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Nanoscale science: a giant leap for mankind

Shining a light on tiny things

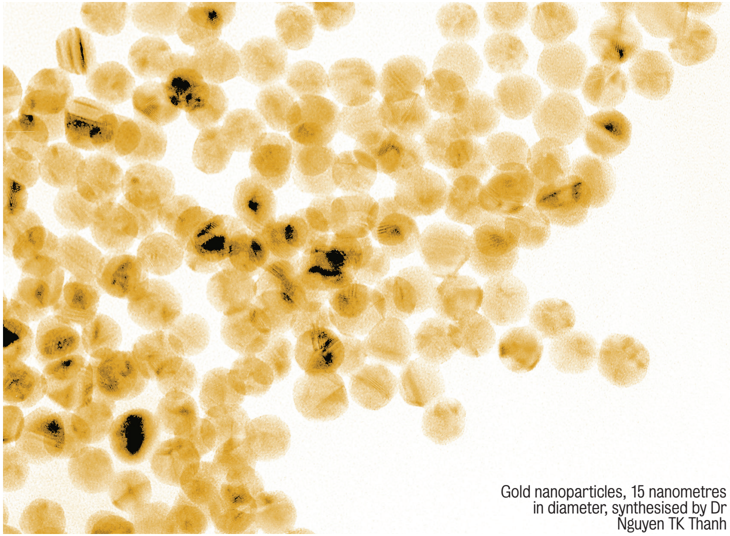
Gold nanoparticles are remarkably useful in the medical sciences because of their optical properties – the way they interact with light. A simple mathematical law can help us to understand what exactly happens when a beam of light is shone at a group of particles dispersed in a transparent medium, for example, water.

As the light beam travels through the mixture, the particles absorb some of it, so the beam emerges weaker at the other end. Just how much is absorbed depends on how many particles there are and on how much light each individual particle absorbs. This fact is captured by a mathematical equation known as the **Beer–Lambert law**. Assuming that the particles are similar to each other in size and chemical make-up, the law says:

Absorbance = Q x Concentration x Distance

Concentration is the number of particles per unit volume and **Distance** refers to the distance the light beam has travelled. The number **Q** is the **absorption coefficient** and is a measure of how individual particles absorb light.

There is an extensive mathematical theory, called **Mie theory**, which enables scientists to work out the value of Q from the properties of individual particles. Using this theory and the Beer-Lambert law, the nanoscale scientists have developed a technique for working out the size and concentration of particles dispersed in water and the degree of their dispersion just by shining a light at them and measuring how much is absorbed. It isn't necessary to understand all the maths to use this technique.



Gold nanoparticles, 15 nanometres in diameter, synthesised by Dr Nguyen TK Thanh

Nanoscientists aren't the only ones who benefit from the Beer-Lambert law. The mathematics of light absorption is used by all kinds of other scientists too, from biologists trying to work out the concentration of DNA in a sample, to environmental scientists measuring the amount of pollutants in the air we breathe and astronomers investigating interstellar dust.

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