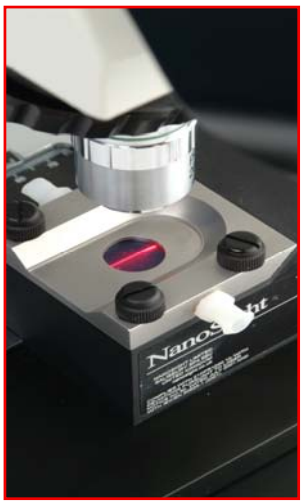
Direct Visualisation and Analysis of Nanoparticles Using *Nanoparticle Tracking Analysis*



NanoBio Project

Supervisor: Teresa Neves Petersen, Gnana Prakash

Nanoparticles – Have you ever seen them?

A **nanoparticle** (or **nanopowder** or **nanocluster** or **nanocrystal**) is a small particle with at least one dimension less than 100 nm. Nanoparticle research is currently an area of intense scientific research, due to a wide **variety of potential applications in biomedical, optical, and electronic fields**. Nanotechnology is expected to be the basis of many of the main technological innovations of the 21st century. Research and development in this field is growing rapidly throughout the world. A major output of this activity is the development of new materials in the nanometre scale, including nanoparticles. These are usually defined as particulate materials with at least one dimension of less than 100 nanometres (nm). One nanometre is 10^{-9} m. By comparison, a human hair is approximately 70,000 nm in diameter, a red blood cell is approximately 5,000 nm wide and simple organic molecules have sizes ranging from 0.5 to 5 nm.

				
Less than a nanometer Individual atoms are up to a few tenths of a nanometer in diameter	**Nanometer** Ten shoulder- to-shoulder hydrogen atoms (blue balls) span 1 nanometer. DNA molecules are about 2.5nm wide	**Thousands of nanometers** Biological cells, like these red blood cells, have diameters in the range of thousands of nanometers	**A million nanometers** An ant is millions of nanometers across	**Billions of nanometers** A two meter tall male is two billion nanometers tall

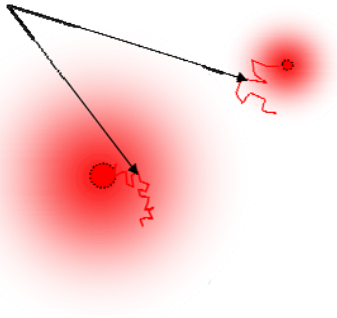
Your project

You will be producing and analyzing nanoparticles, including magnetic nanoparticles. In order to visualize the nanoparticles you will be using a new technology called Nanoparticle tracking analysis (NTA). It allows nanoscale particles to be individually visualised (but not imaged) in liquids and from which higher resolution particle size distribution profiles can be obtained compared to other light scattering techniques. Sample pre-treatment is minimal requiring only dilution with a suitable solvent to an acceptable concentration range (between 10^5 and 10^{10} per ml depending on sample type). Accurate and reproducible analyses can be obtained from video of only a few seconds duration and the results allow particle number concentration to be recovered. Given the close to real-time nature of the technique, particle-particle interactions are accessible as is information about sample aggregation and dissemination. All particle types can be measured and in any solvent type providing that the particles scatter sufficient light to be visible (i.e. are not indexed matched). The minimum detectable size measurable depends on particle refractive index but can be as low as 9-15nm for high refractive index materials such as colloidal silver.

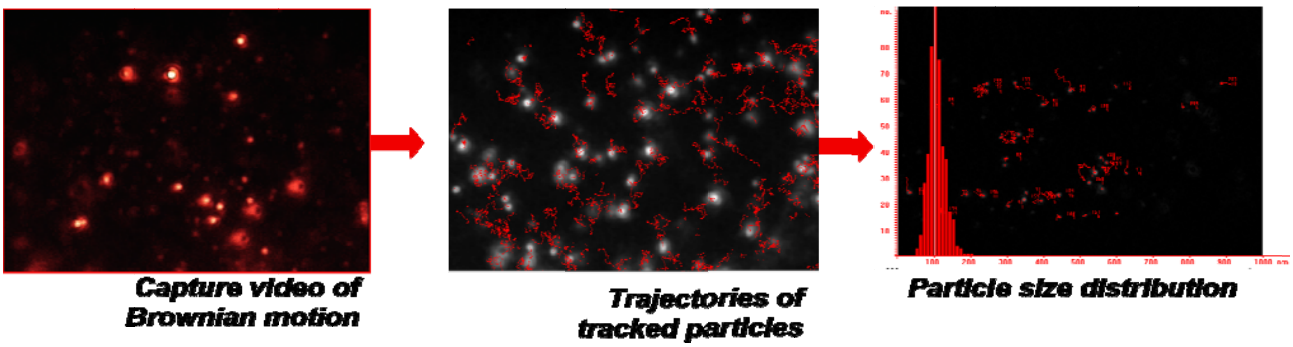
The nanoparticles can also be derivatised with biomolecules or other molecules, and those new particles will also be caracterised. Such systems can be used to monitor molecular interactions, between e.g. antibody-antigene, enzyme-substrate. Magnetic nanoparticles will be tracked in the absence and presence of magnetic fields. You will learn to analyze data in order to quantify your observations.

Principle of NanoSight Measurement

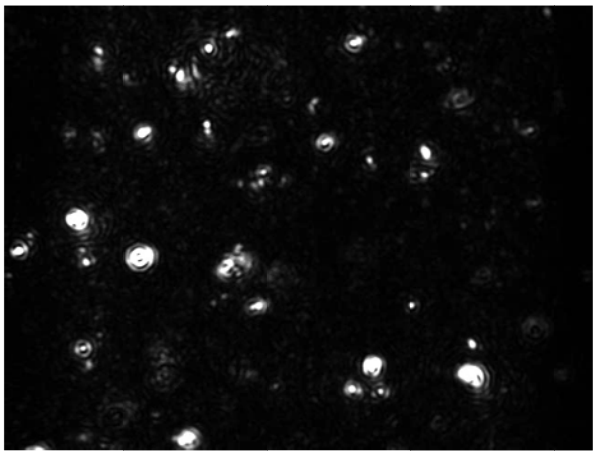
- Nanoscale particles move randomly under solvent bombardment (Brownian motion) at a speed related to their size.
- Intensity of light scattered by a nano-particle is related (through power law) to the size of the nanoparticle.
- Small particles move faster and further than large particles.
- Distance moved by each particle is measured and the average determined.
- Particle Diffusion Coefficient is calculated which relates to a sphere equivalent hydrodynamic diameter (Stokes-Einstein equation).
- Visualisation of particles down to 10nm



Nanoparticle Tracking Analysis (NTA) gathers unique information through the monitoring of individual particles, rather than averaging over a bulk sample



Example – Bacterial Contamination



A video of a sample contaminated with motile bacteria in which non-Brownian motion is obvious.

Motile Bacteria in aqueous solution