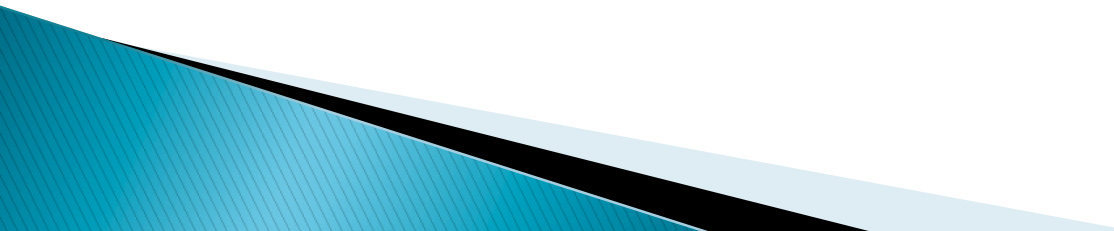


Using Light to See the Size and Shape of Nanometer Sized Objects

Jessica Hoy
Daniel Schiffels
Deborah Fygenon

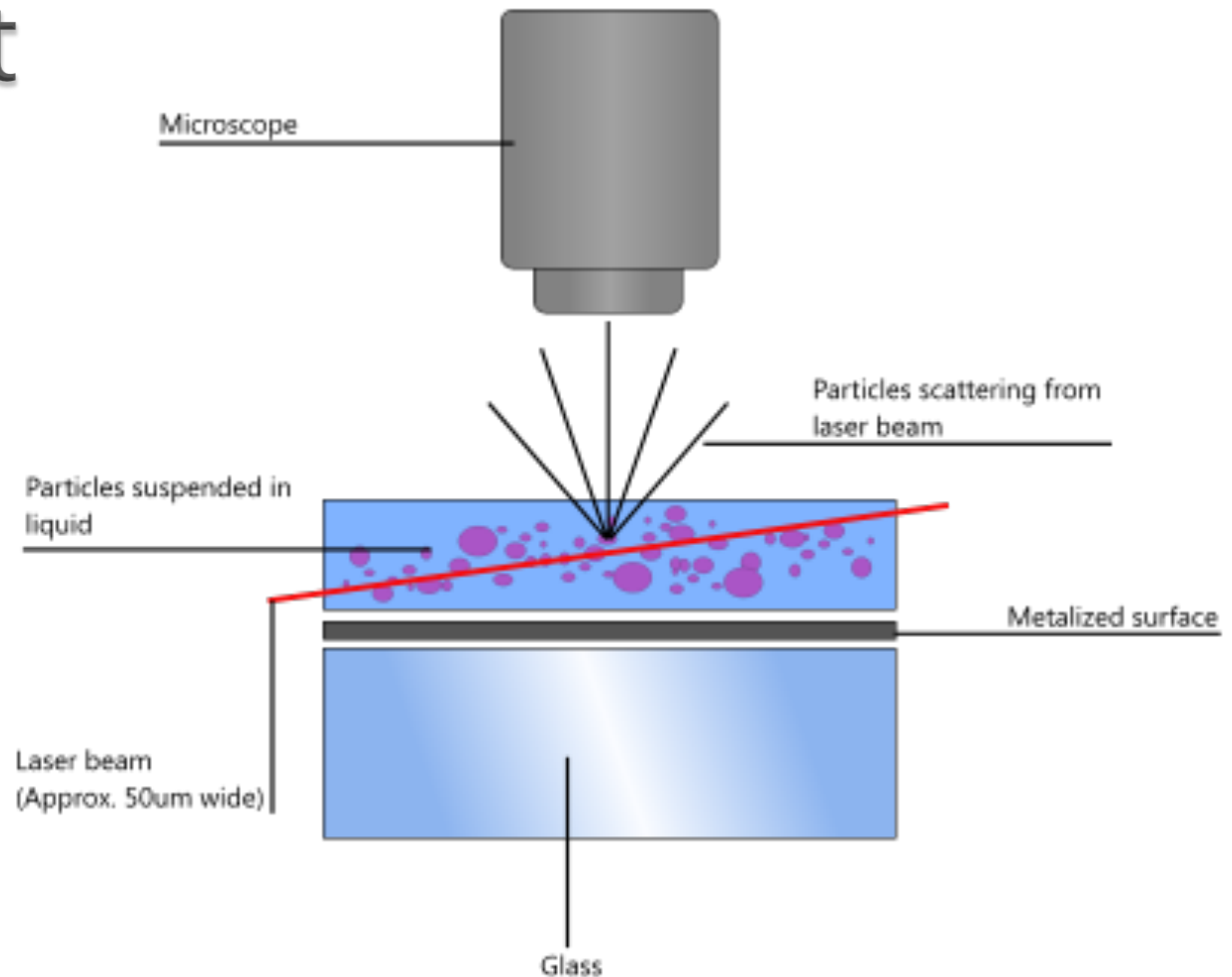
Motivation and Purpose

- ▶ The shape of a nanoparticle has important implications for drug delivery
 - ▶ Need an easy and fast measurement of shape as well as size of sub resolution particles
 - ▶ We can measure size by studying diffusion, but what about shape??
- 

