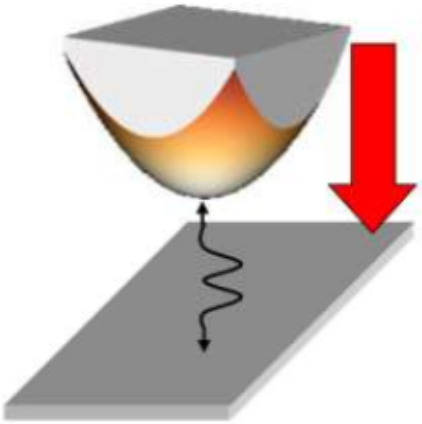
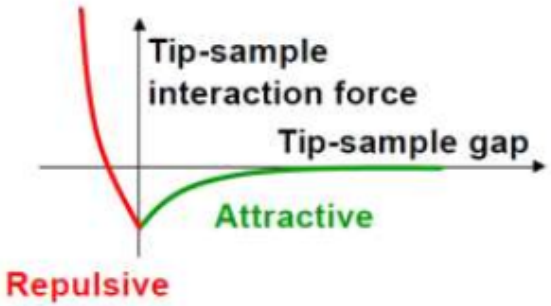
Atomic force microscopy (AFM) is one of a range of different imaging techniques that are used to gain information about structures at the micro- and nanoscale.

In AFM, a probe is scanned across the surface in order to obtain information about its topography (or in variations of the AFM technique about other properties, such as elastic modulus or chemical composition).

Atomic force microscopes were first reported in 1986 [1]. Since then, a wide variety of variations of the AFM concept have appeared.

Types of Forces:

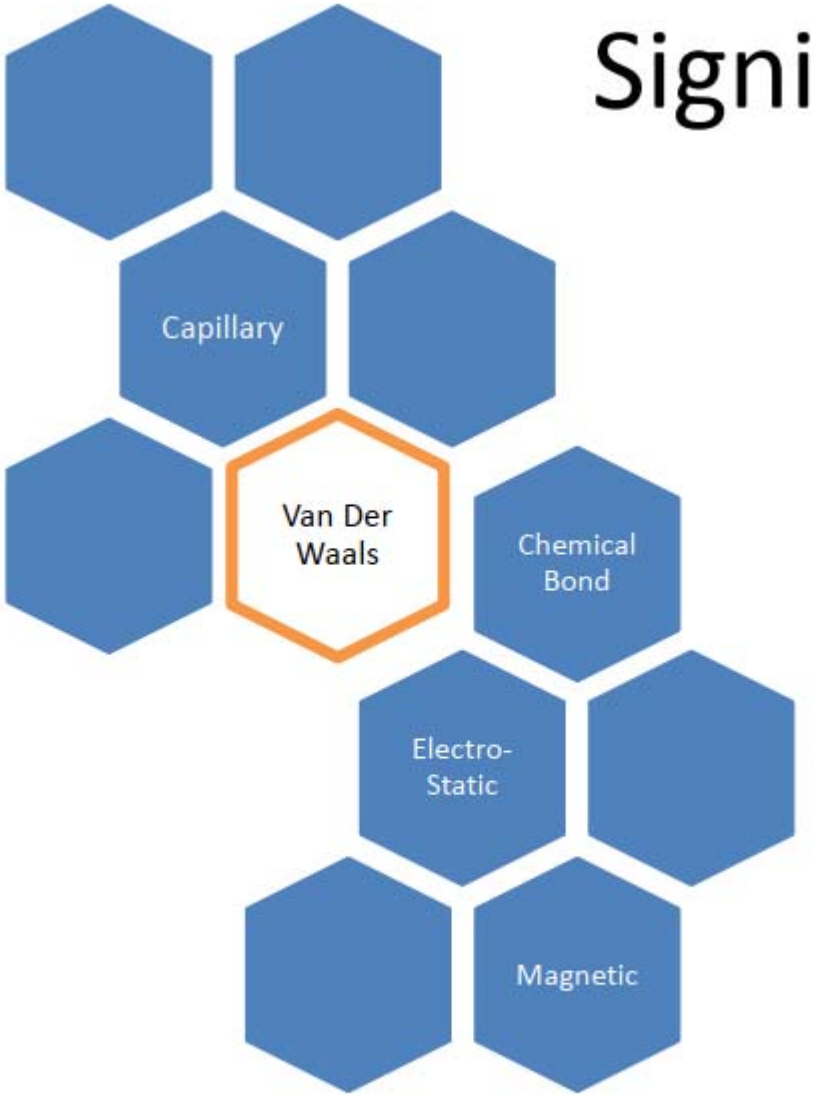


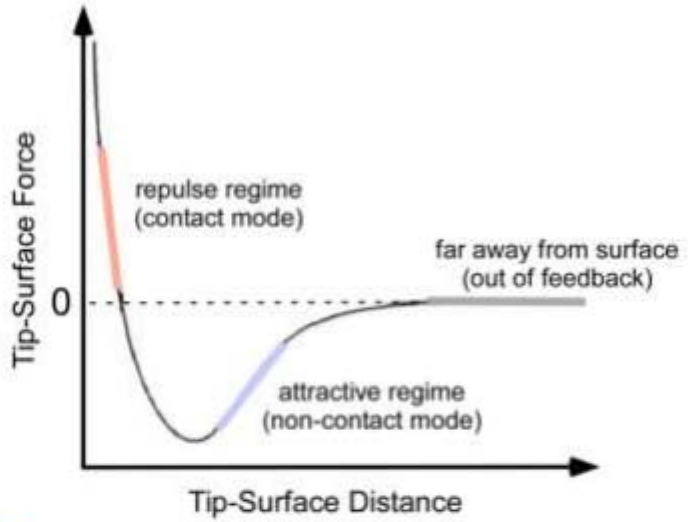


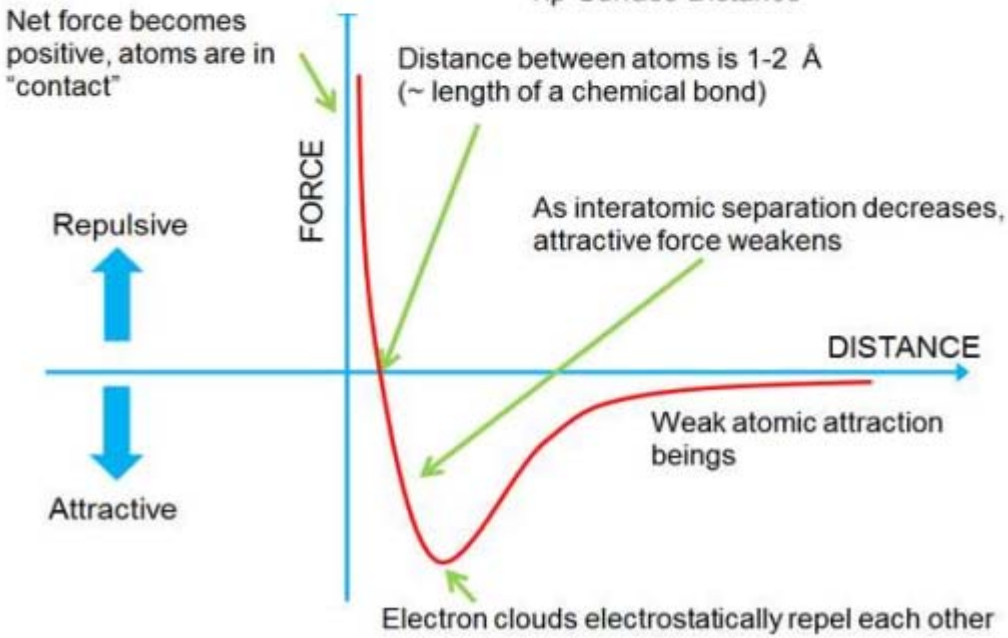
- Long-range electrostatic and magnetic forces (up to 100 nm)
- Capillary forces (few nm)
- Vander Waals forces (few nm) that are fundamentally quantum mechanical (electrodynamic) in nature
- Casimir forces
- Short-range chemical forces (fraction of nm)
- Contact forces
- Electrostatic double-layer forces
- Salvation forces
- Neoconservative forces

