


# Dynamic and Electrophoretic Light Scattering Overview

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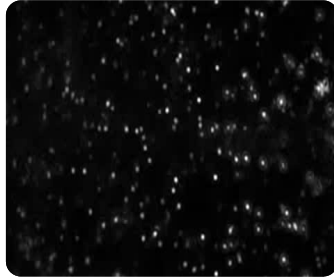
- › Light scattering
- › Dynamic light scattering (DLS)
- › Electrophoretic light scattering (ELS)

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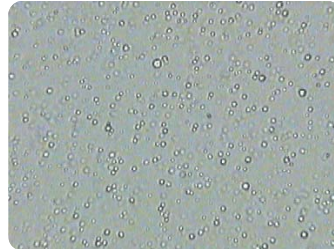
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## Brownian Motion and Particle Size

Nanoparticles



Emulsion Droplets



**Small** particles diffuse **rapidly**

**Large** particles diffuse **slowly**

The speed of diffusion depends upon.....

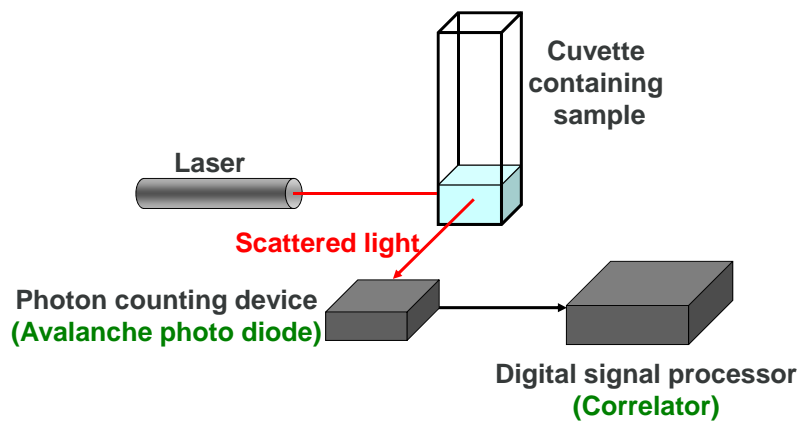
- Particle Size
- Dispersant Viscosity



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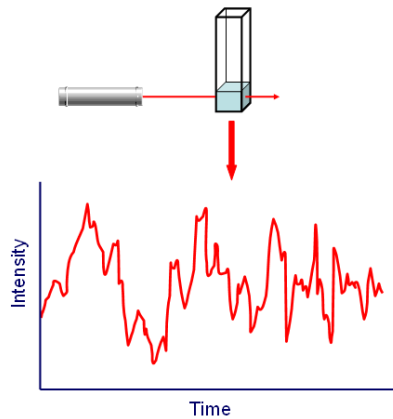
## DLS Instrument Components



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## Dynamic Light Scattering



- ▶ DLS measures the **time dependent fluctuations** in the scattering intensity to determine the **translational diffusion coefficient (D)**, and subsequently the **hydrodynamic diameter (D<sub>H</sub>)** (from the Stokes-Einstein equation)

$$D = \frac{kT}{3\pi\eta D_H}$$

Where k = Boltzmann's constant,

T = absolute temperature,

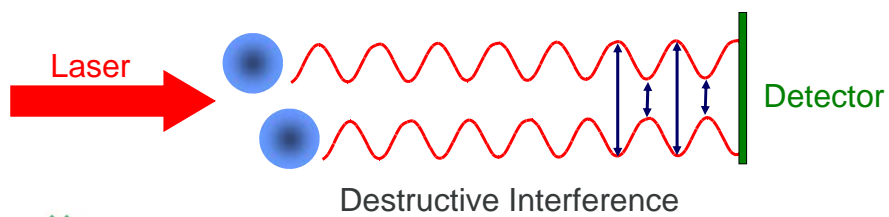
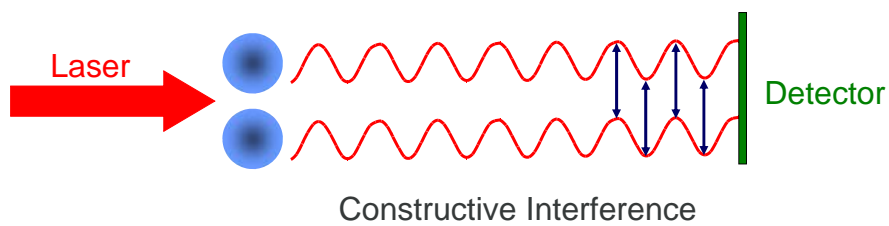
η = viscosity