NanoSight

$$\langle x^2 \rangle = 4D_T t$$

$$D_T = kT / 6\pi\eta r_H$$



GOAL: Determine if Nanoparticle Tracking Analysis (NTA) can be used to obtain information about shape

Non-spherical particles blink as they diffuse



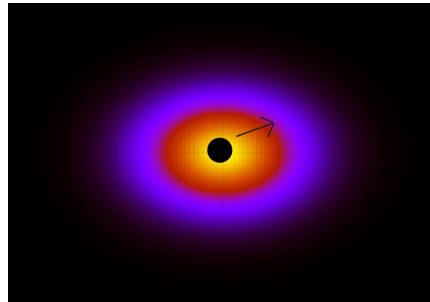
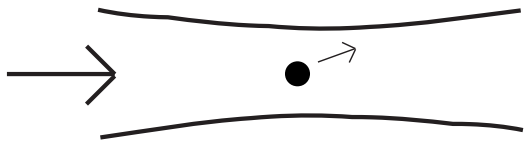
107 μm



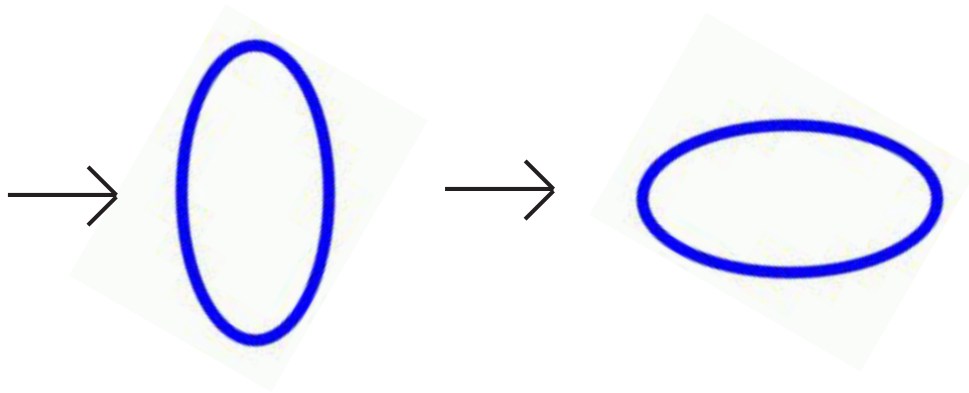
107 μm

Two types of Diffusion

Non-uniform beam of light~Gaussian



A translational step causes a change in intensity.

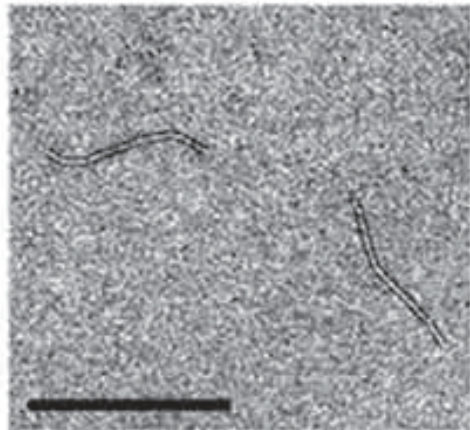
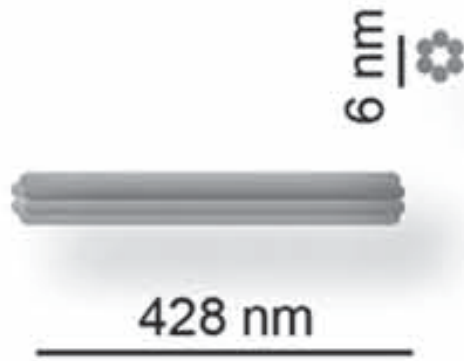


A rotation also causes a change in intensity.

DNA origami

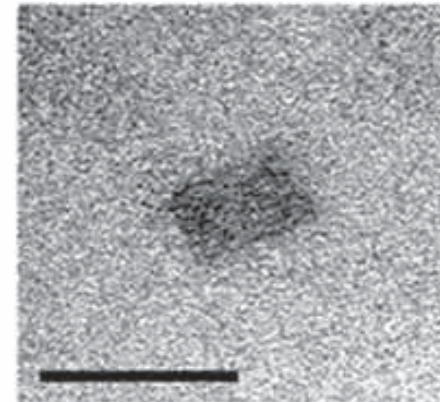
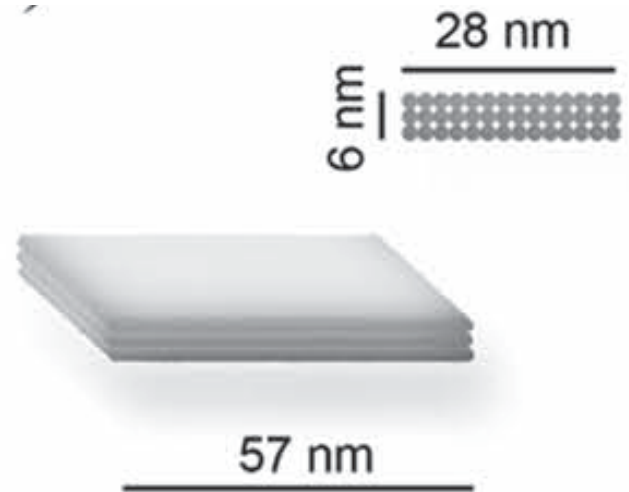
Movie by Shawn Douglas

