ME 517: Micro- and Nanoscale Processes

Lecture 10:
Atomic Force Microscopy - Introduction

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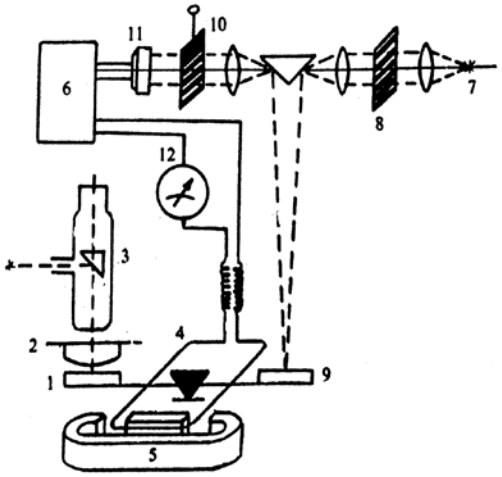
Transduction: Turning one kind of signal into another

- Concentrate on chemical/mechanical phenomena
- Try to turn normally imperceptible microscopic phenomena into measurable signals
- Enabling technology:
  - Cantilevers and
  - Membranes
- Strictly continuum analysis of these systems although we will consider thermal noise

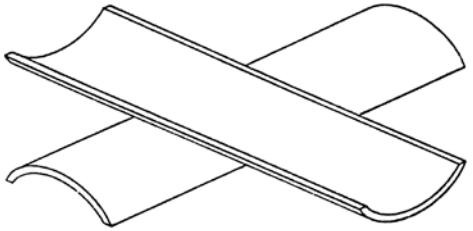
Surface Forces Measurement Techniques

DLVO - van der Waals and double-layer

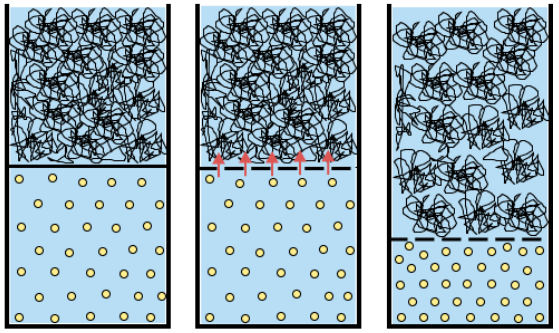


B.V. Derjaguin, Y.I. Rabinovich, and N.V. Churaev, *Nature* 1978.