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## Constructive and Destructive Interference



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## Correlation in Dynamic Light Scattering

- › Technique for extracting the time dependence of a signal in the presence of “noise”
- › Time analysis carried out with a correlator
- › Constructs the time autocorrelation function  $G(\tau)$  of the scattered intensity according to

$$G(\tau) = \left\langle \frac{I(t_0) * I(t_0 + \tau)}{I(t_\infty)^2} \right\rangle$$

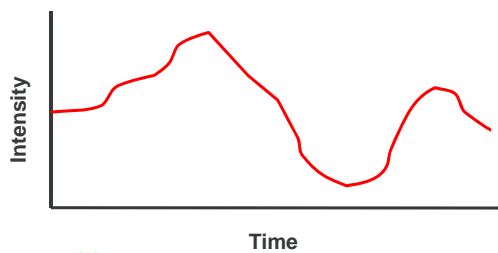
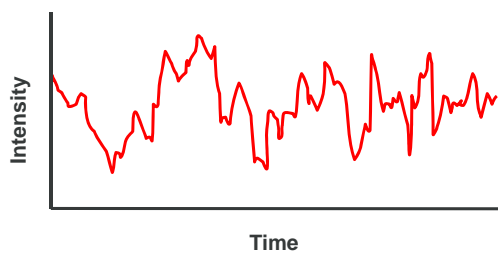
where  $I$  = intensity,  $t$  is the time and  $\tau$  = the delay time