Cylinder



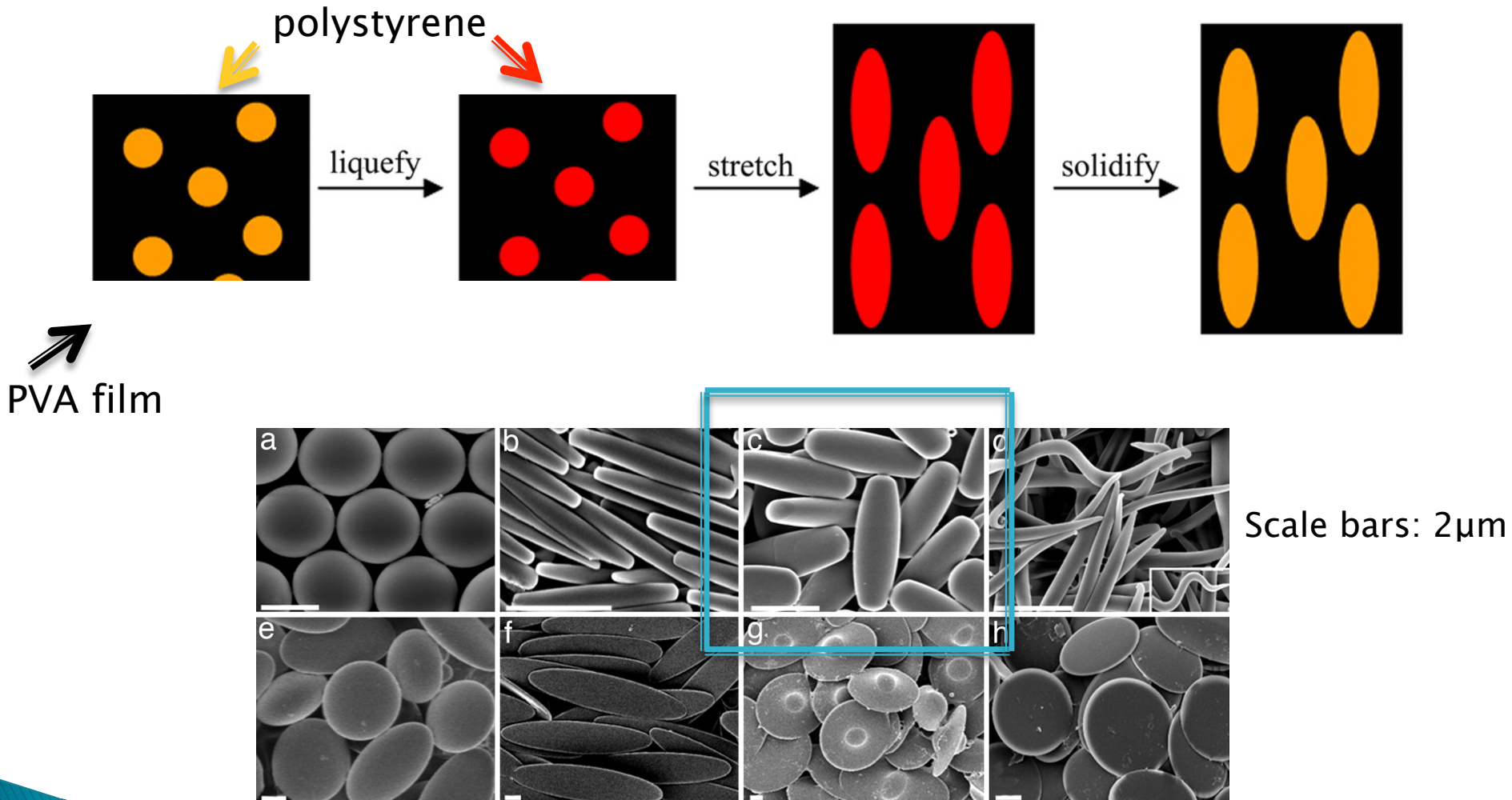
200 nm

Block



100 nm

Ellipsoids

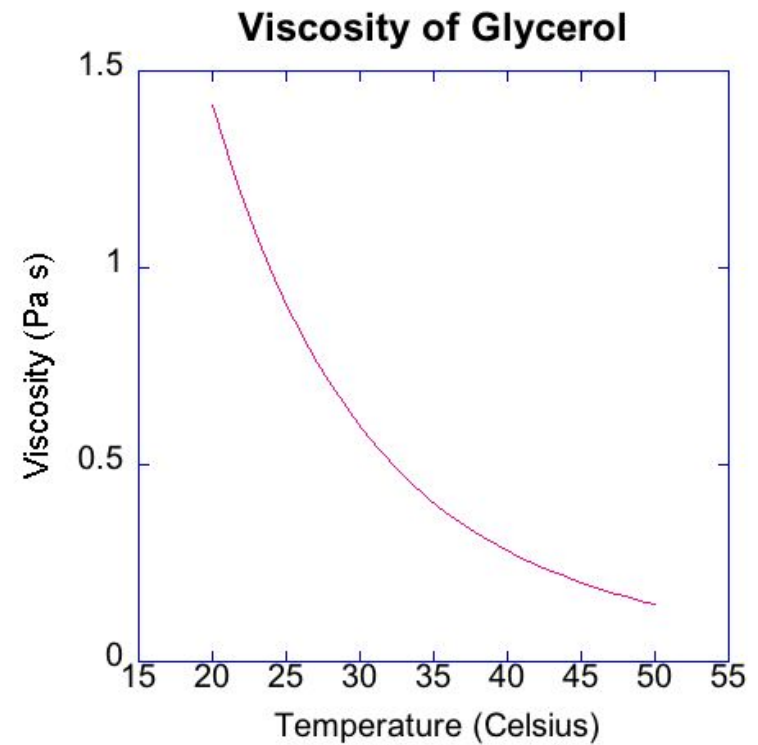


Expected Rotational Diffusion

- ▶ Rotation too fast to resolve
- ▶ $\eta_{\text{glycerol}} = 1000\eta_{\text{water}}$
- ▶ Vary temperature to observe change in rotation

$$D_r = \frac{3kT[\ln(2r_{\text{max}}/r_{\text{min}}) - 0.5]}{8\pi\eta r_{\text{max}}^3}$$

