X-Ray Spectroscopy

Kvantfysik 2018-2019

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Production of X-rays

X-rays are emitted when outer-shell electrons fill a vacancy in the atoms inner shell.

Characteristic X-rays

Each element releases x-rays in a characteristic pattern.

Need of screening constant

Interaction among electrons

Moseleys law

$$\sqrt{E/R_y} = (Z - c)\sqrt{\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

Grants the energy released by each transition.

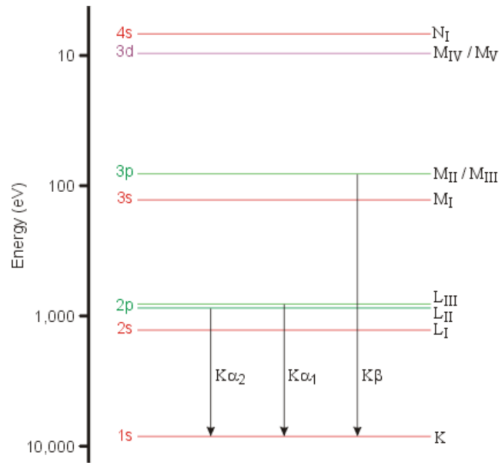


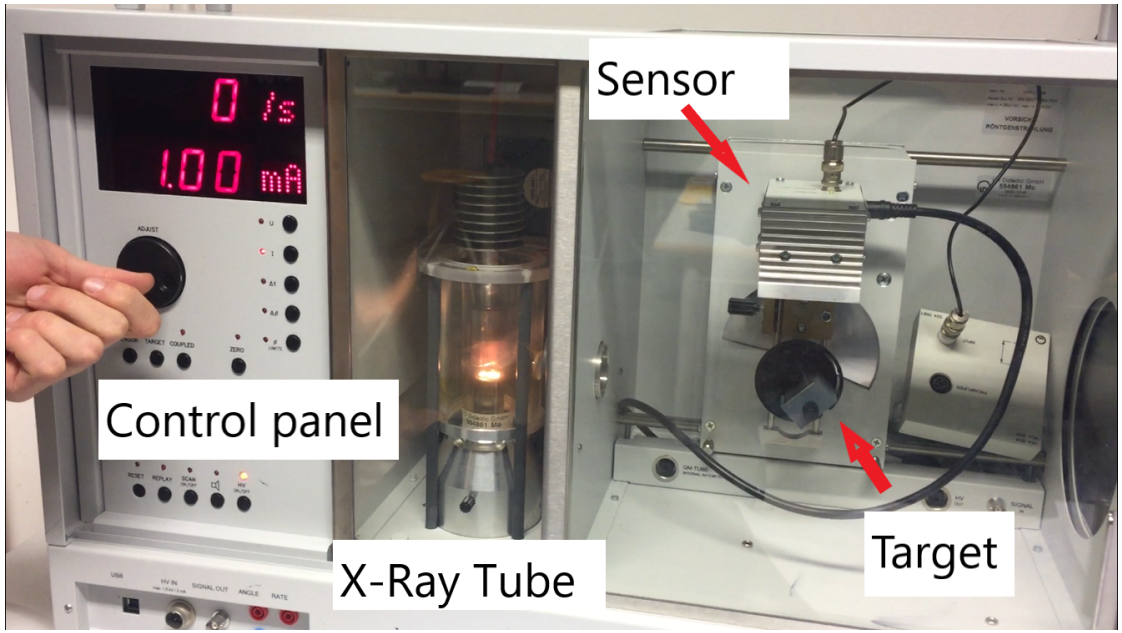
Figure: Energy level diagram. Image from: http://pd.chem.ucl.ac.uk/pdnn/inst1/xrays.html

Methods

- Setting up panel control and software
- Calibration procedure
- Measurement of samples

Measuring procedure

- Turn on the high voltage
- Adjust current
- Wait for the measurement to finish and calculate peak center



