

# New measurements of X-ray fundamental parameters



Hubbell vs Bambynek

Krause vs Bambynek



**State of the art** 

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### X-ray fundamental parameters are of primary importance for quantitative and qualitative X-ray based techniques. In reference-free methods, the quality of the analysis result is directly dependent on the reliability of such parameters characterizing the interaction between X-ray photons and matter: μ, ω, f. New values of these parameters can be obtained either by experimental work, using modern facilities (synchrotron), or through quantum mechanical calculations.

The X-ray intensities of radionuclides are also strongly linked to the fluorescence yields.



The mass attenuation coefficients  $(\mu/\rho)$ 

Several databases exist and some of them are accessible to the community: Berger<sup>a</sup> (available online (NIST-XCOM) or xraylib), Henke<sup>b</sup> (available online (CXRO)), Elam<sup>c</sup>, Ebel<sup>d</sup>, Cullen<sup>e</sup>. Unfortunately, large

### The fluorescence yields $(\omega)$

The available databases contain only limited experimental results, together with theoretical calculations. Nonetheless, discrepancies exist between tables: see example between Bambynek<sup>f</sup>, Krause<sup>g</sup> and Hubbell<sup>h</sup>

#### Estimated percentage uncertainties for fluorescence and Coster-Kronig yields

M. Krause et al., "X-ray fluorescence cross sections for K and L X-rays of the elements", Oak Ridge National Laboratory, Report No ORNL-5399 (1978)



[a] M.J. Berger et al., XCOM: Photon Cross Sections Database. Available online: http://physics.nist.gov/PhysRefData/Xcom/Text/XCOM.html

[b] B.L. Henke *et al.*, photoabsorption, scattering, transmission, and reflection at E=50-30000 eV, Z=1-92, Atomic Data and Nuclear Data Tables Vol. 54 (2), 181-342 (1993). Available online: http://henke.lbl.gov/optical\_constants/

[c] W.T. Elam et al., A new atomic database for X-ray spectroscopic calculations, Radiation Physics and Chemistry, Vol. 63, pp. 121128, 2002

[d] H. Ebel et al., Numerical description of photoelectric absorption coefficients for fundamental parameters programs, X-Ray Spectrometry, vol. 32, no. 6, pp. 442451, 2003

[e] Dermott E. Cullen, UCRL-50400, Vol. 6, Rev. 5; "EPDL97: the Evaluated Photon Data Library".



[f] W. Bambynek *et al.*, Review of Modern Physics, Vol. 44 (1972)

[g] M.O. Krause, J. Phys. Chem. Ref. Data., Vol. 8 (1979)

[h] J.H. Hubbell et al., J. Phys. Chem. Ref. Data., Vol. 23 (1994)

## New measurement of mass attenuation coefficients

Transmission measurement of thin samples: the Beer-Lambert law links the transmission to the total mass attenuation coefficient  $\frac{\mu}{\rho} = -\frac{A}{M} \times \ln\left(\frac{I_t - I_{dark}}{I_0 - I_{dark}}\right) \times k_P$ 



10 20 30 40



# New measurement of fluorescence yields



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