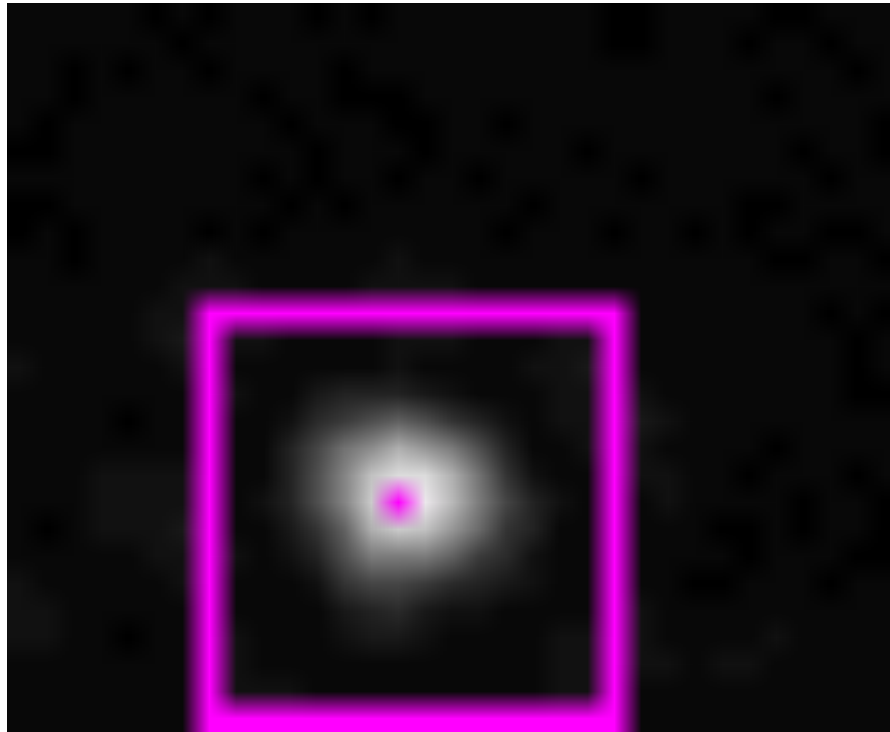
*



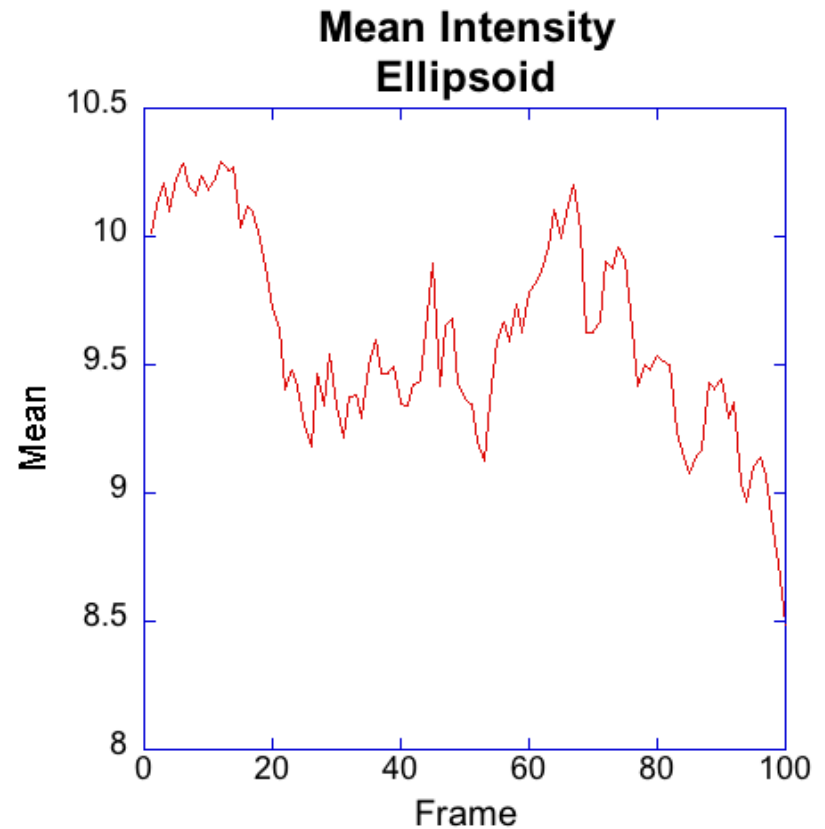
*

Particle Tracking Macros

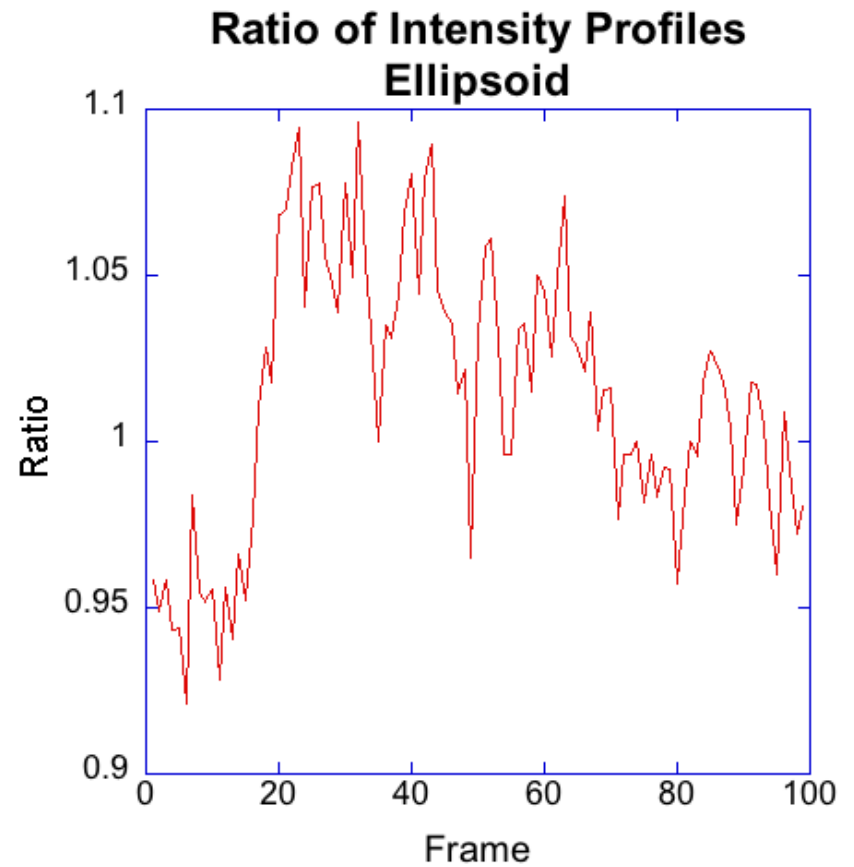