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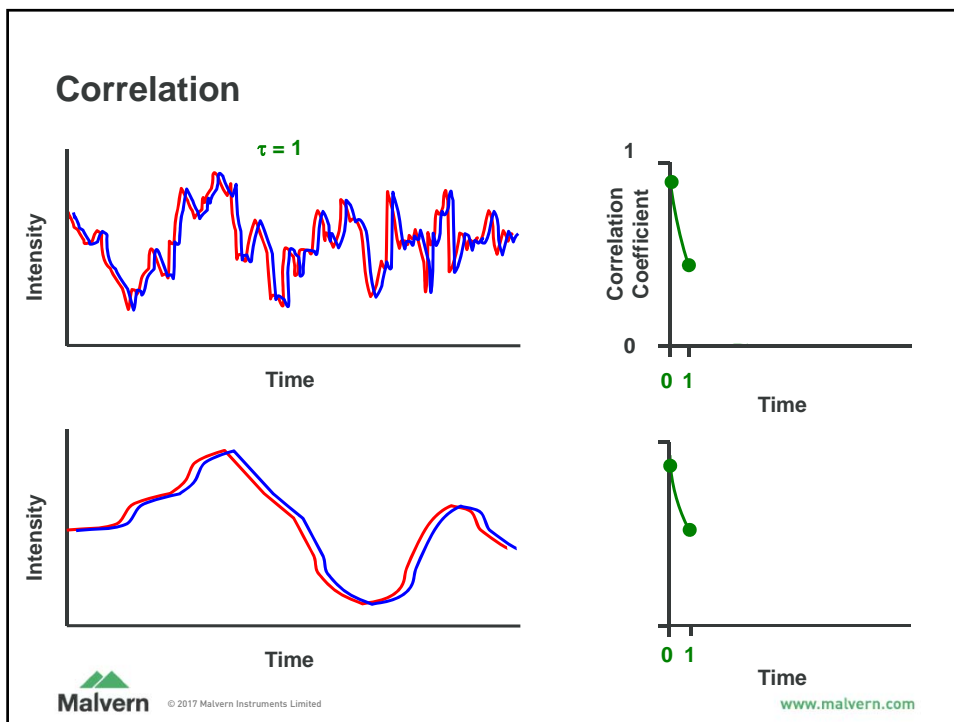
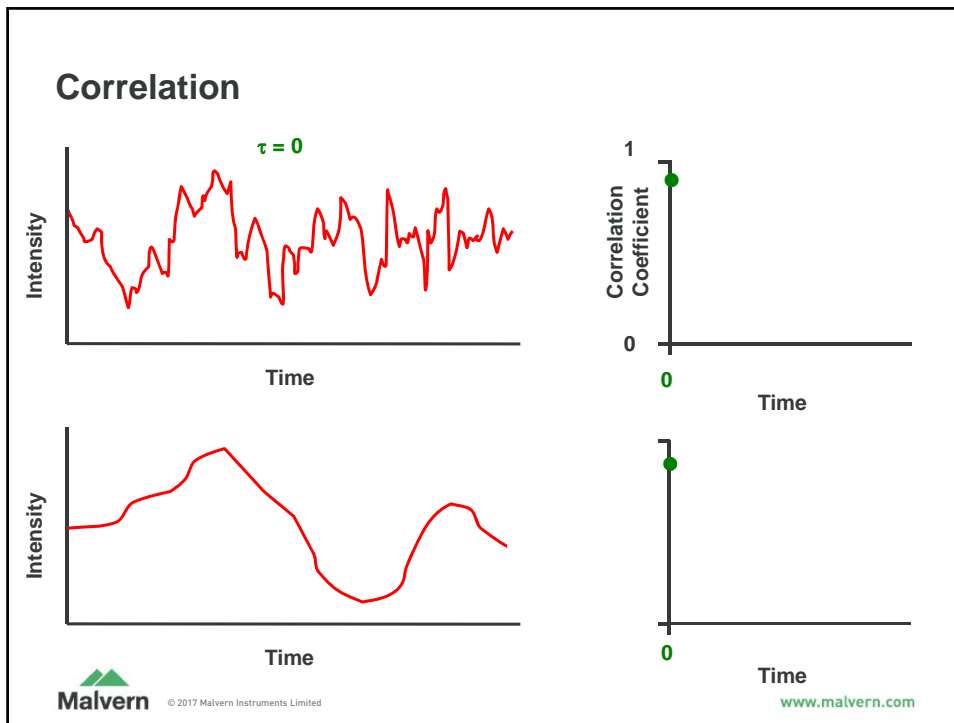
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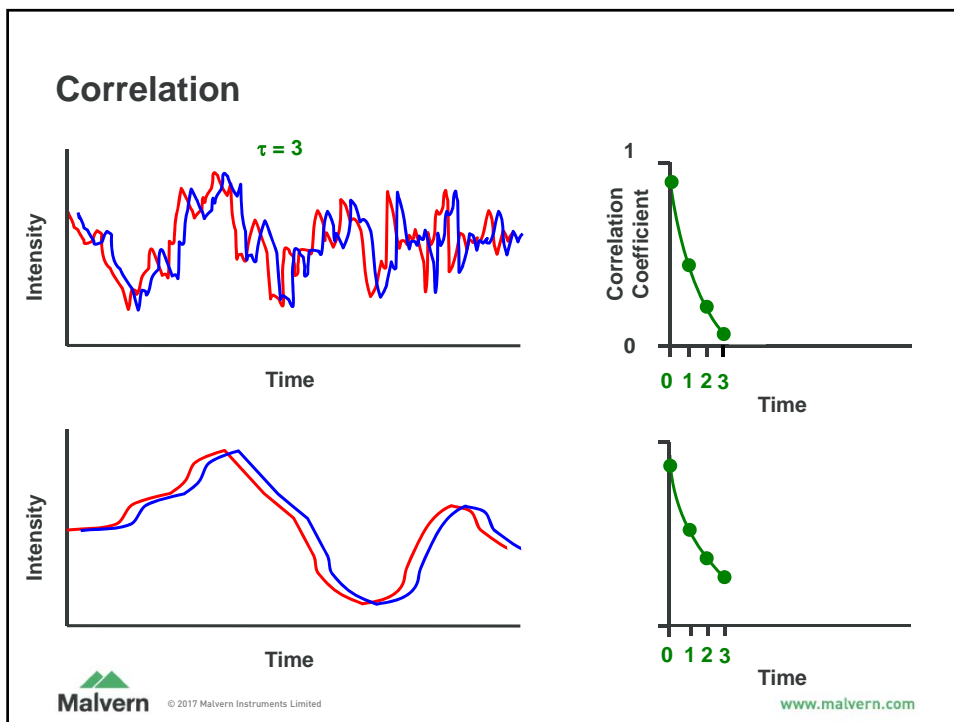
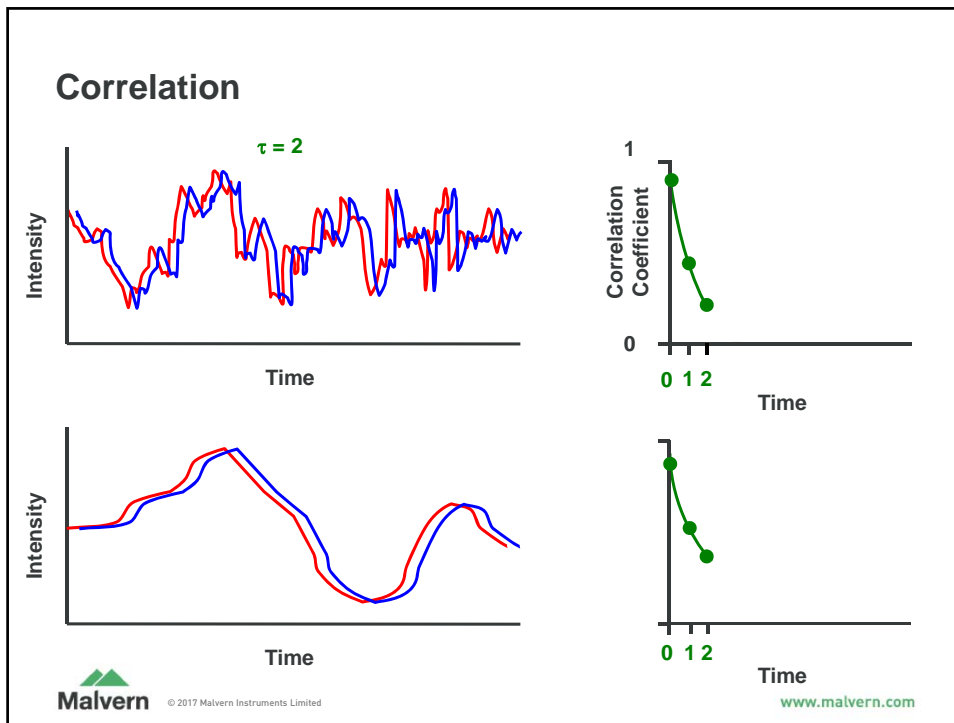
## Correlation

