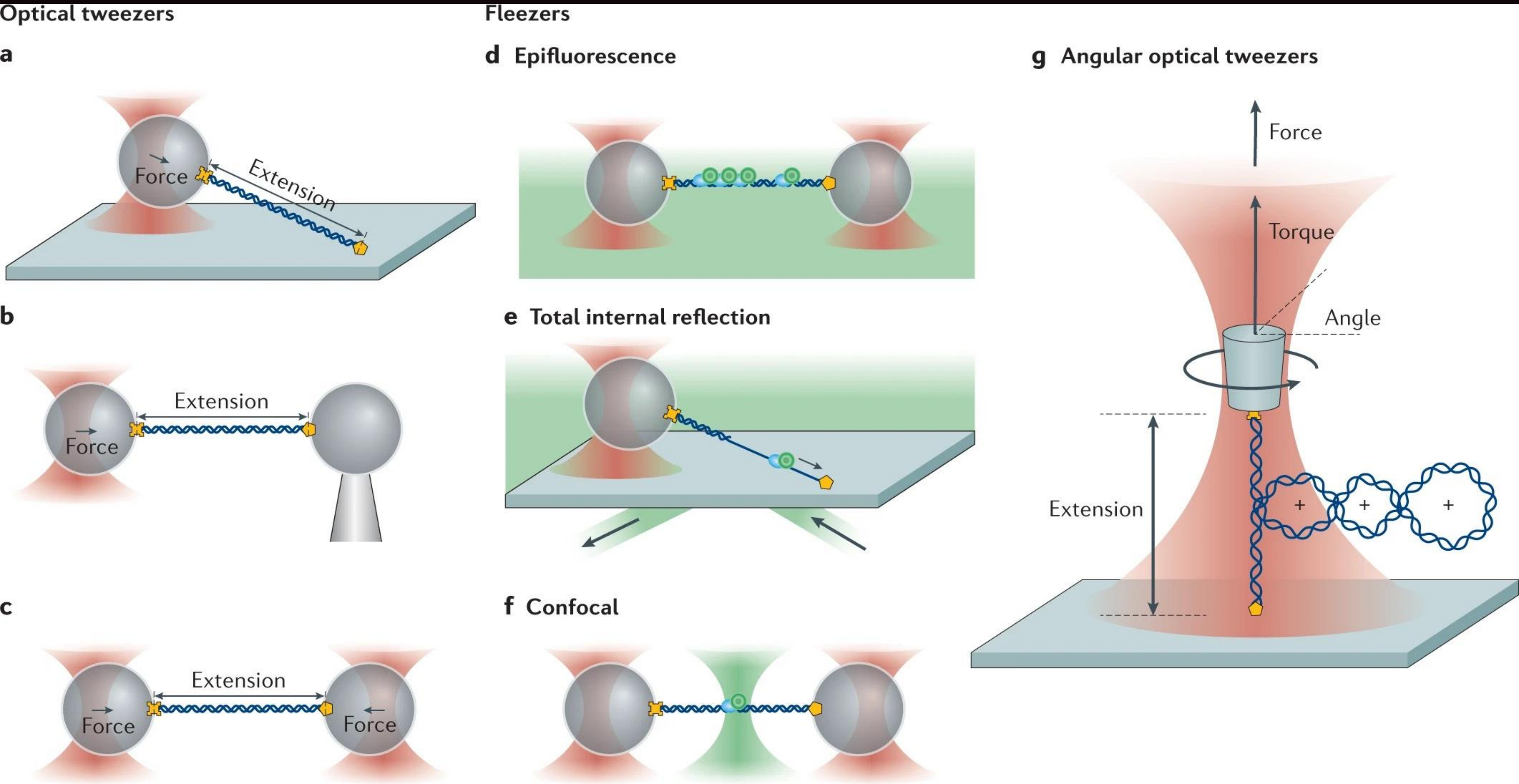


Use Coupled Dielectric Sphere

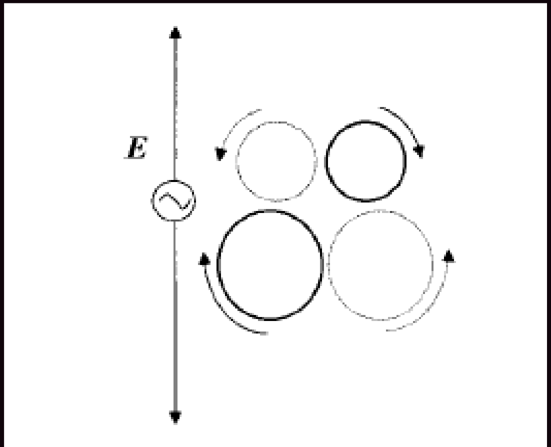


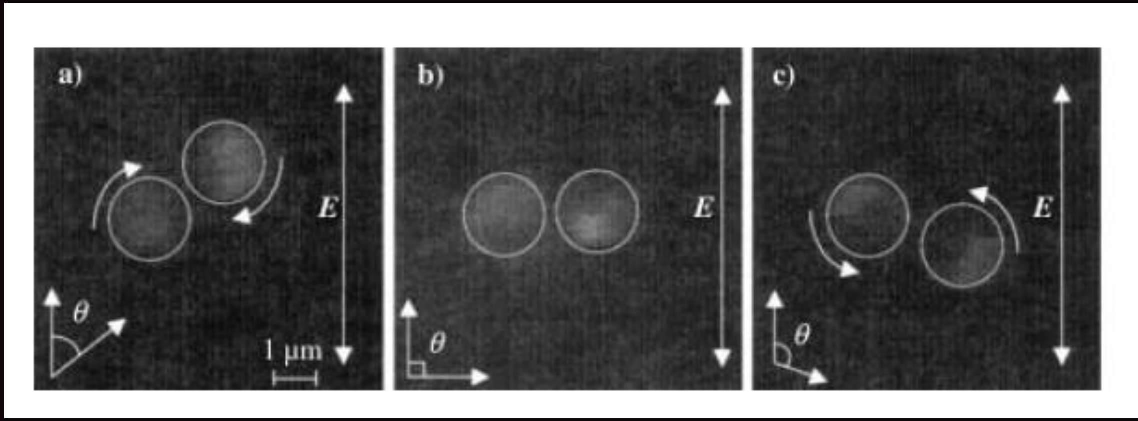


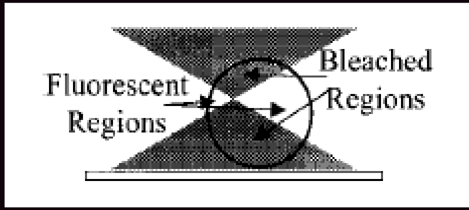
Different Useges

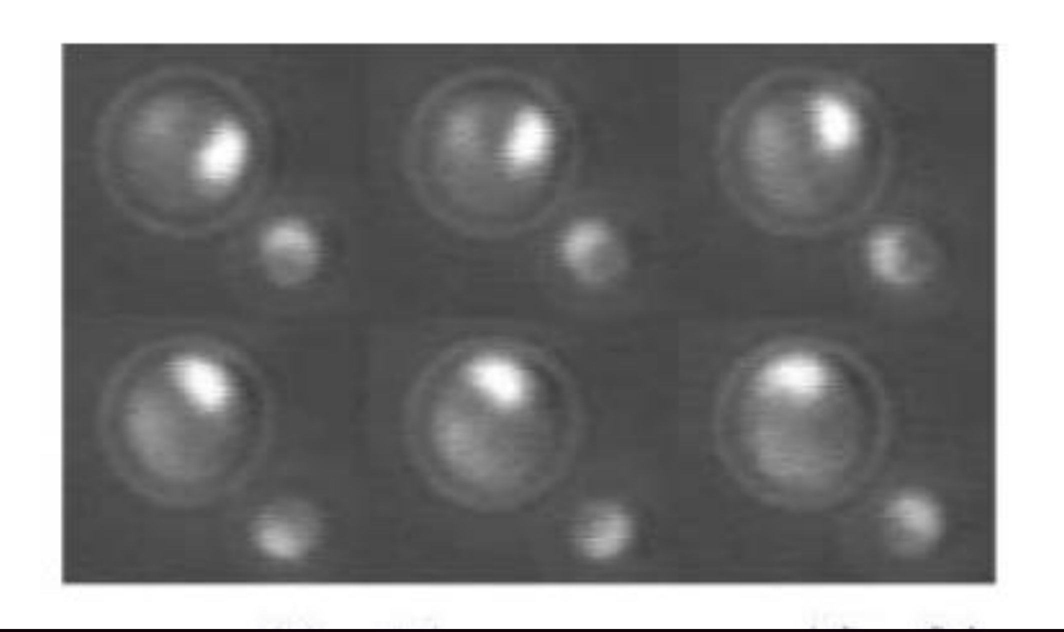


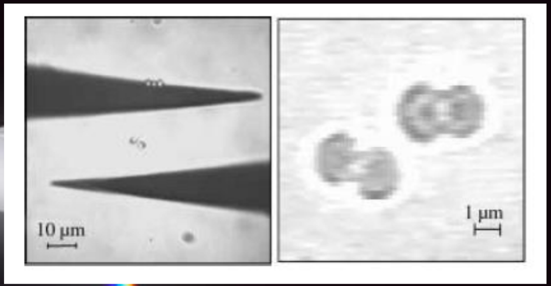
A Different Problem



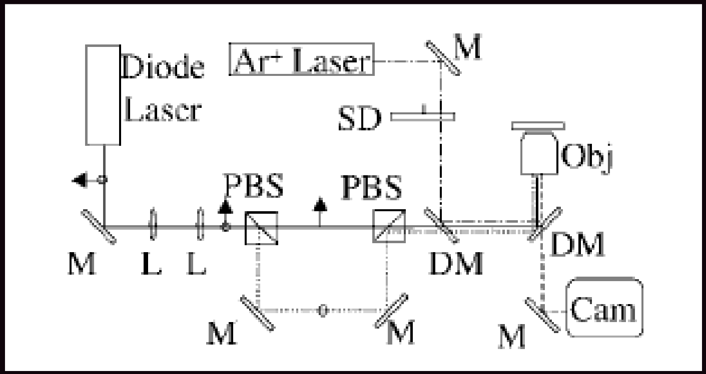