Ellipsoid



5.54 μm

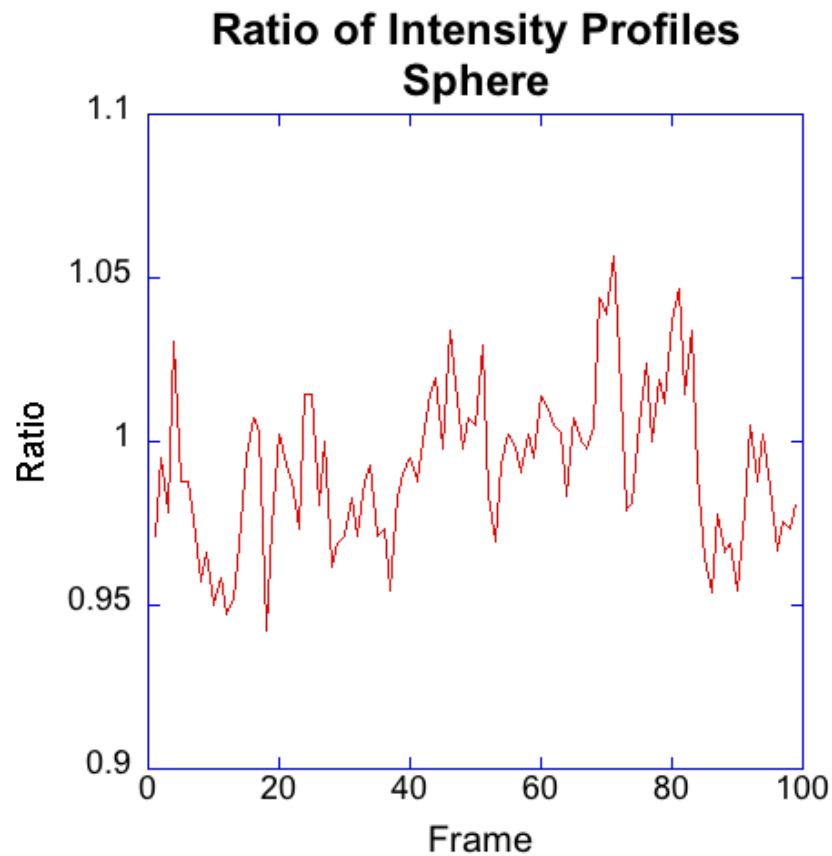


Ellipsoid



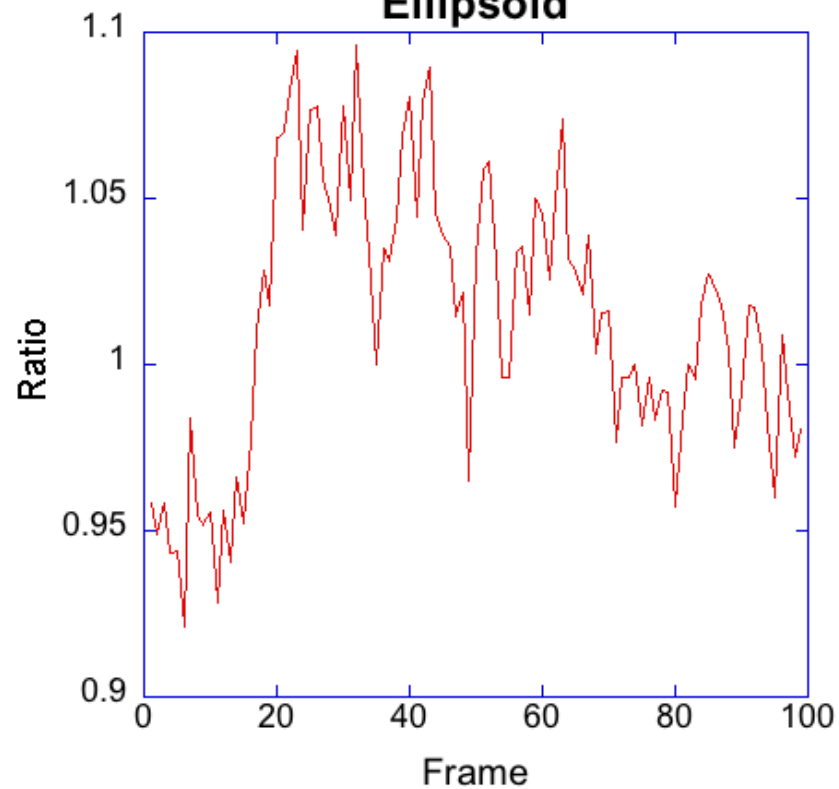
