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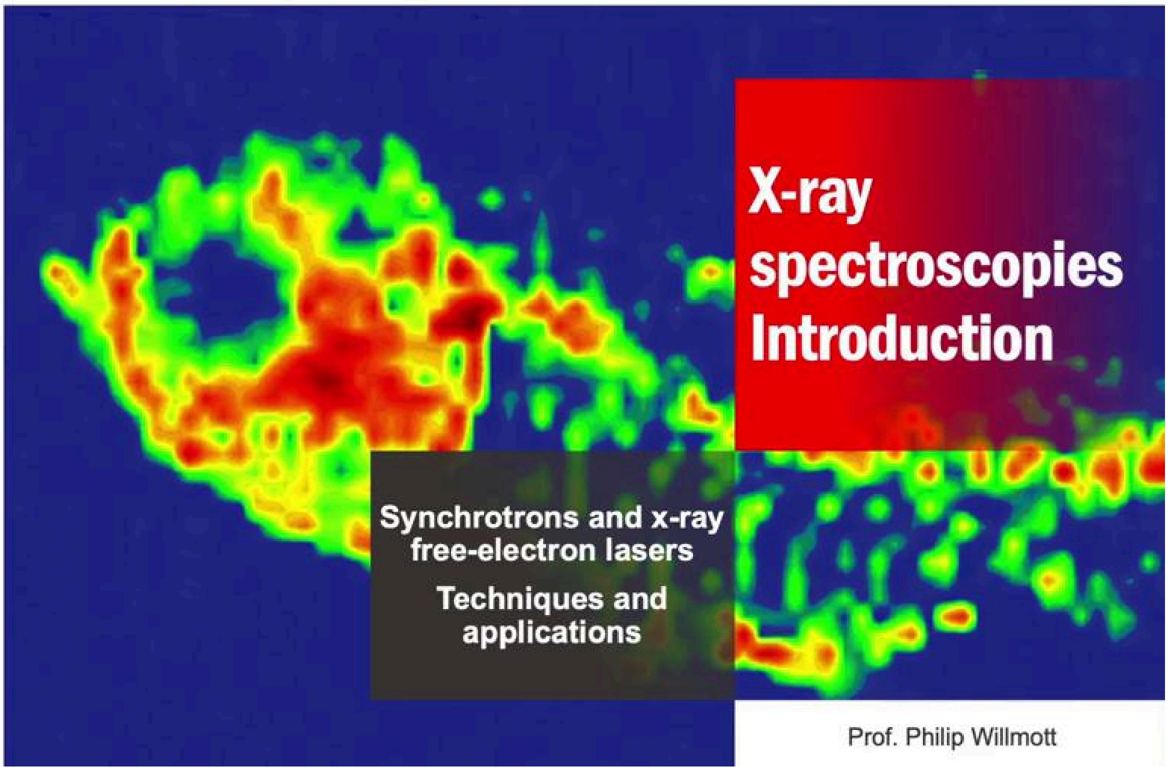