Short-Range - Solvation, steric, hydrophobic and thermal fluctuation



D. Tabor and R.H.S. Winterton, *Nature* 1968.

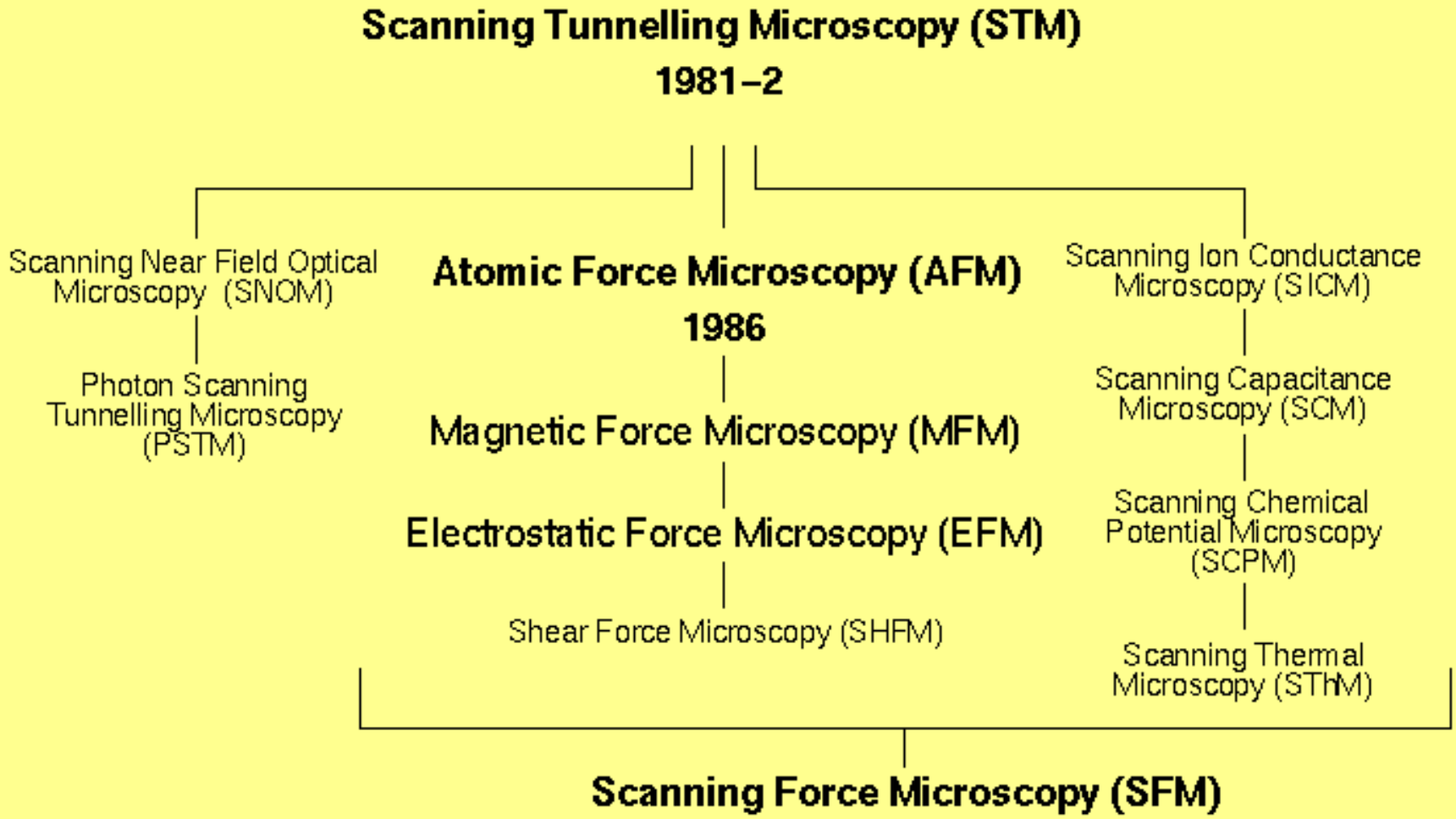


D.M. LeNeveu, R.P. Rand and V.A. Parsegian, *Science* 1976.

Measure Very Small Forces

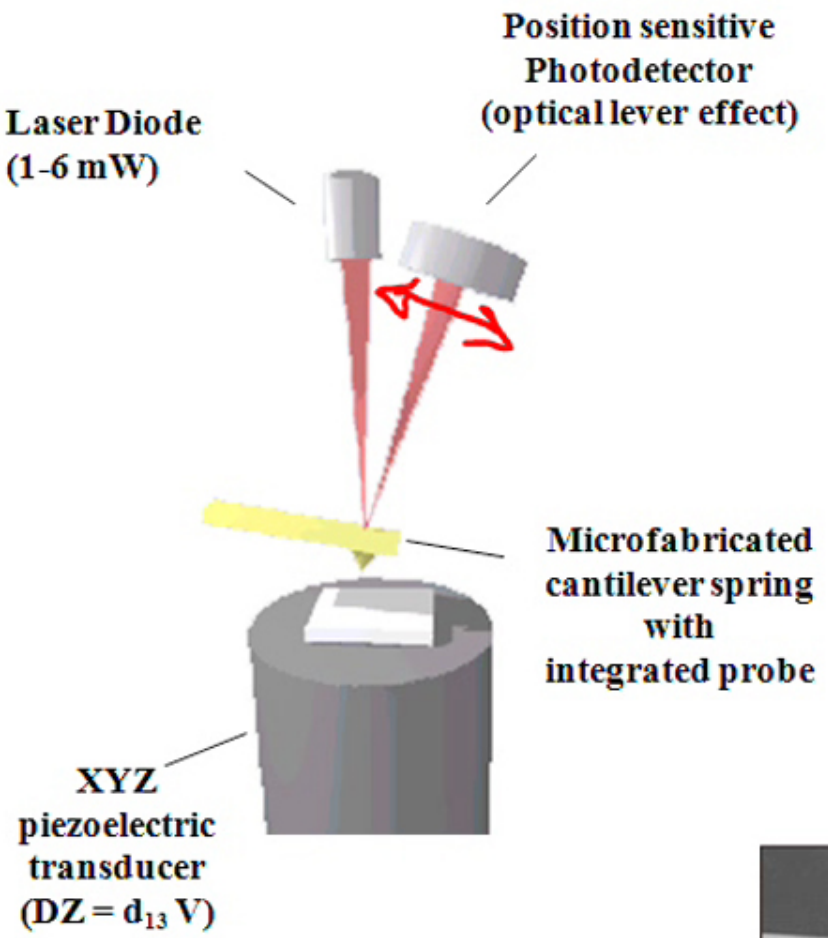
- Atomic Force Microscopy (AFM) is a special case of Scanning Probe Microscopy (SPM)
- Very sharp cantilever tip interacts with van der Waals forces near atoms
- Force measured using light reflected off cantilever over large distance

