

by J B West

This section will focus on the use of this technique in the study of atoms and molecules in the gas phase. It is also widely used in the study of solids and the solid/surface interface; details on this can be found [here](#).

PES is the experimental method used to determine the energies of electrons ejected from an experimental sample by bombarding it with photons. In this way the binding energies of the electrons in the sample can be determined; a typical experimental layout can be seen [here](#). It was developed in the late 1950s and early 1960s, and at that time the major light sources available were discharge sources providing discrete lines in the VUV and X-ray regions of the spectrum. With the advent of synchrotron radiation, providing an intense continuum in the vacuum ultraviolet (VUV) and X-ray regions, it became possible to measure interactions between separate groups of electrons, and further information was obtained by measuring the angular distributions of the electrons ejected, which gave information on the symmetry of the electron orbitals. The first measurements of this kind were carried out at the NINA SRF; by obtaining data over a wide photon energy range, it soon became clear that electrons in different orbitals could not be treated independently. These measurements challenged current theoretical analysis, a challenge taken up by theorists in the USSR who successfully modelled the process by including such interactions.

Although the photon intensity from the NINA SRF was a major advance for PES experiments, nonetheless these were limited to "single channel" counting, ie data could be collected at only one electron energy at a time. The much higher intensity from the SRS, coupled with improvements in area detectors, meant that a whole electron spectrum at a time, for a given photon energy, could be taken. The method was pioneered at the SRS, and three dimensional spectra were produced with photon energy along one axis, electron energy along the other and intensities shown as different colours. In this way very weak features were easy to see and shed new light, particularly in resonance regions, on electron-electron interactions. Much higher electron and photon resolution could be used; this was particularly important for molecular studies; in a collaboration with The National Institute of Science and Technology (NIST) in the USA, a complete experimental apparatus with two analysers set at 90 degrees to each other and perpendicular to the photon beam, each equipped with multichannel detectors was sent from NIST and fitted to a high resolution VUV spectrometer at the SRS. This [spectrometer](#) represented the state of the art at that time, and produced a wealth of new data on small molecules such as H

$N_2$   
 $N_2$   
and CO  
 $N_2$   
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