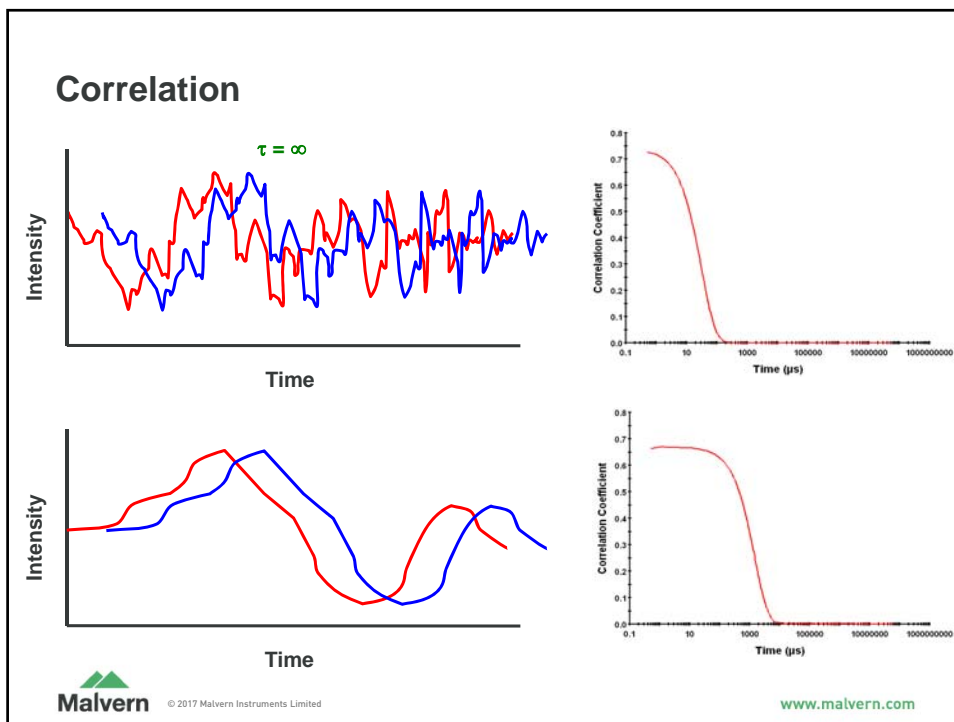
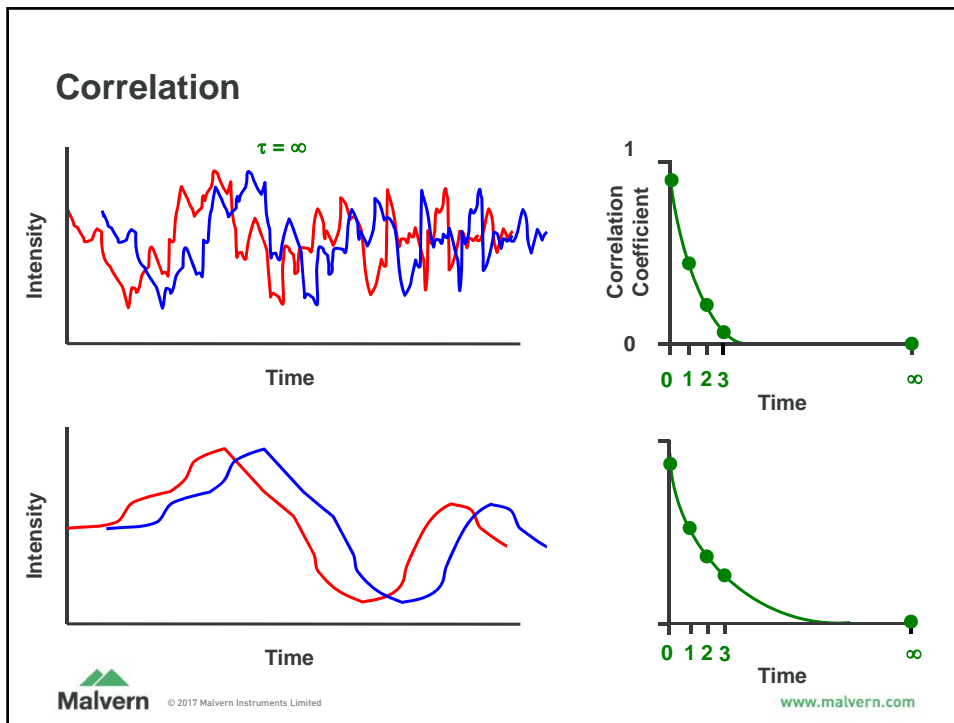


