# Dynamic Light Scattering (DLS)

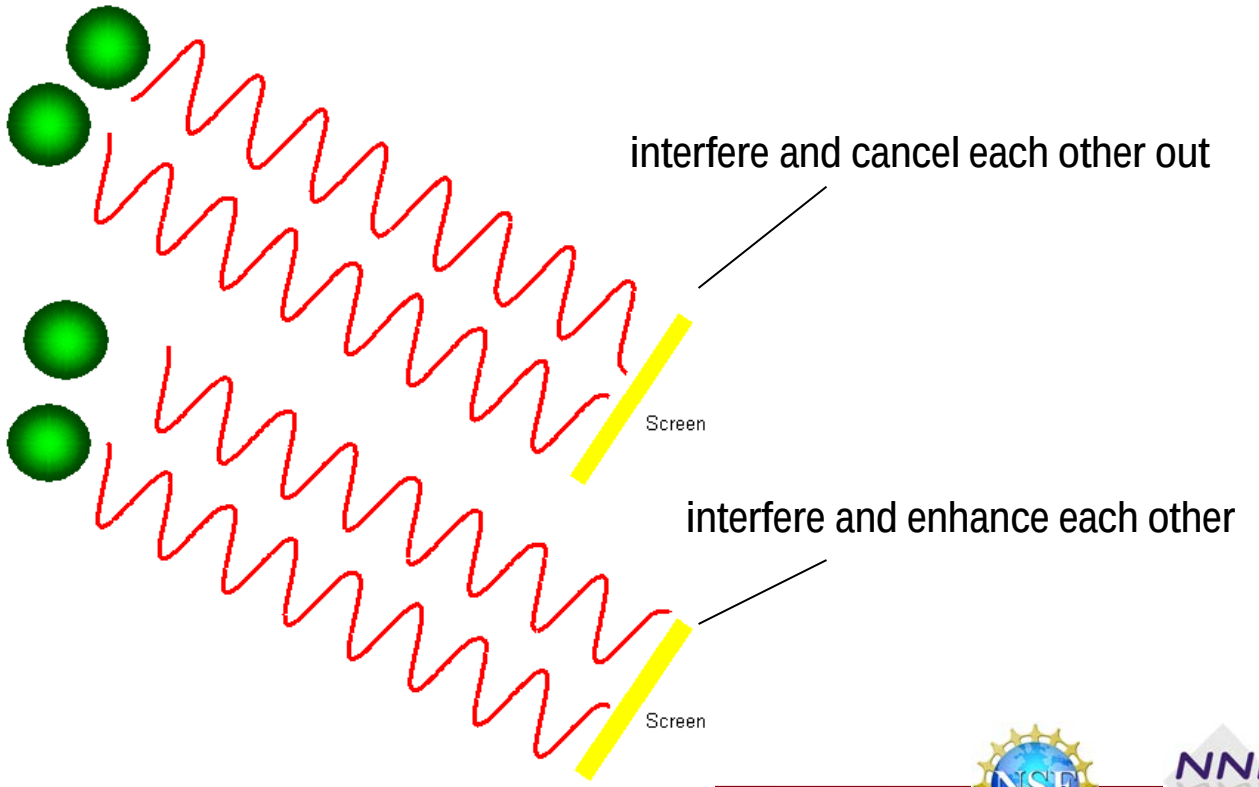
- What's it for: measuring the size of particles typically in the sub micron region, also referred to as Photon Correlation Spectroscopy or Quasi-Elastic Light Scattering.

- How it works: particles suspended within a liquid undergo Brownian Motion. The larger the particle, the slower the Brownian motion will be. DLS monitors the Brownian Motion with light scattering.

- Other functions: measuring the zetapotential of a particle and measuring or estimating the molecular weight of organic compounds.

# DLS Measurement – Scattered Light Intensity Fluctuation

- DLS Measurement: the speed at which the particles are diffusing due to Brownian motion is measured by recording the rate at which the intensity of the scattered light fluctuates.
- Phase addition of scattered light