https://nanohub.org/resources/522/download/2005.11.28-raman.pdf

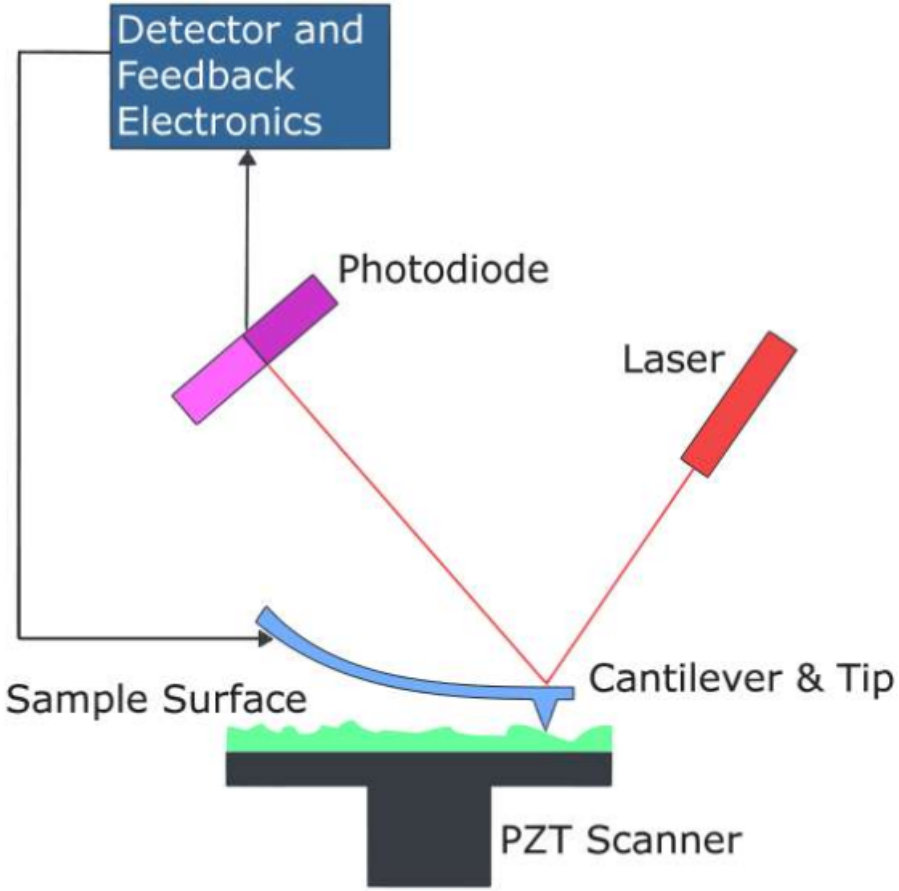
Significant Forces



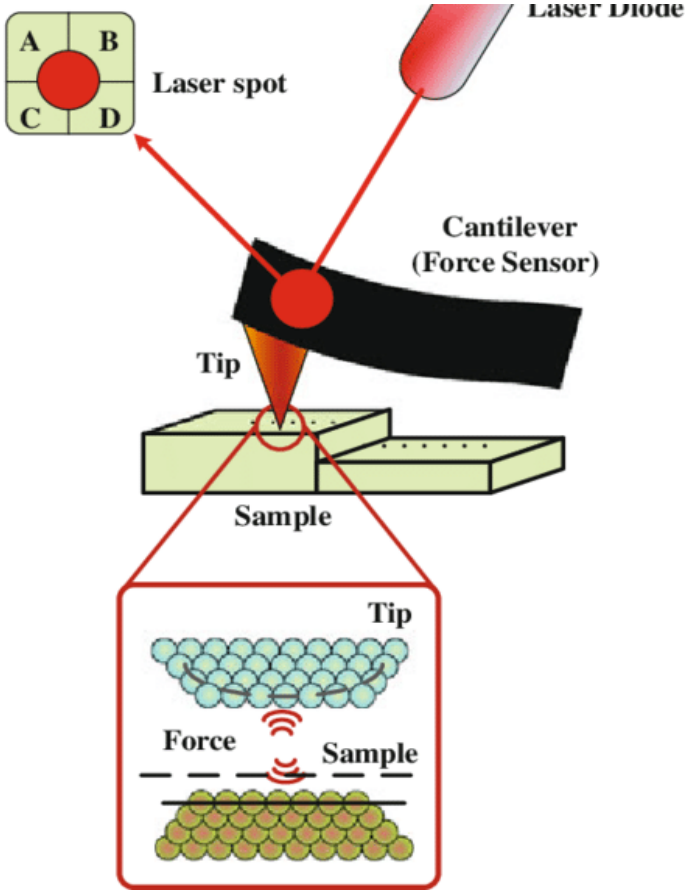




Principle of AFM:



Block diagram:



Principle of AFM: An **AFM** uses a cantilever with a very sharp tip to scan over a solid sample surface. As the tip approaches the surface, the close-range, attractive force between the surface and the tip cause the cantilever to deflect towards the surface. A laser beam is used to detect cantilever deflections towards or away from the surface.

A non planar sample is difficult to scan with an AFM, Very sticky and adhesives also cannot be scanned with an AFM as it makes the tip stick to the sample surface, which is known as tip crash.

- These include a large diversity of cantilever designs, different methods of reading out how much a cantilever has deflected when it interacts with a surface, various distinct AFM operating modes, and a variety of ways of interacting with the surface.
- For example, conventional AFMs have three main operational modes. In contact mode, the cantilever tip is “pressed” against the sample surface. Repulsive forces between the sample and the cantilever cause the cantilever to bend, and the bending is recorded optically.
- In non-contact mode, the cantilever tip is held a short distance away from the sample surface. At this distance, attractive forces between the cantilever and the sample cause the cantilever to bend, and the bending is once again recorded optically.
- In the third major mode, tapping mode, the cantilever oscillates back and forth above the sample. The amplitude of the cantilever’s oscillation varies with the topography encountered by its tip, and once again the information is recorded optically.

3d image generation: The measurement is made by observing the deflection of a laser beam reflected off the back of the cantilever. This combination of motions, back and forth for the **sample** and up and down for the stylus, **produces** a **3D image** of the surface. The **AFM** is capable of nanometer resolution.