

Ultimate Energy Resolution of the PHOIBOS 100 CCD

Application Notes

We have measured the line width of the Xe $5p_{3/2}$ gas line using the SPECS gas cell UGC 10 and the SPECS UV-light source UVS 300. The special geometry of the cell includes space charge compensation electrodes to demonstrate the ultimate energy resolution of the PHOIBOS 100 analyzer together with the 2D-CCD Imaging Detector.

The Doppler broadening ΔE_D of the target gas in the cell depends on the mass and the kinetic energy. It is due to the thermal motion of the emitting atoms or ions. For a Maxwellian velocity distribution, the line shape is Gaussian; the full width at half maximum intensity (FWHM) is, in meV,

$$\Delta E_D = 0.7215 \sqrt{\frac{E_{kin} \cdot T}{M}}$$

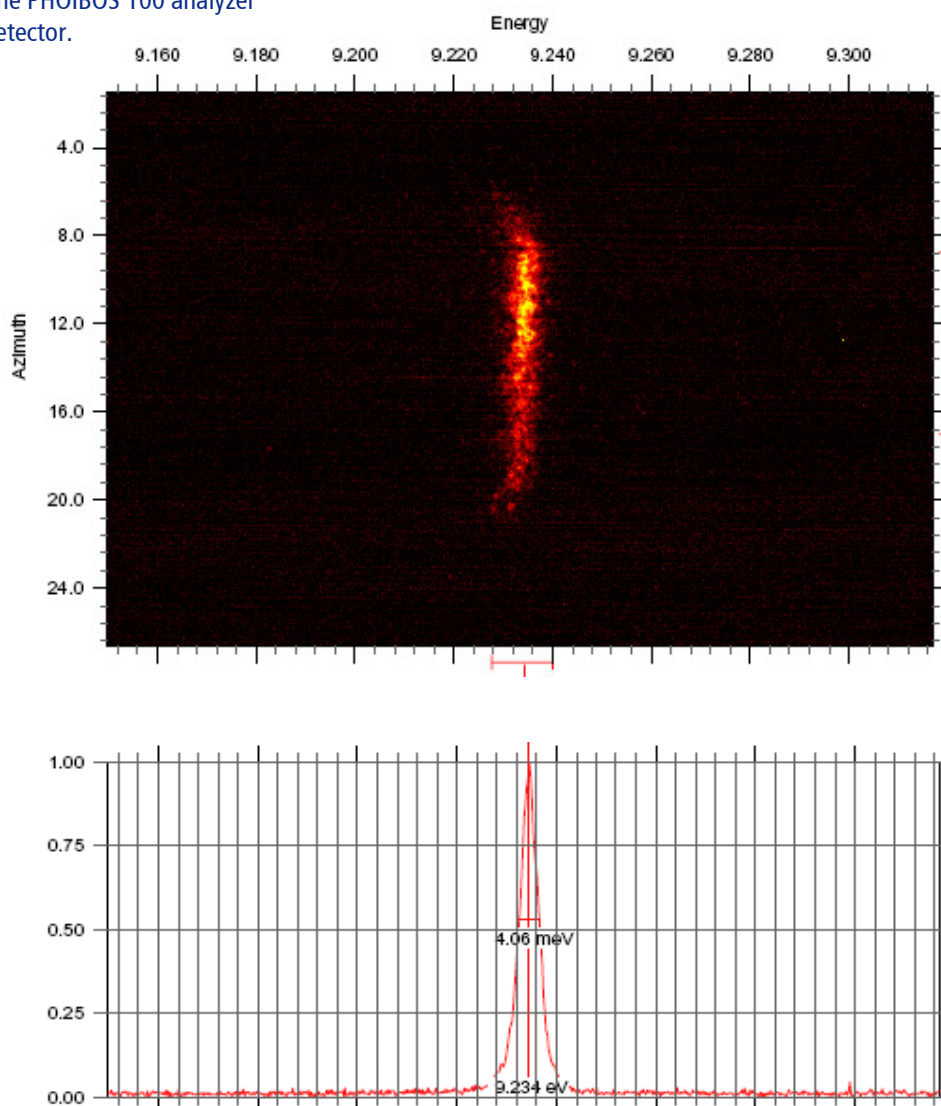
This expression (ΔE_D in meV) is derived from the Boltzmann distribution, where E_{kin} is the photoelectron energy in eV, T is the absolute temperature, and M is the molecular mass expressed in atomic mass units. The theoretical foundations of line broadening are discussed in *Atomic, Molecular, & Optical Physics Handbook*, Chaps. 19 and 57, ed. G.W.F. Drake (AIP, Woodbury, NY, 1996).

The "ultimate analyzer resolution" is determined by correcting the measured line width against all known broadening contributions. Considering a UV-source contribution of about 1 meV and 3.3 meV Doppler broadening of the target gas, the ultimate analyzer resolution is $FWHM_{Analyzer} = 2.8$ meV.

$$FWHM_{Analyzer} = \sqrt{(FWHM_{Measured})^2 - (FWHM_{UV-Source})^2 - (FWHM_{Doppler})^2}$$

The figure below depicts the Xe $5p_{3/2}$ level excited with He I UV radiation measured with a PHOIBOS 100 2D-CCD analyzer at a pass energy E_p of 0.75 eV and a slit width s_s of 0.2 mm. The curve fitting is performed using a Gaussian line shape. The FWHM of 4 meV includes the line broadening of the excitation source ΔE_s , the Doppler broadening ΔE_D and the analyzer resolution ΔE_A . The ultimate analyzer resolution is $\text{FWHM}_{\text{Analyzer}} = 2.8 \text{ meV}$.

Xe $5p_{3/2}$ (excited with He I UV radiation) measured with FAT 0.75. The curve fitting was performed using a Gaussian line shape. It shows the very high resolution capabilities of the PHOIBOS 100 analyzer together with a 2D-CCD detector.



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