Results

Known samples

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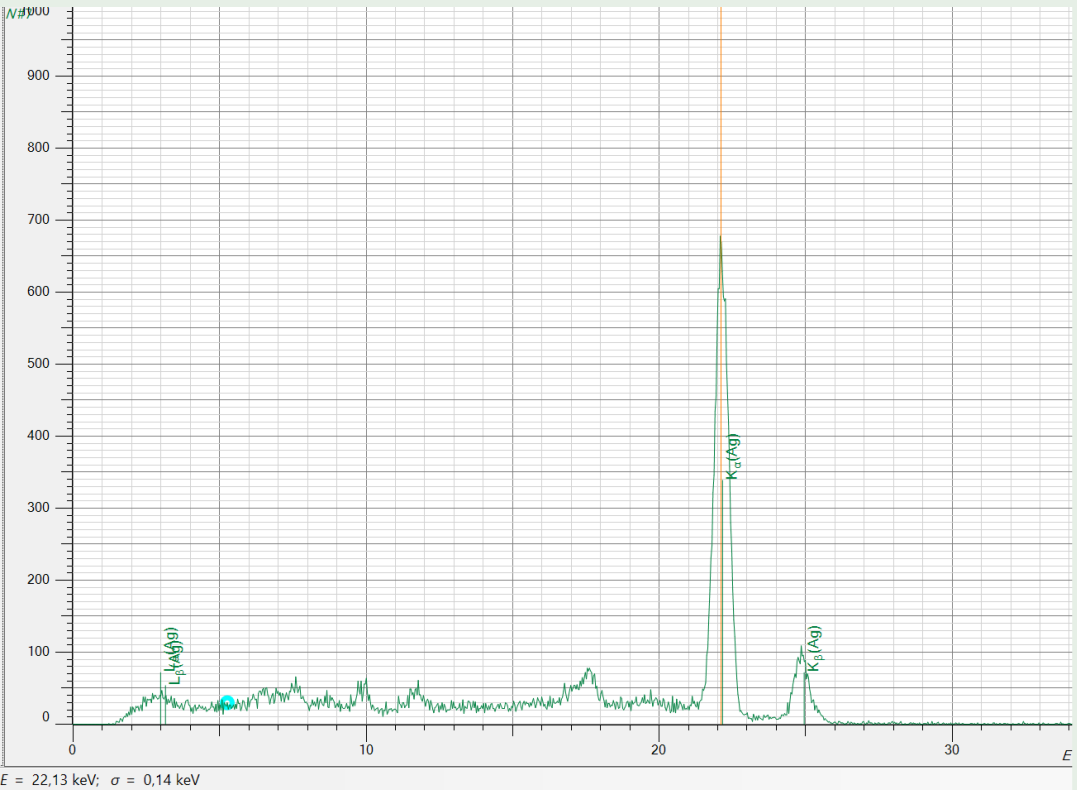
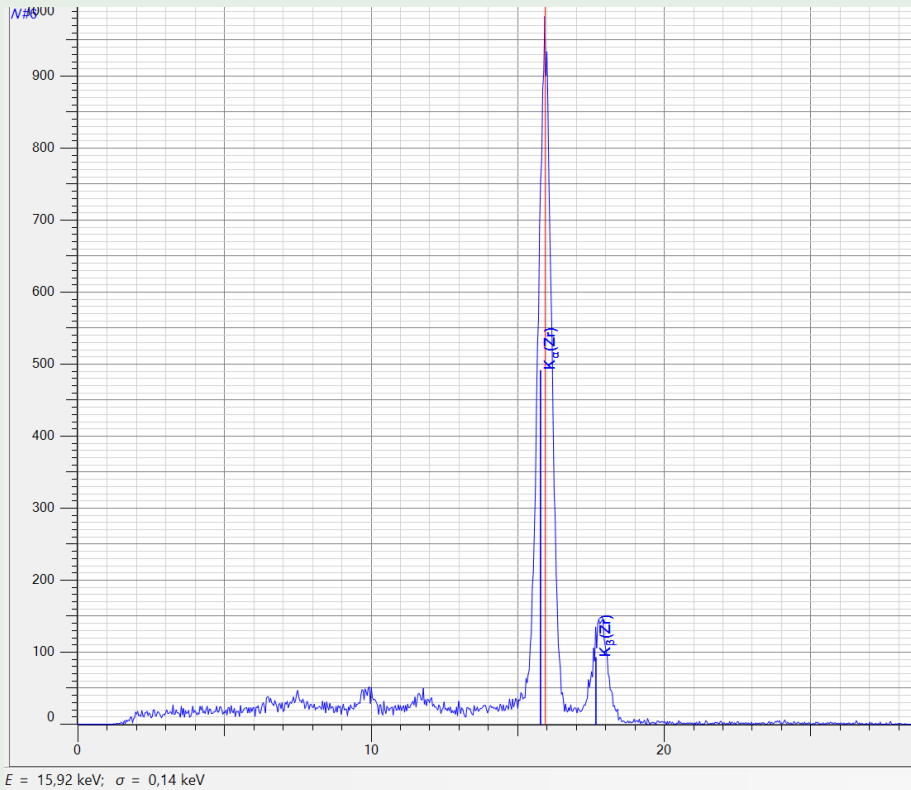
Silver sample