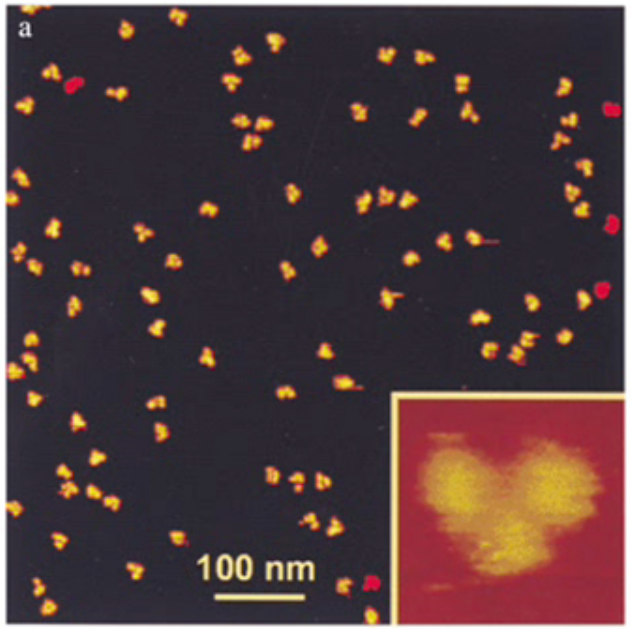
Scanning Probe Microscopy "Family Tree"
(SPM)