# DLS Measurement – Scattered Light Intensity Fluctuation

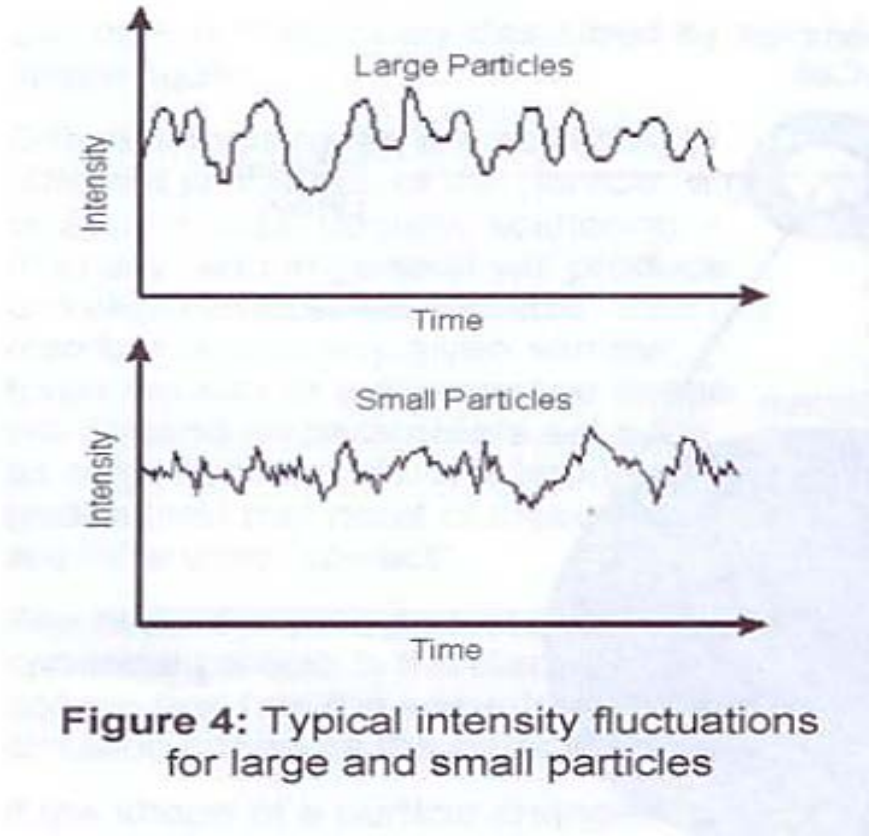


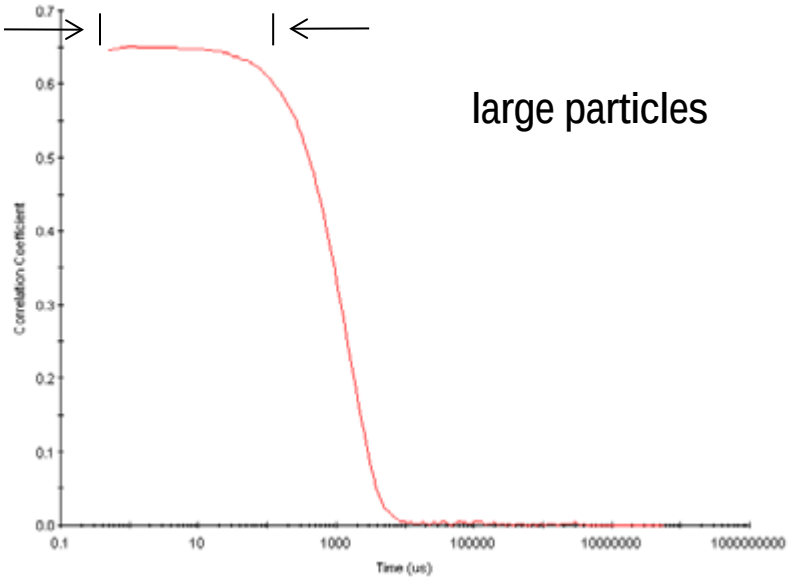

**Figure 4:** Typical intensity fluctuations for large and small particles

- Smaller particles cause the intensity to fluctuate more rapidly than large particles.

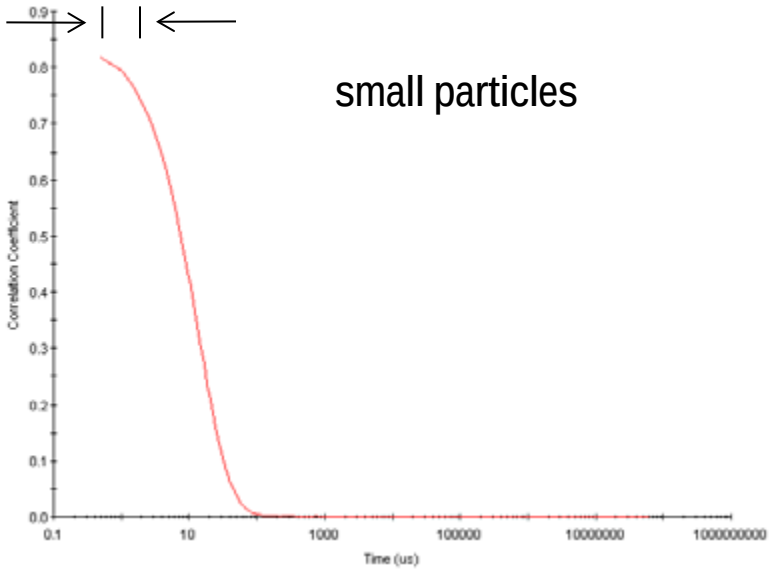
# Correlator – Monitor Light Intensity Fluctuation