Tabulated value:

$$K_\alpha = 22.17 \ \ keV \qquad \epsilon = 0.18\%$$

Zirconium sample



Tabulated value:

$$K_\alpha = 15.77 \ \ keV \qquad \epsilon = 0.95\%$$

Results

Unknown samples

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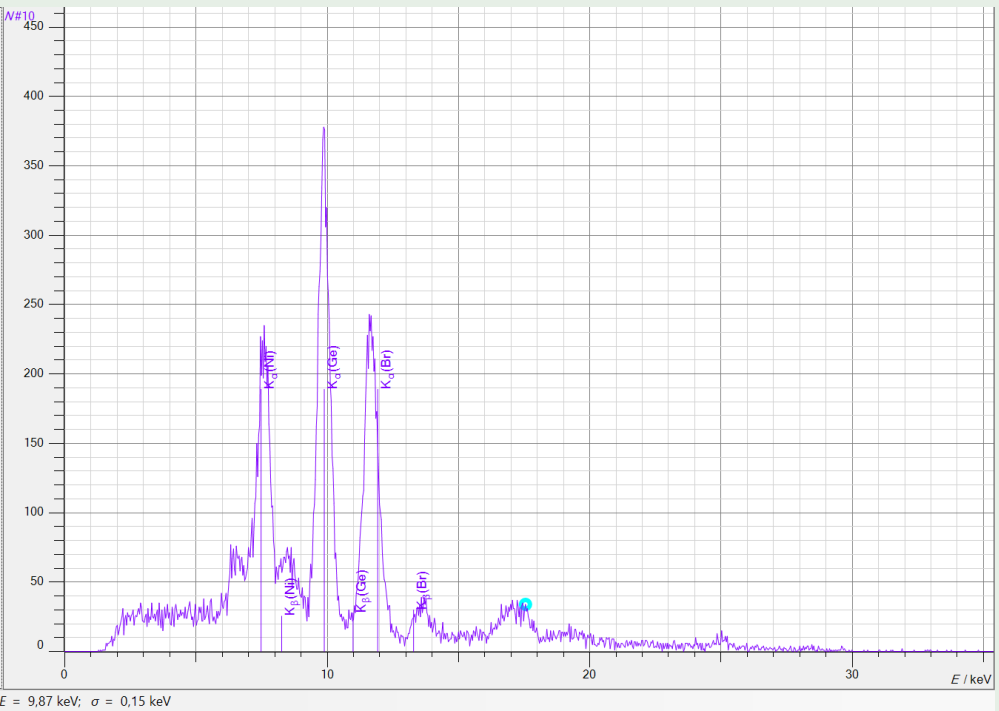
6th sample