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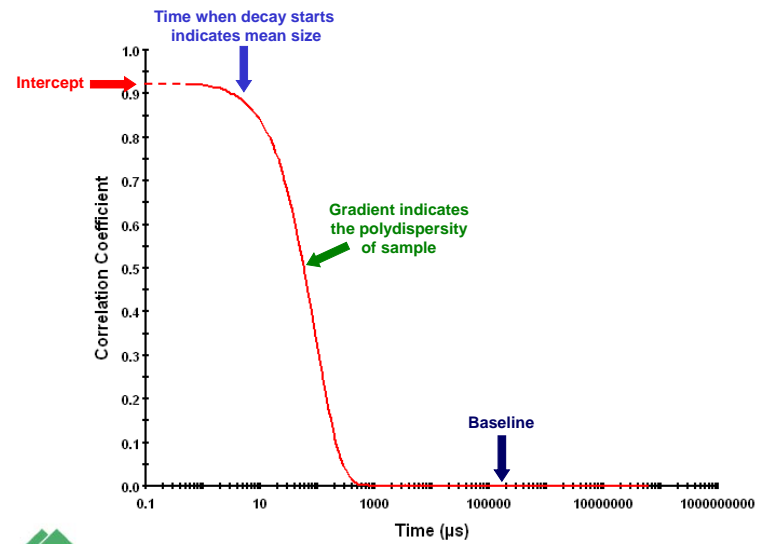
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## Correlation Functions



