

Title: Soft X-ray spectroscopies using synchrotron radiation.

Lecturer: Tony Cafolla, Dublin City University

Duration: 12 hours.

Short Abstract:

This course covers the theory and principles of synchrotron radiation and its applications as a research tool. It addresses topics such as light and matter interactions, specific techniques using soft-x-rays and data analysis. In the first part of the course the fundamental properties of synchrotron radiation produced by bending magnets and insertion devices are described; the properties of synchrotron radiation such as energy and angular distribution, brilliance, polarization, coherence and time structure are covered. Soft x-rays cover an energy range of importance for spectroscopic studies of many elements in the periodic table. They are well suited to characterising surfaces and near-surface interfacial layers. The second part of the course covers soft x-ray spectroscopic and imaging techniques. It will describe different techniques for determining the local geometric and/or electronic structure of matter such as x-ray photoemission and x-ray absorption. Recent developments in these techniques such as near ambient pressure photoelectron spectroscopy (NAP-XPS) , hard x-ray photoelectron spectroscopy (HAXPES) and imaging techniques (PEEM, ESCA microscopy) will be discussed.

Outline of Course Content:

Theory of Synchrotron Radiation

Review of the central features of synchrotron radiation, Characteristics of bending magnet radiation, undulator radiation: Calculations of radiated power, brightness and harmonics, wiggler radiation: power and flux, monochromators.

X-ray Photoemission Spectroscopy (XPS)

Introduction to electron spectroscopies: background and theory, instrumentation for electron spectroscopies, Core level XPS, Ultraviolet photoelectron spectroscopy (UPS), Data acquisition and Analysis, Applications and case studies, Recent developments: Hard x-ray photoelectron spectroscopy (HAXPES), Near Ambient Pressure Photoelectron Spectroscopy (NAP-XPS).

X-ray absorption spectroscopy (XAS)

Principles of X-ray absorption, X-ray absorption, X-ray fluorescence, Measurement of x-ray absorption spectra, Instrumentation and techniques, High resolution XAS measurements
Linear polarized measurements , x-ray magnetic circular dichroism (XMCD)
Spatially resolved measurements, Applications of XAS.

Angular resolved photoemission (APES) (soft x-ray)

Theoretical description, Principles and instrumentation, Applications and case studies, Scientific Impact: 2D materials and correlated electron systems.

Soft x-ray imaging techniques:

Principles of soft x-ray imaging, photoelectron emission microscopy (PEEM), x-ray absorption and ESCA microscopy; soft-x-ray imaging techniques