God made solids, but surfaces were the work of the devil

-----Wolfgang Pauli

Goal of the course:
- Understanding the basic concepts of physics at solid surfaces/interfaces
- Understanding the basic principles of major surface sensitive techniques
- Comprehending the current development in surface physics and the impact to general condensed matter physics and modern technology, including nanotechnology

Main Reference books:

Other Reference books:

Homework assignment:
- Reading papers, references, and writing essays

Exams:
- A writing report on a special subject on surface science
- An oral presentation on a special subject/topic of surface physics

Grading Policy:
- Based on your homework (30%), written report (30%), Oral presentation (25%) and Attendance (15%).

Basic physics at surfaces:
- Lattice structure, lattice dynamics, and lattice phase transitions
- Electronic structure, electronic excitations, and electronic phase transitions
- Magnetic structure, magnetic excitations, and magnetic phase transitions
- New physics under broken symmetry
- Many body physics in reduced dimensionality

Part one: Theoretical treatments

Part Two: Experimental methods for the studies at surfaces
- Determination of near lattice structure
- LEED, LEED I(V), FIM, STM, AFM, SEXAFS, x-ray diffraction

- **Determination of chemical composition**
  - AES, SAM, XPS, UPS
    - P. Auger, *J. Phys. Radium* 6, 205 (1925)

- **Characterization of electronic band structure**
  - UPS, XPS, ARPES, IPES, EELS, STM

- **Characterization of magnetism**
  - SPEELS, SP-STM, MFM, SMOKE

- **Characterization of lattice dynamics, phonon band structure**
  - EELS, He-scattering
    - Characterization of electronic and magnetic excitation: EELS, SP-EELS, two-photon spectroscopy

**Part three: Thin film growth**
- CVD, MOCVD; MBE; PLD, Laser-MBE

**Part Four: Recent development on surface physics**
- Impact to condensed matter physics
  - Physics with broken symmetry, Physics in reduced dimensionality
- Impact to modern technology
  - Nanotechnology

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*Surfaces are the playground of Solid State Physics*
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*E. W. Plummer*