5.54 μm

Sphere

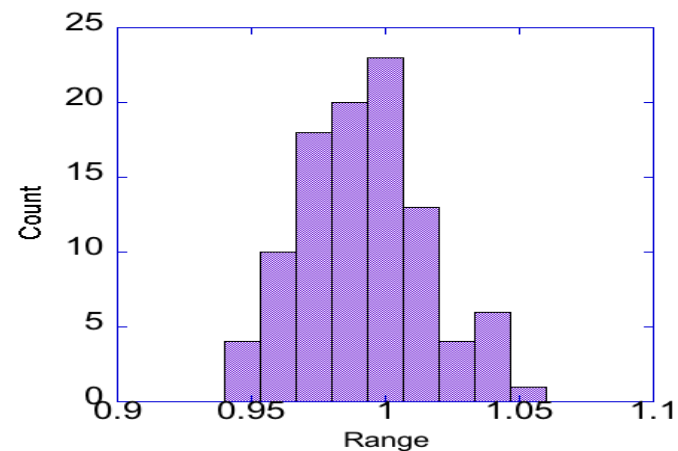
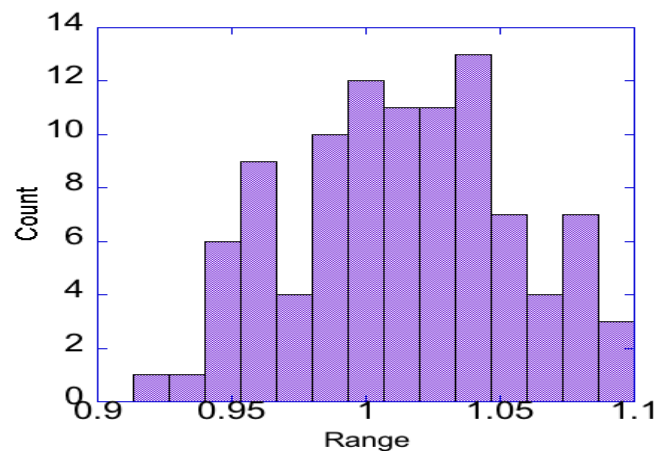
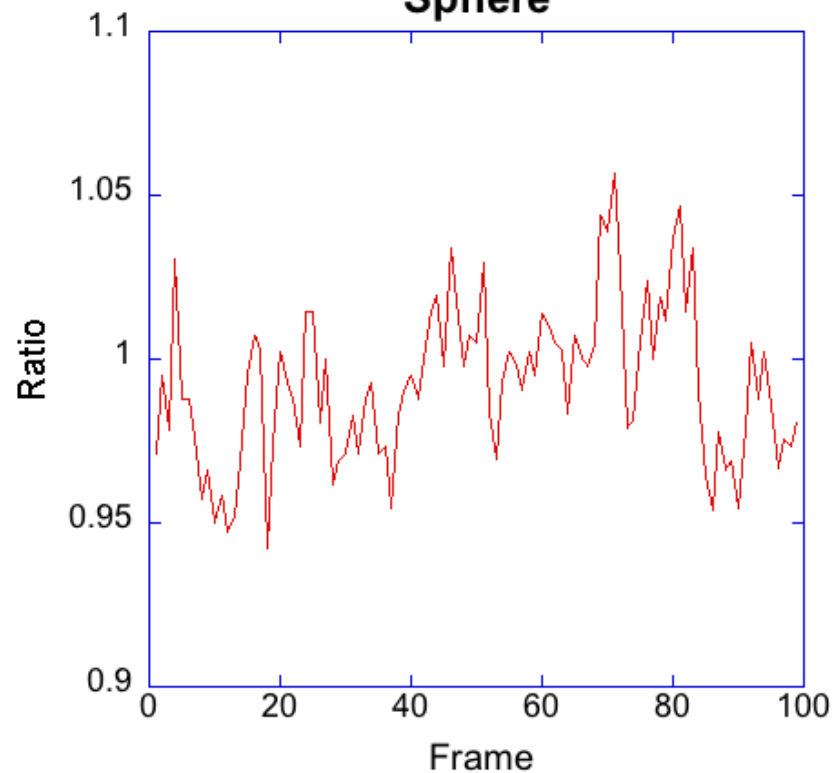