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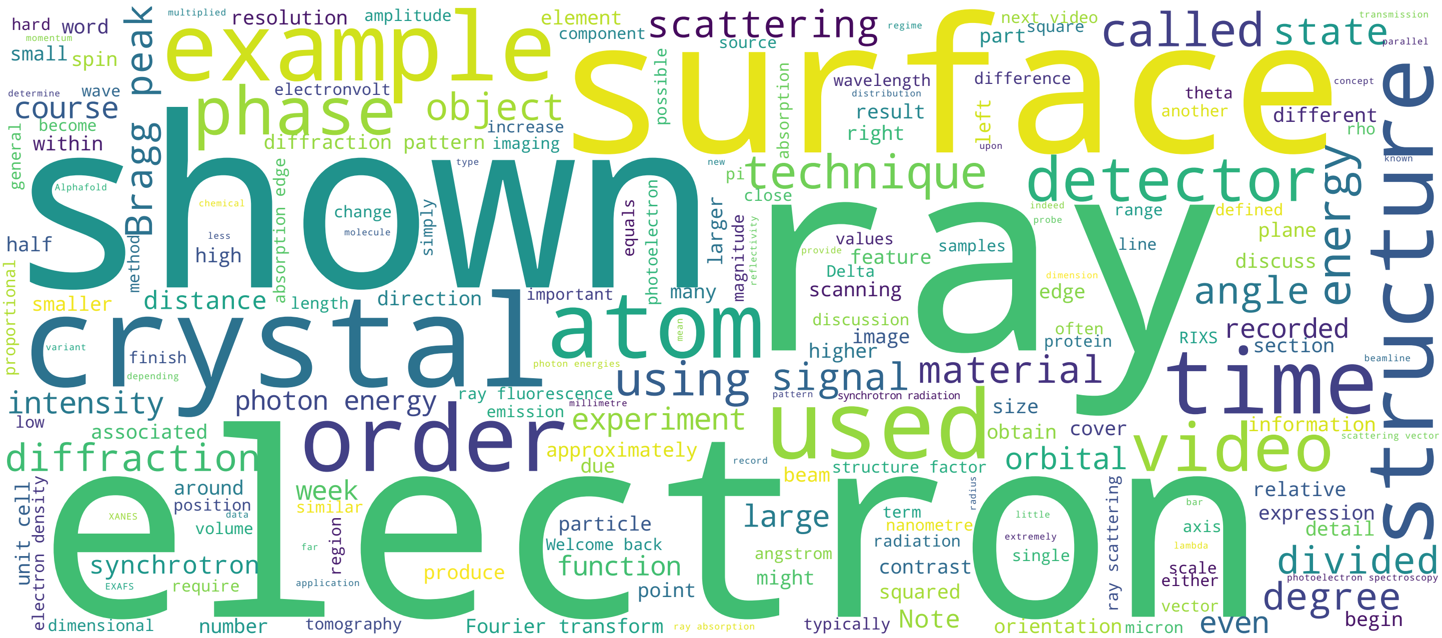

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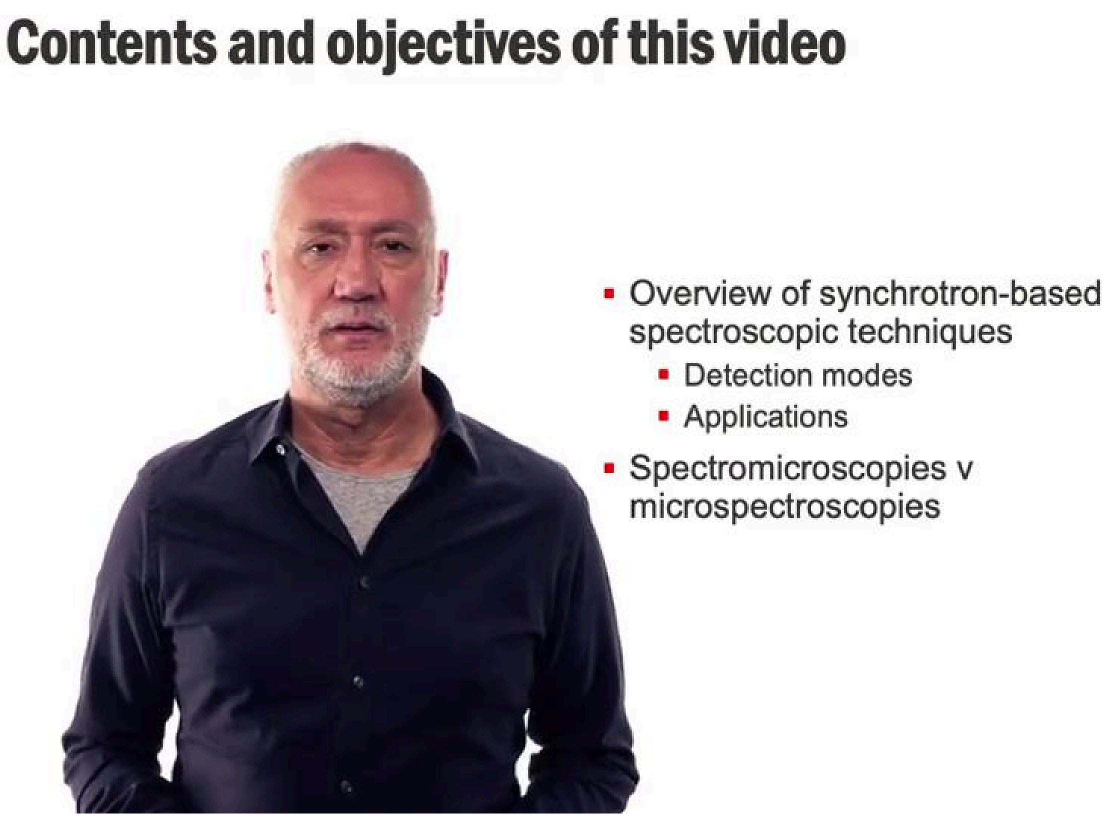
Video