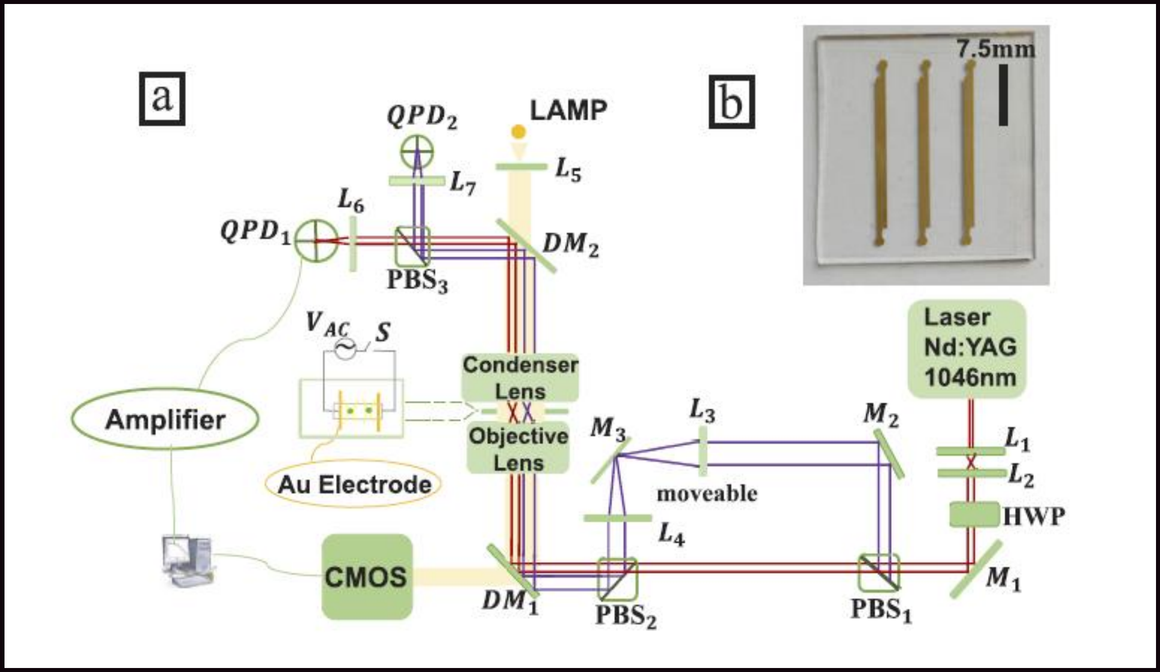


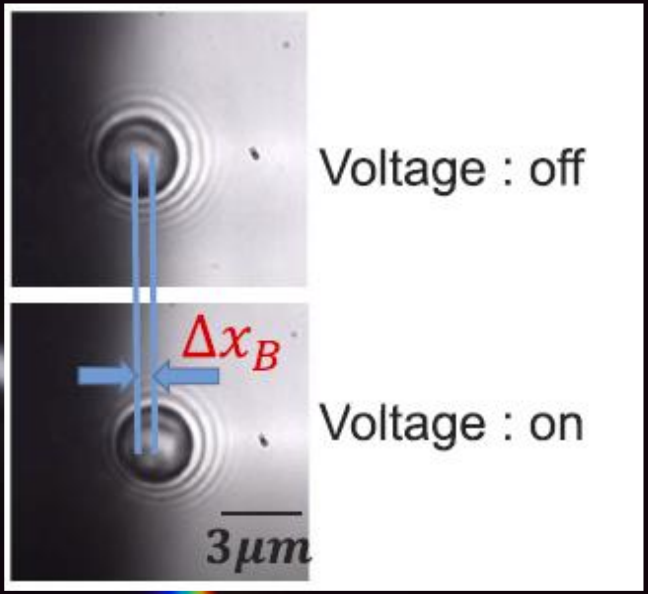




Setups and Our Advantage







Resources:

- Coupled Electrorotation: Two Proximate Microspheres Spin in Registry with an AC Electric Field Garth J. Simpson,Clyde F. Wilson, Karl-Heinz Gericke, and Richard N.Zare
- Proper measurement of pure dielectrophoresis force acting on a RBC using optical tweezers MEHRZAD SASANPOUR, ALI AZADBAKHT, PARISA MOLLAEI, AND S.NADER S. REIHANI
- Passive and Active Microrheology for Biomedical Systems by Yating Mao,Paige Nielsen,Jamel Ali
- https://lsinstruments.ch/en/theory/rheology/microrheology
- https://en.wikipedia.org/wiki/Optical_tweezers

Thanks for your attentions!