5.54 μm

**Ratio of Intensity Profiles
Ellipsoid**



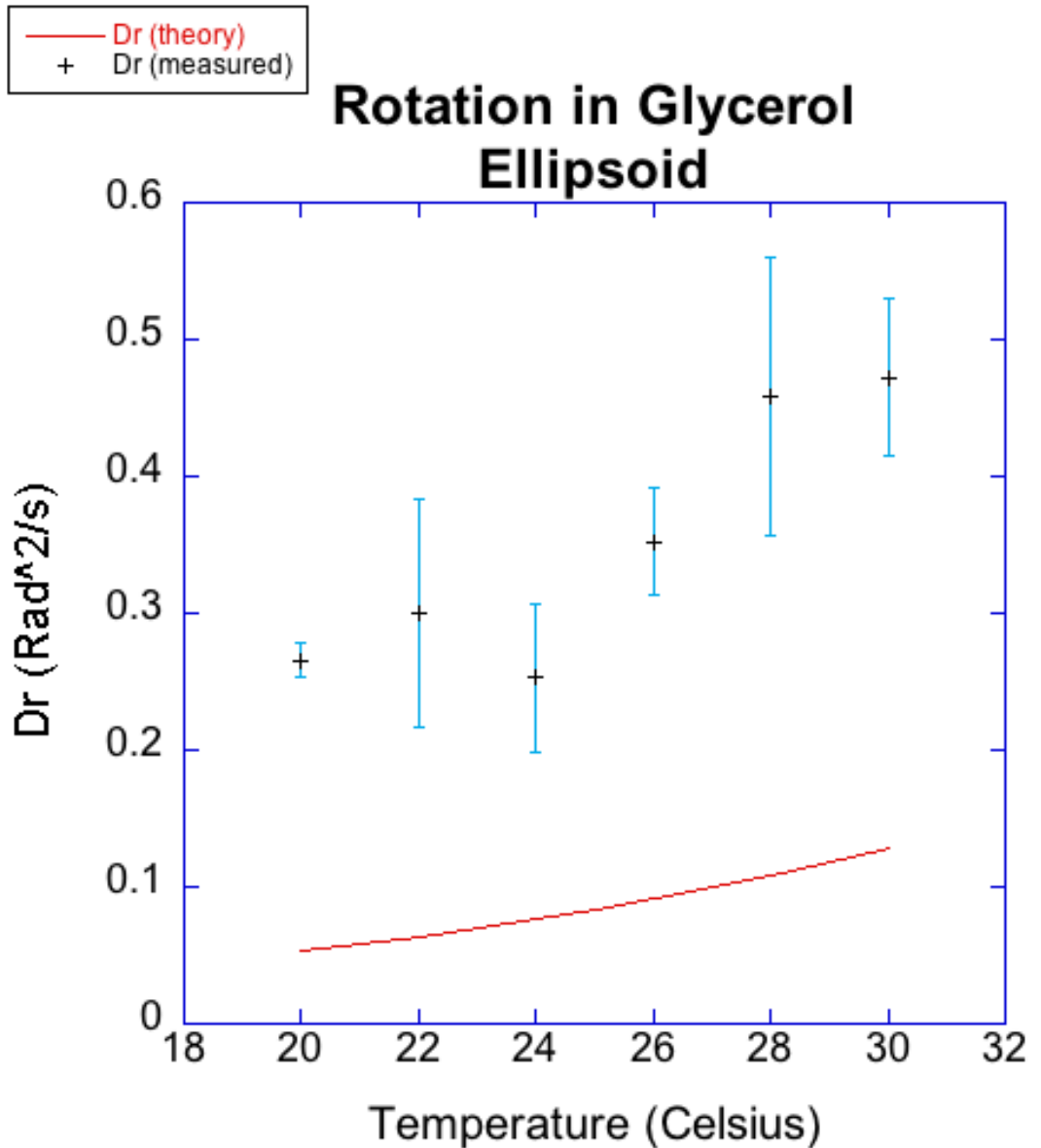
**Ratio of Intensity Profiles
Sphere**



- ▶ Translate ratio of intensities to an angle:

$$\Theta = (90 / R_{\max} - R_{\min}) [R - R_{\min}]$$

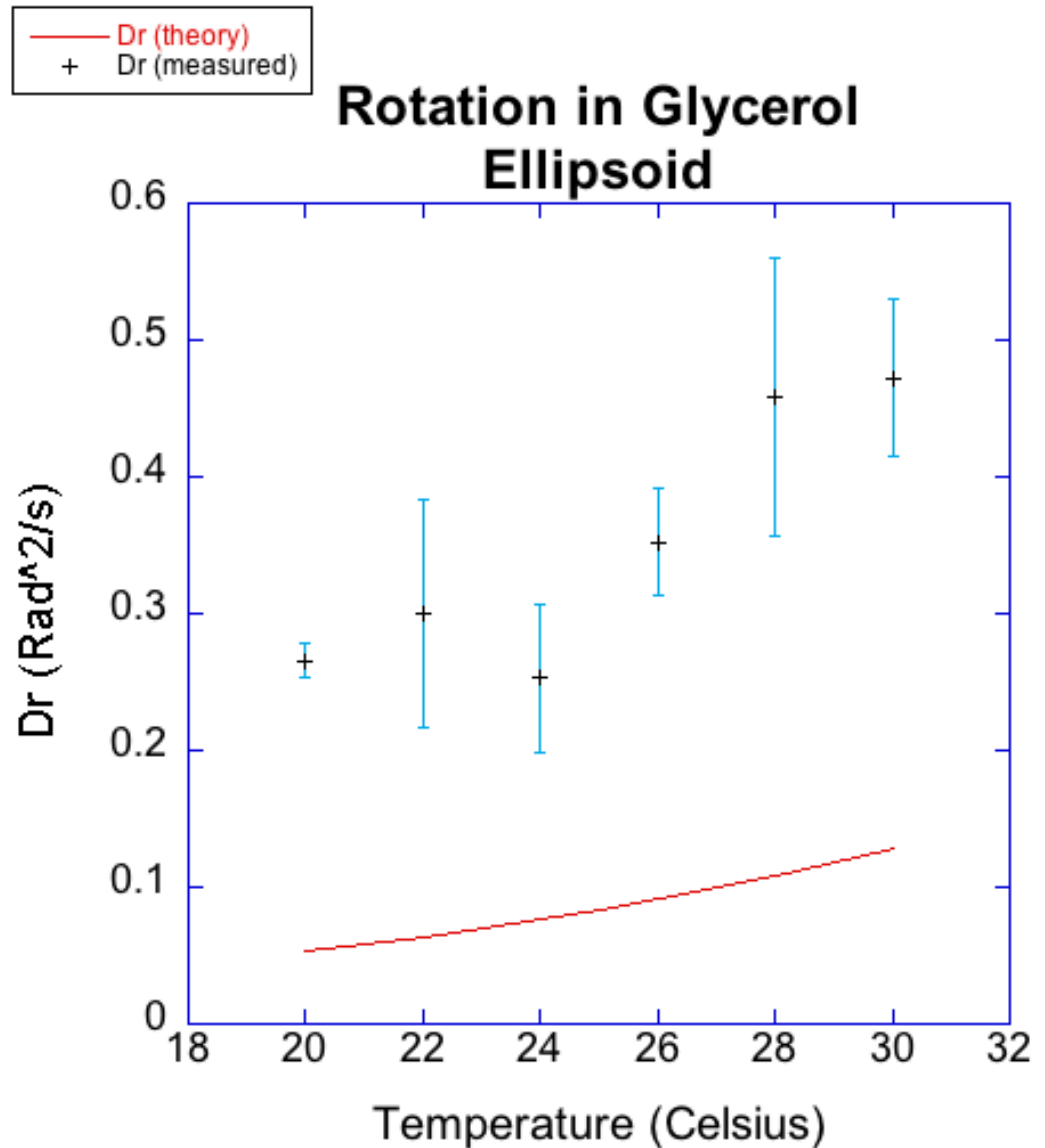
- ▶ Measure a diffusion coefficient



- Systematic error in size?

$$D_r = \frac{3kT[\ln(2r_{\max}/r_{\min}) - 0.5]}{8\pi\eta r_{\max}^3}$$

- Uncertainty in translation of intensity ratio to angle



Conclusions

- ▶ We are able to distinguish between different rotation speeds of a particle
- ▶ We have learned the limitations of this technique
 - Need faster camera speeds, uniform illumination, focal confinement of particles
 - Challenges of moving to smaller particles (less scattering, faster rotation)

What did I do?