http://spm.phy.bris.ac.uk/

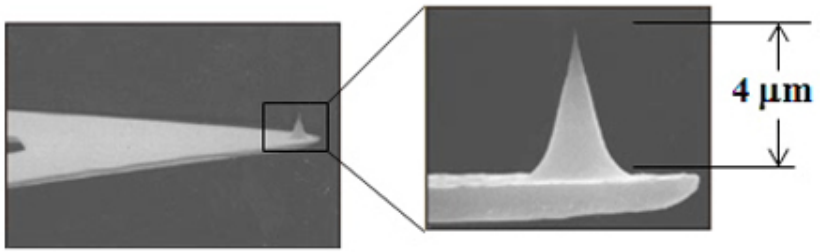
Atomic Force Microscope



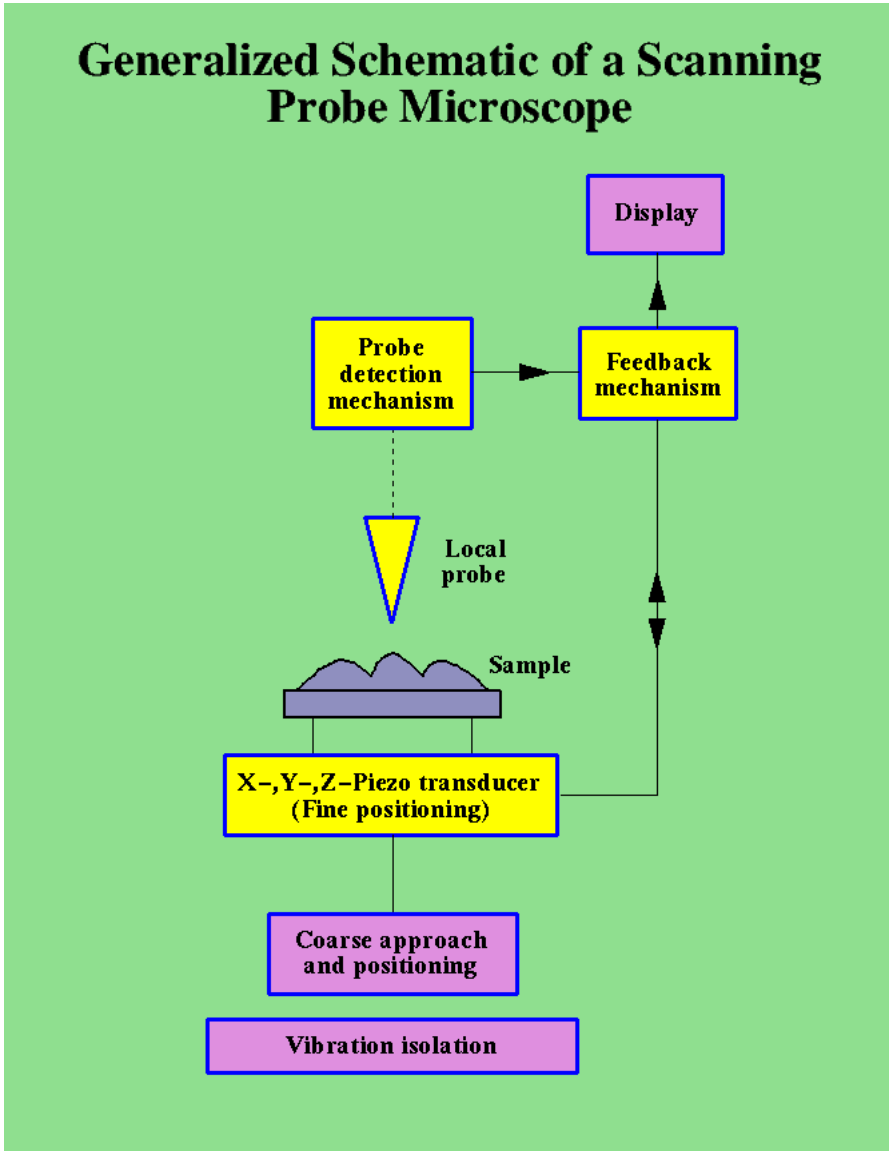


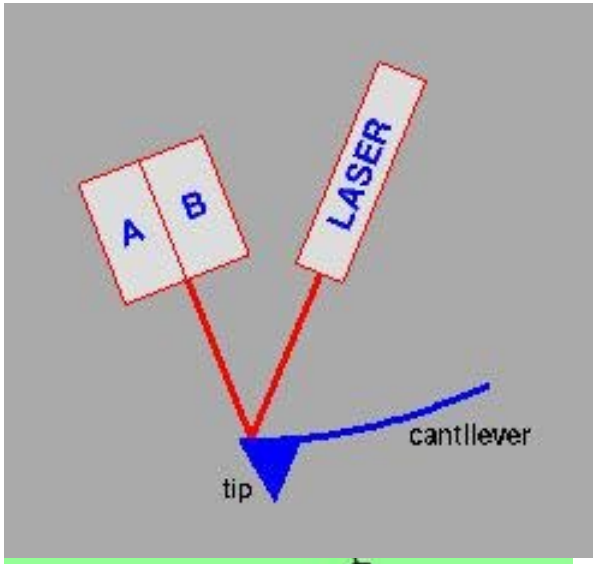
D. Anafi, G.-M. Wu (Amagen)

