

Hand-in exercise 1: Photoemission from Argon

In the figure below an Ar 3p ultraviolet photoelectron spectrum is shown, which was measured on gaseous Ar using the UV light of the so-called He I α line from a helium lamp (I should say that today one can measure much nicer spectra – the spectrum shown is quite old). He I α light has a photon energy of 21.2 eV.

1. Which other photoemission lines can you measure on Ar gas using He I α light? What if you use He II α light (41.81 eV)? And what if you use Al K α light (1486.6 eV)? At which binding energies do you expect to see the lines? And at which kinetic energies?
2. What is the value of the spin orbital momentum of the 3p shell of Ar? And the angular orbital momentum?
3. The spin-orbit coupling term of the Hamiltonian of the argon atom (or any other atom, of course) is $\sim \mathbf{L} \cdot \mathbf{S}$. Considering your answer to question 2, how can you explain that the photoemission line in the figure is “spin-orbit-split”?
4. Now that we know that the 3p line is spin-orbit-split, what intensity ratio do you expect for the two lines?

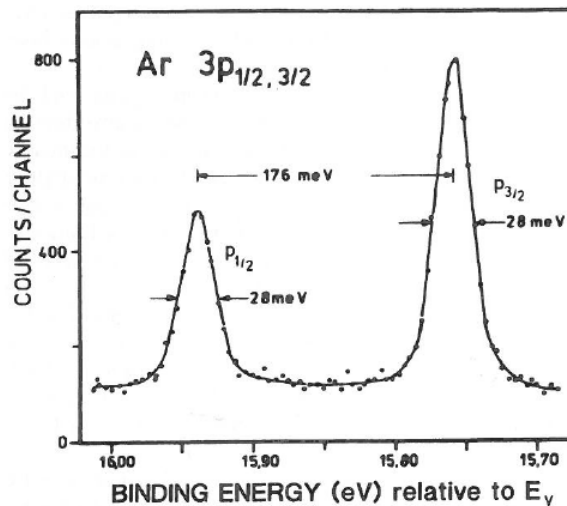


Fig. 5.1a. UPS spectrum (HeI, 21.2 eV) of gaseous argon showing the 3p_{1/2, 3/2} doublet. The linewidth is an indication of the resolution (almost exclusively determined by the electron spectrometer). Spectra like this one are often used to measure the resolution of a PE spectrometer