- Compare the intensity of signal at time = *t* to the intensity a very small time later (***t+δt***)

$$G(\tau) = \langle I(t).I(t+\tau) \rangle$$




large particles




small particles

- Larger particles in which the correlation of the signal takes a long time to decay.
- Small particles move more rapidly so correlation decreases more quickly

# Correlation Function

- Correlation function:

$$G(\tau) = \langle I(t).I(t+\tau) \rangle$$

- Monodisperse particles: cumulants analysis

$$G(\tau) = A[1 + B \exp(-2\Gamma\tau)]$$

$$\Gamma = Dq^2$$

refractive index of dispersant

$$q = (4 \pi n / \lambda_o) \sin(\theta/2)$$

D=Translational diffusion Coefficient (The velocity of the Brownian motion is defined by a property known as the translational diffusion coefficient )

- Polydisperse particles: non-negative least squares (NNLS) or CONTIN

sum of all the exponential decays

$$G(\tau) = A[1 + B\, g_1(\tau)^2]$$

# Principles of DLS

- Particle size is given in terms of hydrodynamic radius
- Hydrodynamic Radius: the diameter of a sphere that has the same translational diffusion coefficient as the particle

Stokes-Einstein equation

$$d(H) = \frac{kT}{3\pi\eta D}$$

Boltzmann's constant

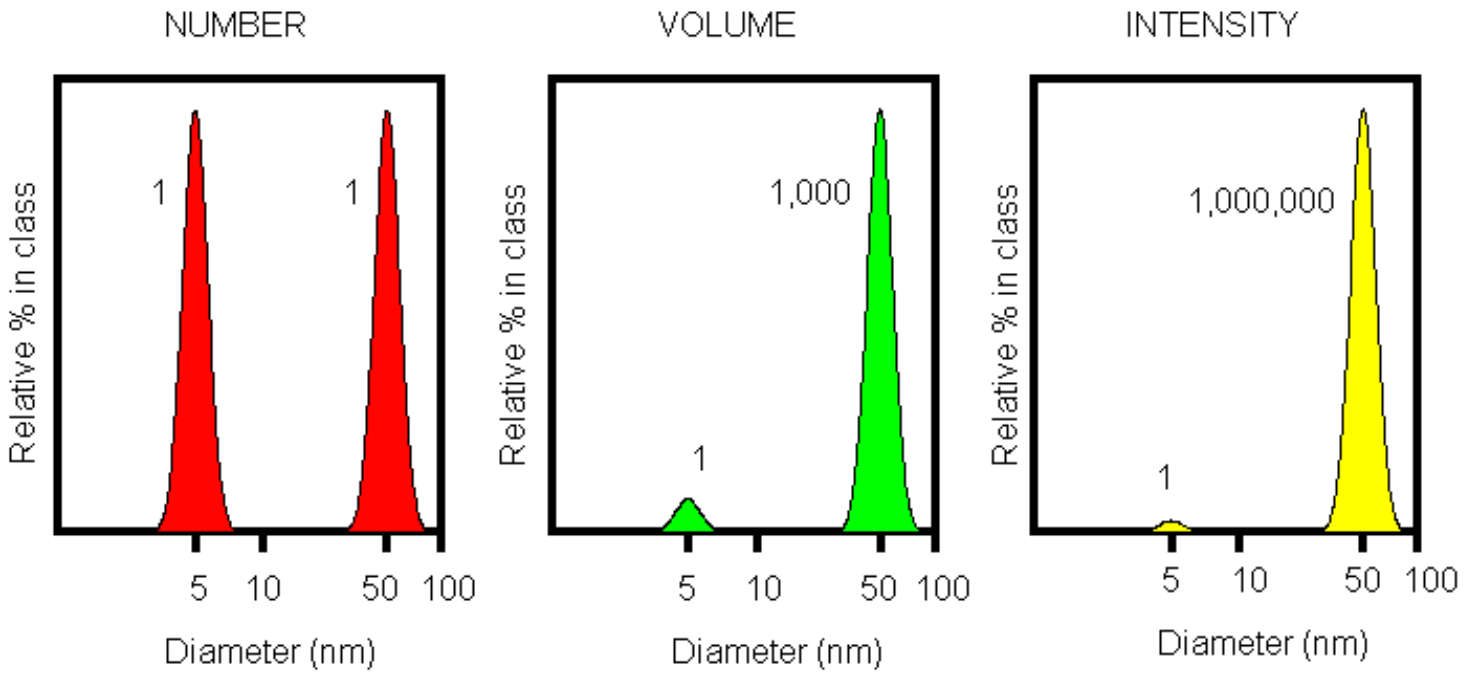
absolute temperature

viscosity

translational diffusion coefficient – velocity of Brownian Motion

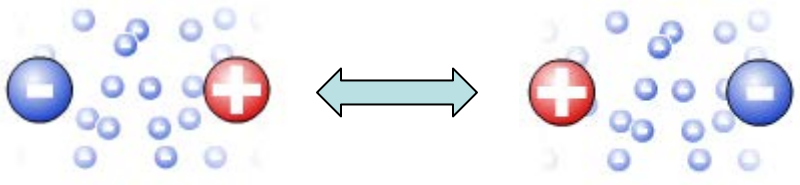
# Number-, Volume- and Intensity-Distribution

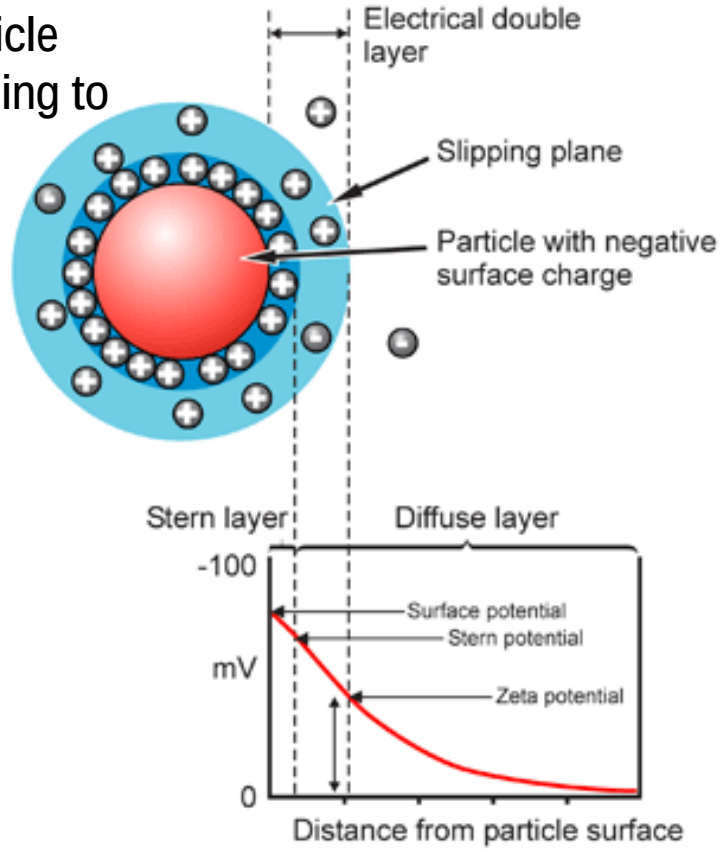
- Rayleigh Scattering: **$I \alpha d^6$ and $I \alpha 1/\lambda^4$**