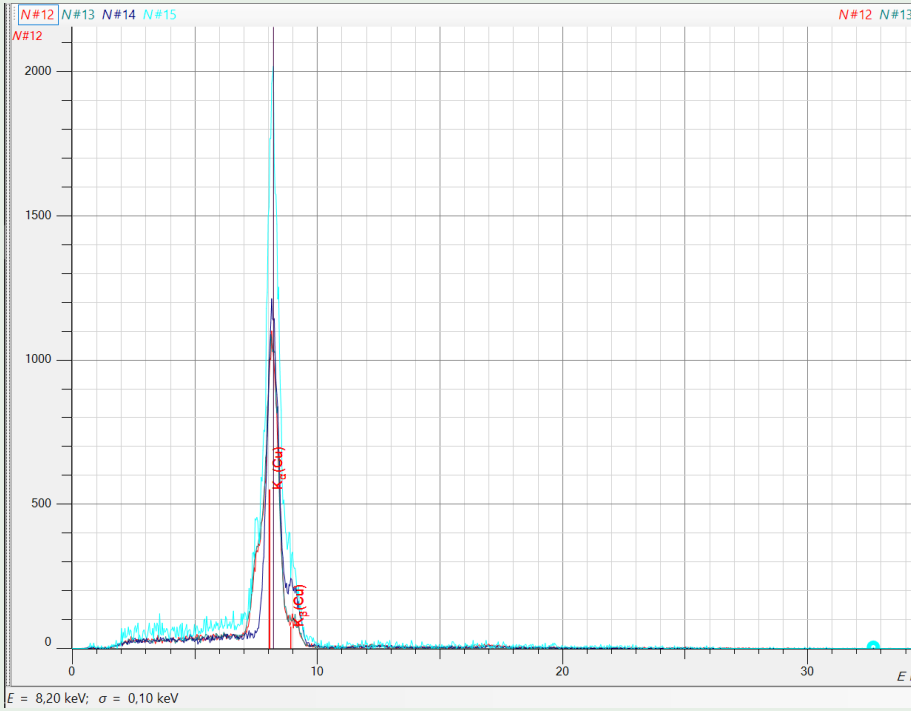


Tabulated values: $K_{\alpha}^{Ge} = 9.88 \quad keV \qquad \epsilon = 0.10\%$

$K_{\alpha}^{Ni} = 7.44 \quad keV \qquad \epsilon = 1.47\%$

$K_{\alpha}^{Br} = 11.92 \quad keV \qquad \epsilon = 2.18\%$

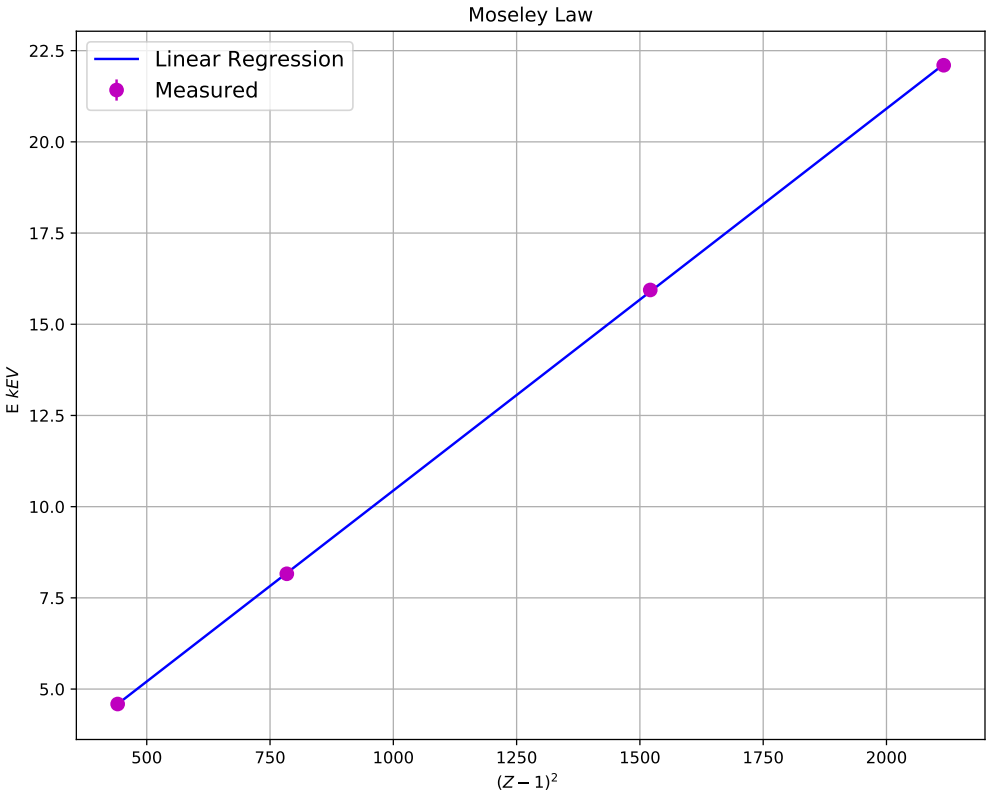
Coins



Tabulated value:

$K_{\alpha}^{Cu} = 8.04 \quad keV \quad \epsilon = 1.99\%$

Verification of Moseley Law



$$y = a \cdot x + b$$

$$a = (0.01047 \pm 0.00030) \quad keV^{-1}$$

$$b = (0.27 \pm 0.41) \quad keV$$

Rydberg constant

$$a = R_y * \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$u_{(R_y)} = \frac{u_{(a)}}{\left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)}$$

$$R_y = (13.958 \pm 0.040) \ eV$$

Comparison with tabulated value

Relative error $\epsilon = 2.60\%$

Discussion of the results and conclusions

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Accuracy of the method

Correct prediction of known samples.

Source of errors

- Contaminated samples
- Incorrect Rate
- Noise

Why did we choose these materials?

After calculating the relative error, these materials best reproduced the accuracy of the method.