

## ELEMENTAL ANALYSIS BY MEANS OF PROTON INDUCED X-RAYS

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Elemental analysis by charged particle induced X-rays<sup>1,2,3)</sup> has been introduced in our laboratory in order to measure the content of sulphur (S) in samples of various plant material. The idea was to use this rather fast and inexpensive method to obtain the content of sulphur in barley and in other cereals. Sulphur is the constituent part of nutritionally very important sulphur amino-acids in cereals. In plant-breeding programs non destructive analytical methods on a single seed basis leaving the embryo intact are very important. The proposed physical method promises to be very convenient: the amount of material used for target preparation is very low ( $\sim 5-10\text{mg}$ ), and the time used to analyse one sample is of order of minutes. Besides sulphur, the content of other elements such as P, Cl, K, Ca, etc. is obtained at the same time.

In experiments the proton beam from 2MV electrostatic accelerator is used. X-ray spectroscopy system consists of Ge Upgrad detector (25  $\mu\text{m}$  Be window), spectroscopy amplifier, ADC, and CDC 1700 on-line computer. The resolution of the system is 170 eV at 5.9 keV.

The targets were made by pipeting the suspension of pulverized sample material in distilled water onto thin mylar foil used as backing. The target thickness was of the order of some 100  $\mu\text{g}/\text{cm}^2$ .

Cs was used as internal standard for the determination of the absolute content of low-Z elements. A small known amount of Cs was mixed in a suspension containing the sample material, before targets were made. Additionally a special "standard" target was made, containing equal number of atoms of Cs and main constituent elements of the sample. This target was made from the water solution of salts of mentioned elements. The X-ray spectra of the "standard" target and of the target containing a barley sample J-14 are shown on Fig. 1. and Fig. 2. res-

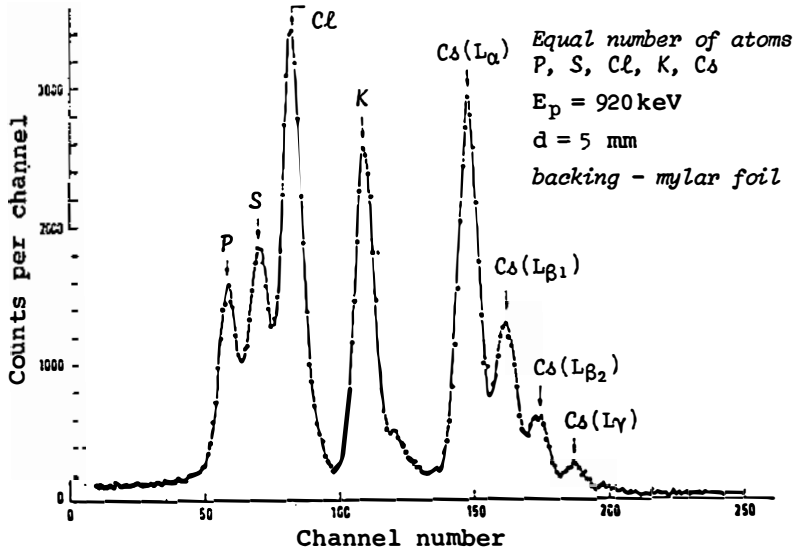


Fig. 1.

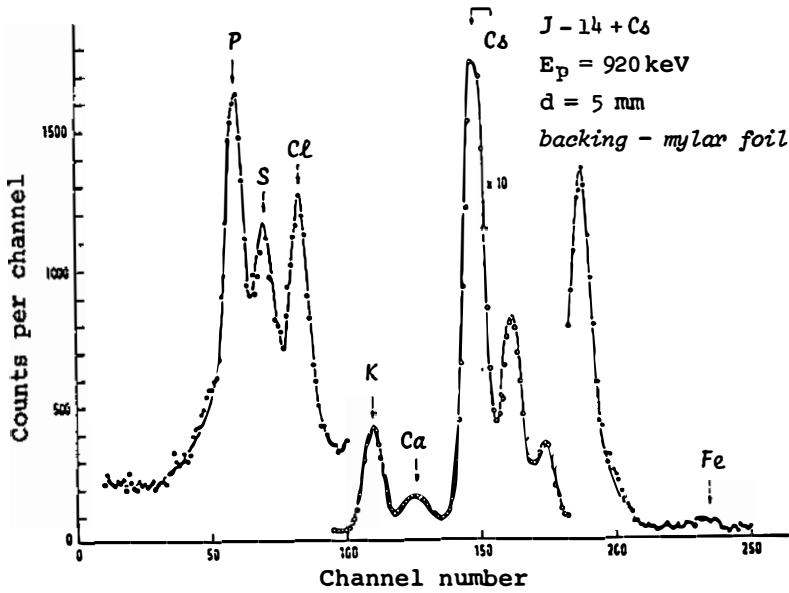


Fig. 2.

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The intensity ratios between low-Z elements K X-rays and Cs L X-rays in a "standard" spectrum contain all informations about Z-dependence of X-ray yields at given proton energy, absorption of X-rays in thin windows (target, chamber and detector), and the geometry of the experiment (detector - target distance, detector efficiency). Using these intensity ratios and corresponding ratios obtained from the spectra measured on targets, where the sample material was marked by internal standards (Cs), it was possible to calculate the absolute content of P, S, Cl, and K in barley J-14. The essential condition was to perform the experiments always at the same proton beam energy and geometry. We estimate the error of quantitative determination of elemental content as 10-20%.

#### REFERENCES

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