EPFL

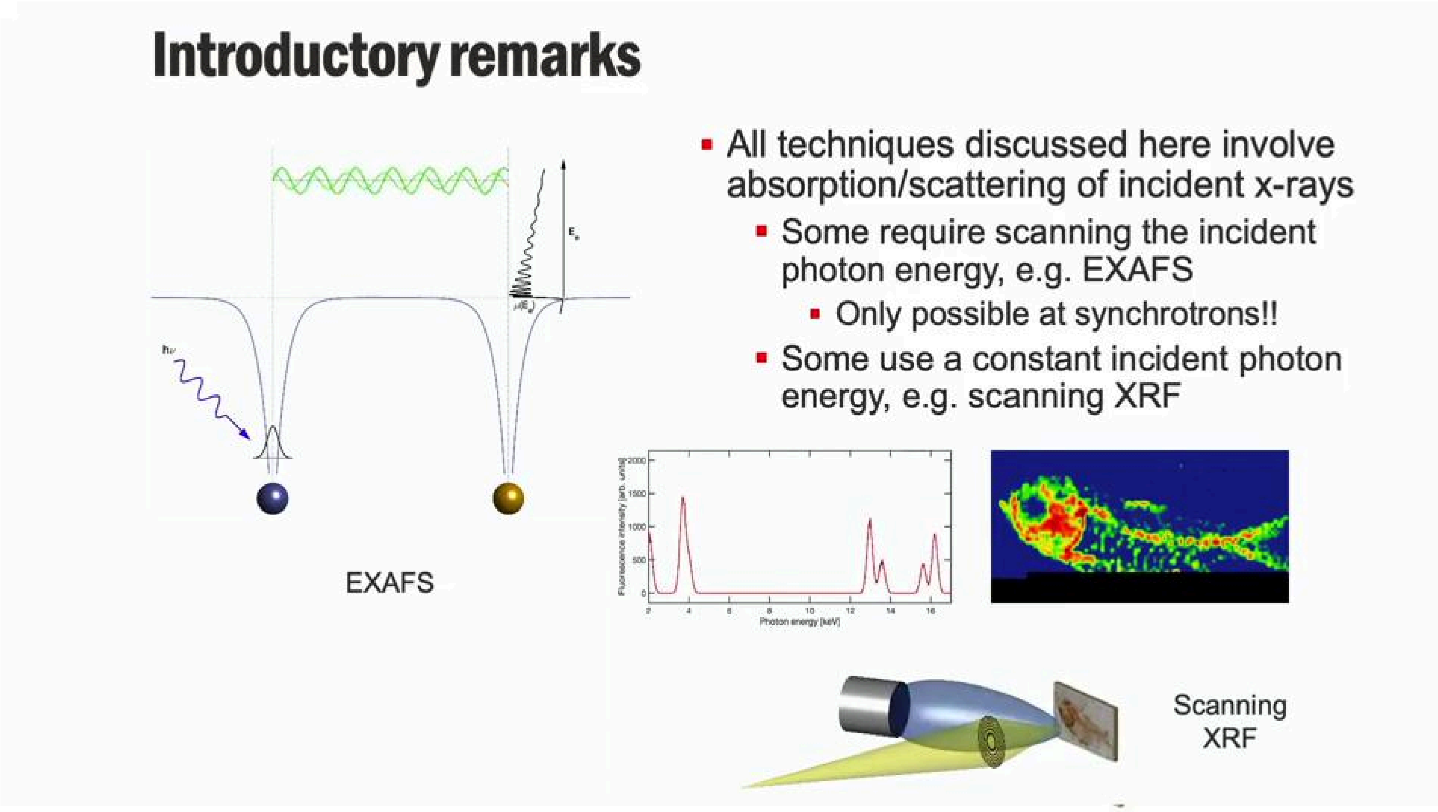


Welcome back to the third week of the second course on synchrotron radiation techniques. This and the fourth week are dedicated to synchrotron-based spectroscopic methods. In this short first introductory video, we will review different types of spectroscopies and detection methods; give a brief overview of typical applications, though this is far from being an exhaustive list; and also make a distinction between spectral microscopies and microspectroscopies.