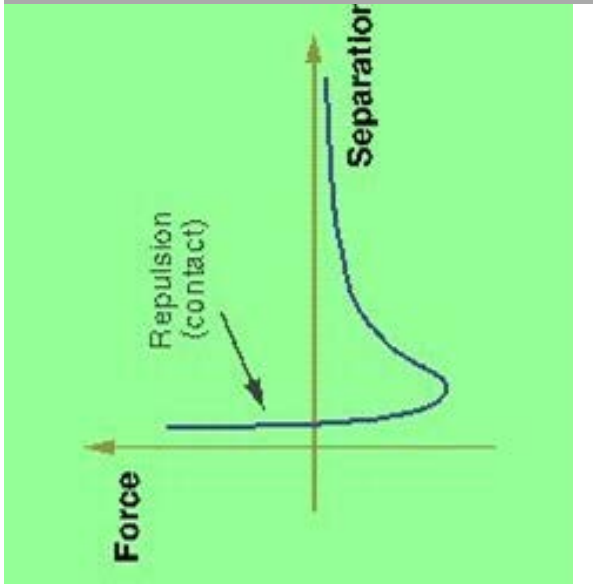
SEM of PSI Ultralever



AFM Schematic







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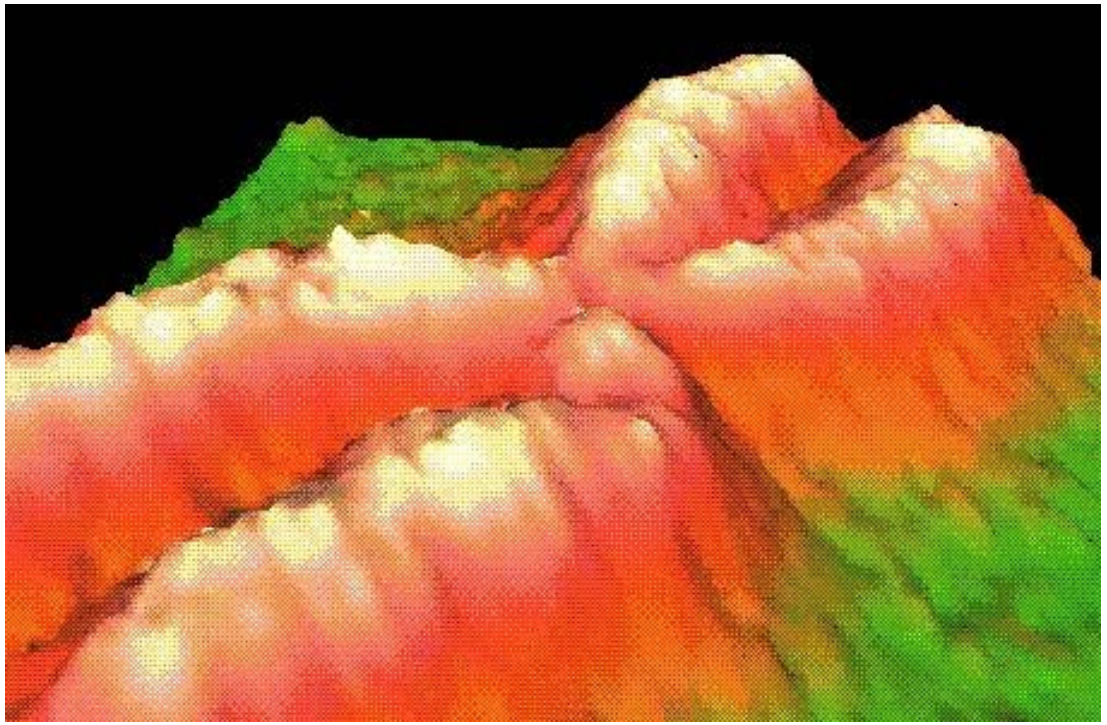
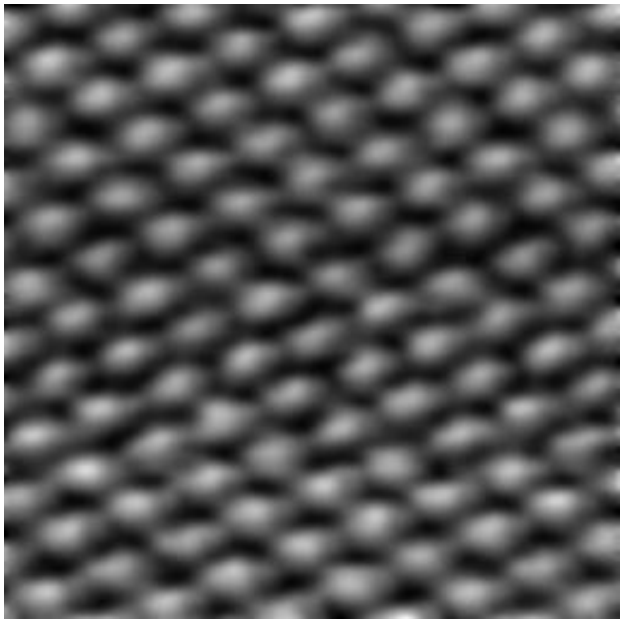
Characteristic AFM Results