## Contents

- › Light scattering
- › Dynamic light scattering (DLS)
- › **Electrophoretic light scattering (ELS)**



## Electrophoretic Light Scattering

- › Combination of **electrophoresis** and **light scattering**
- › **Electrophoresis** = movement of a charged particle relative to the liquid it is suspended in under the influence of an applied electric field

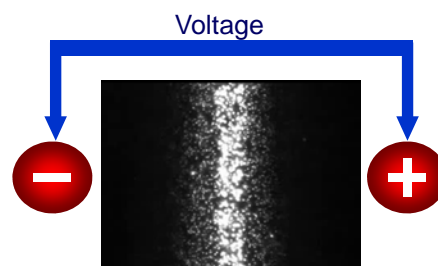


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## Electrophoretic Light Scattering

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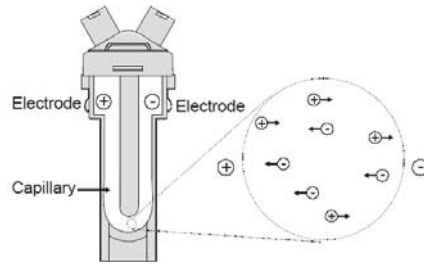


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## Measuring Zeta Potential

- › **Electrophoresis** = movement of a charged particle relative to the liquid it is suspended in under the influence of an applied electric field



Particles velocity dependent on:

- **Zeta potential**
- Field strength
- Dielectric constant of medium
- Viscosity of the medium

## Electrophoretic Light Scattering

- › Scattered light is frequency shifted

- › Frequency shift

$$\Delta f = 2v \sin(\theta/2) / \lambda$$

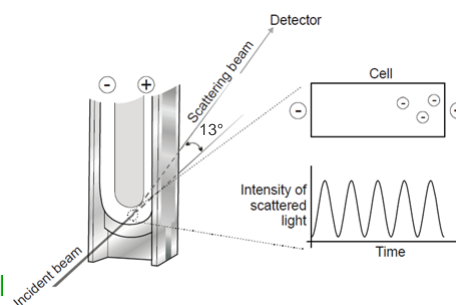
$v$  = the particle velocity

$\lambda$  = laser wavelength

$\theta$  = scattering angle

- › Frequency shifts determined | **Fourier transformation** and **phase analysis light scattering**

- ▶ Measured **electrophoretic mobility** converted into **zeta potential** using Henry's equation



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VISCOSIZER 200

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