Notes

Summary

0m 05s



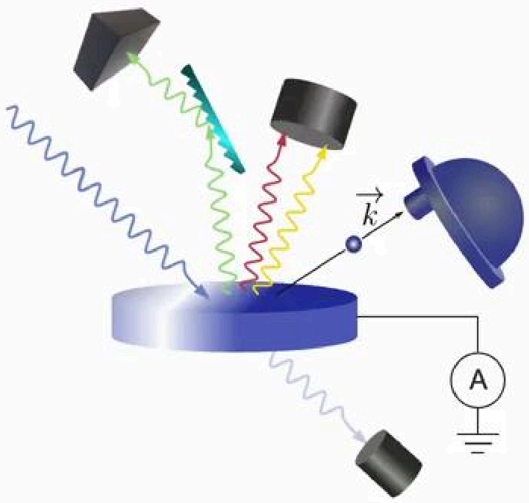
The first thing to stress here is that all the techniques discussed in this and next week involve the absorption or scattering of an incident beam of X-rays. Some, such as EXAFS, require that the incident photon energy be scanned and as such is only possible at synchrotrons, while others might use a constant incident photon energy as is often the case in scanning X-ray fluorescence.

Notes

Summary

0m 36s

Introductory remarks



- Form of detection
  1. Transmitted x-radiation
  2. Emitted photoelectrons
     - Also as function of $\vec{k}$
  3. Auger electrons
  4. Emitted fluorescence
  5. Inelastically scattered x-radiation

  (Items 1–4: Spectrally resolved)

  6. Secondary electrons/total electron yield
     - Not spectrally resolved
     - Used as a measure of absorption strength

All forms of detection are typically used in X-ray spectroscopies. If the sample isn't too thin or too thick, the transmitted signal can be recorded. Absorption often results in the production of photoelectrons, which can be detected with some energy dispersive electron analyser. If either this analyser or the orientation of the sample can be changed, one can also determine how the photoelectron yield changes with its momentum. In other words, it's emission direction. Auger electrons can also be detected using the same analyser. Another product of photoabsorption is fluorescence, which can be either recorded as an integrated signal or dispersed along with inelastic scattered photons such as in resonant inelastic X-ray scattering or RIXS. Finally, the current generated by the emission of all the electrons, including secondary electrons, can often be used as a measure of the absorption strength.