A human chromosome arrested in metaphase imaged by AFM, showing the characteristic arms



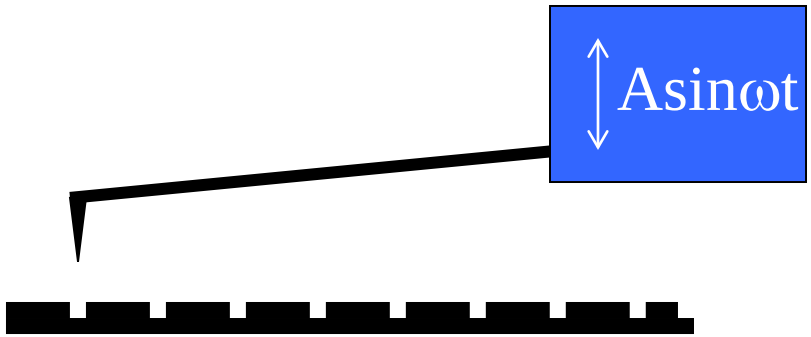
Individual carbon atoms on the surface of a graphite crystal

AFM results in 3-D map of surface heights versus x and y positions. Post experiment data interrogation very important.

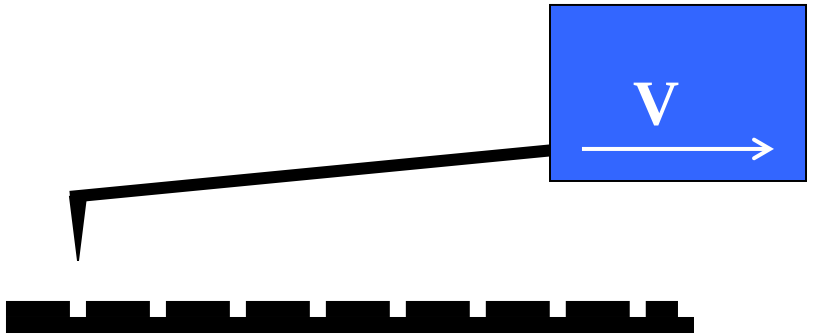
http://spm.phy.bris.ac.uk/

AFM Dynamic Problems

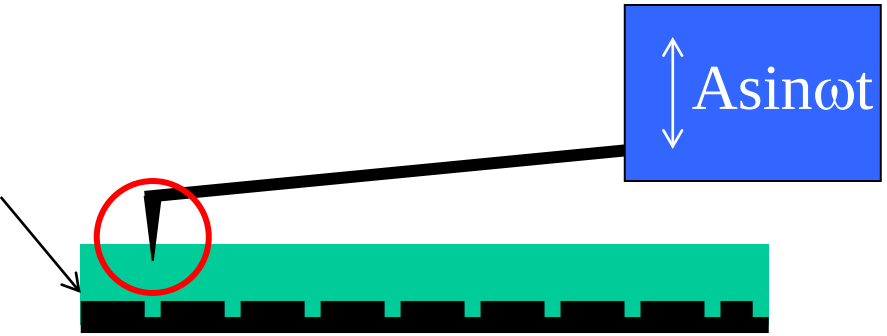
Tapping Mode



Contact Mode



L ω_e=V/L – excitation freq



Model boundary condition
as damped free end