- Volume of a sphere: **$4/3\pi(d/2)^3$**



# Zeta Potential – Measurement of Charge

- Zeta potential: A potential exists between the particle surface and dispersing liquid which varies according to the distance from the particle surface.
- Why do we use it: determine whether the particle within a liquid will tend to flocculate or not.
- Measurement: with laser Doppler velocimetry and phase analysis light scattering (PALS)





# Common Terms Defined

- Z-Average size or cumulants mean: Harmonic intensity averaged particle diameter.

- Polydispersity Index : It is dimensionless and scaled such that values smaller than 0.05 are rarely seen other than with highly monodisperse standards. Values greater than 0.7 indicate that the sample has a very broad size distribution.

- Correlation Curve – or correlation function
  Measured data in a experiment is the correlation curve which should be a smooth, single exponential decay function for a mono-size particle dispersion.

- **Y-Intercept or Intercept** : Refers to the intersection of the correlation curve on the y-axis of the correlogram. The y-intercept can be used to evaluate the signal-to-noise ratio from a measured sample and thus is often used to judge data quality. It is usually scaled such that an ideal signal will give a value of 1, and a good system will give intercepts in excess of 0.6, and greater than 0.9 for the best systems.

# Common Terms Defined

Count Rate or Photon Count Rate: The number of photons detected and is usually stated in a “per second” basis.