Notes

Summary

1m 07s

Spectroscopic techniques covered in this course

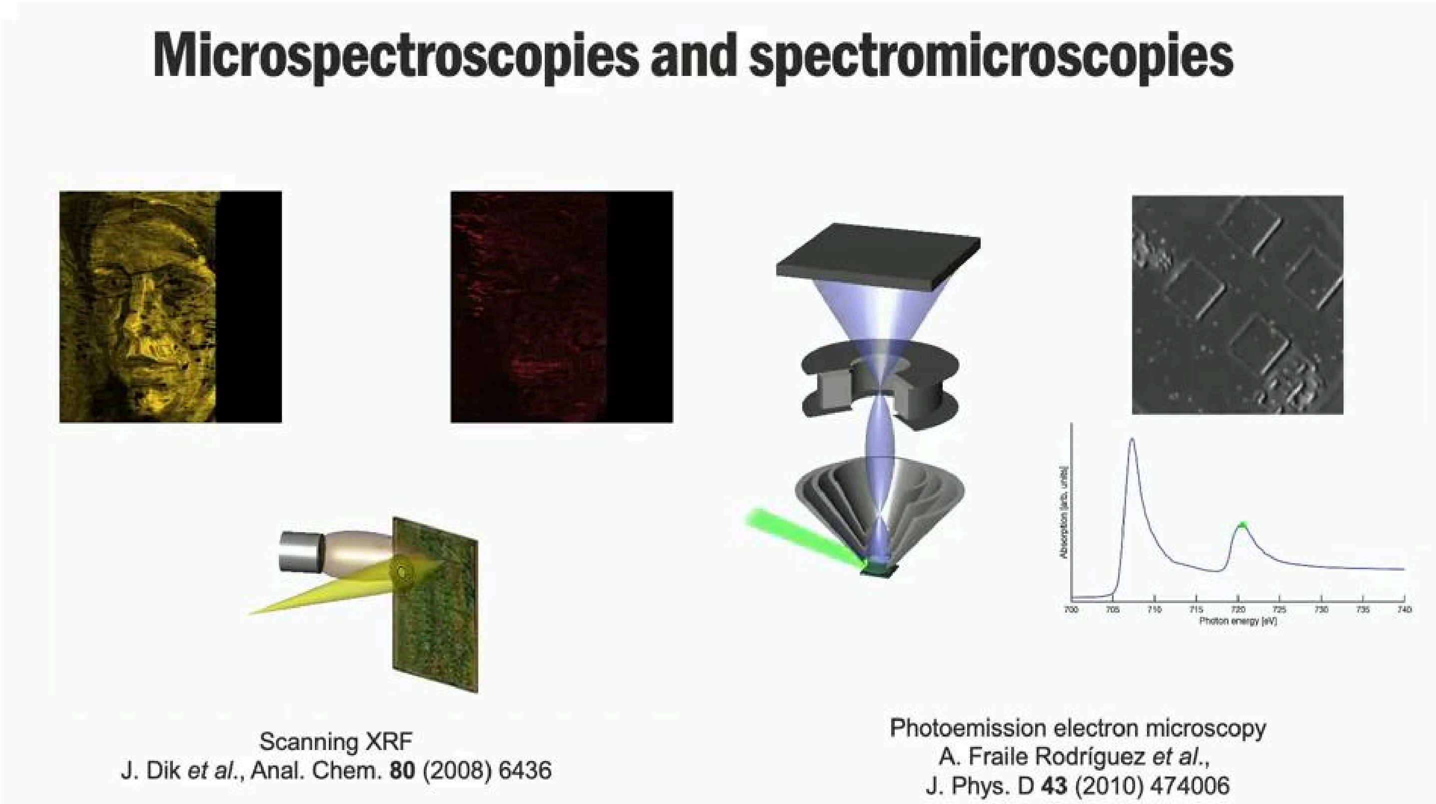
Technique	Abbreviation	Scanned $h\nu_{in}$?	Detection methods	Applications
X-ray absorption near-edge spectroscopy	XANES	✓	1, 2, 4, 6	Local chemistry, absorbate structure/orientation, oxidation state, coordination, spin state
Photoemission electron microscopy	PEEM	✓ Variations of XAS	6	Magnetic structures (ferro-, ferri-, antiferromagnetisms). Variant of XANES
Scanning transmission x-ray microscopy	STXM	✓	1, 3	Polymer physics, thin films, segregation, morphology. Variant of XANES
Extended x-ray absorption fine structure	EXAFS	✓	1, 2, 4, 6	Local structure in disordered ("real") systems, trace element detection, chemical dynamics, catalysis
X-ray fluorescence	XRF		4	Geochemistry, archaeology, forensic science, cultural artifacts/heritage
Resonant inelastic x-ray scattering	RIXS	✓	5	Electronic structure (charge, orbital, spin), materials science
Angle-resolved photoelectron spectroscopy	ARPES	(✓)	2	Electronic structure, surface and interface science
X-ray photoelectron spectroscopy	XPS	(✓)	2, 3	Chemistry, surface/absorbate structure, interface chemistry

In this course, we will cover the spectroscopic techniques which are listed in this table. Although the selected techniques cover a good fraction of synchrotron-based spectroscopies, it isn't exhaustive, and apologies, if the technique that you're most interested in is not listed here. The first four are all variations of X-ray absorption spectroscopy. The column listing the detection methods correspond to the list in the previous slide 1-6. The list of applications is also not meant to cover all instances which have ever been published, but is more a general guide. Feel free to pause the video now to peruse the table in a little more detail.

Notes

Summary

2m 22s



We should also distinguish between microspectroscopies, which record spectra from narrowly focussed beams, often accompanied by scanning such as in scanning X-ray fluorescence shown on the left, and spectromicroscopies, in which microscopic images are recorded at different photon energies such as in photoemission electron microscopy shown on the right.

Notes

Summary

3m 07s

In the next video, we cover some important background concepts in X-ray spectroscopy, beginning with a discussion of electron orbitals, the free electron model, and the Fermi Energy.

Notes

Summary

3m 30s