F How do we see or "feel" the nanoworld?

To find something out about an object we have to approach it in some way and obtain information from it. The methods we can use may be grouped into three families: (i) methods that study a signal that is naturally or artificially emitted by an object, (ii) methods that send a signal to it and study the signal it re-emits, and (iii) methods that use direct contact with the object to measure a force of interaction between it and a probe.

Detecting signals emitted by the object

We can see the stars without having to interact with them. Large structures can naturally emit signals that are strong enough to be detected far away. The emissions from nano-objects are generally so weak they are smothered by the signals of neighbouring objects. There are two ways to get round this: we can (i) isolate the nano-object to make sure the emitted signal really originates there and nowhere else (e.g., isolation of atoms with a laser beam or of certain nanostructures on etched nanodots to study their luminescence), or (ii) position the detector close to the object. However, most nano-objects are not radioactive or naturally phosphorescent, and so they have to be stimulated in some way to emit a signal. *The Tomographic Atom Probe* is a powerful technique that analyses a particular signal (for more details see http://www.cameca.fr/html/tap_technique.html). A short, intense electric pulse is used to strip atoms, layer by layer, from an object that has been shaped to a fine point. The atomic mass of the stripped atoms can be determined by mass spectrometry, and the three-dimensional atomic structure can be reconstructed layer by layer. Unfortunately, this method requires a conducting object and a perfect radius of curvature, and not all nano-objects can be given this shape. In **scanning tunnelling microscopy (STM)**, a very fine point is brought near the surface of the object and strips electrons locally.

Using a probe signal

This is the "classical" approach used by all **conventional microscopy**. A probe is brought to the object and the re-emission (reflection or transmission) of the incident signal is used to characterize the object. Depending on the type of probe used (visible light, X-rays, electrons, ions, ultrasound), we have **optical, Raman, X-ray, electron, ion or acoustic microscopy**. Here, the resolution attained by the method is determined by the wavelength associated with the probe signal. A strong interaction between the probe and the object is necessary to obtain an image of a small lone object.

Pseudocontact or interaction force

This is the "groping in the dark" method. A probe is brought near the object until a force of interaction, or "pseudocontact" is established. The information is obtained by scanning the surface of the object and observing how the force acting on the probe varies. To obtain highly local spatial information the contact probe must be very small. This method generally yields information only about the surface, but it is a fascinating technique and one of the few that can manipulate atoms *individually*! *Atomic force* microscopy (**AFM**) and *magnetic force* microscopy (**MFM**) belong to this family.