NEW MEASUREMENT OF K^--MASS

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For the first time the experiment in which the crystal-diffraction method is used for kaonic atom X-ray study has been carried out [1]. The application of this method increased metrological precision of measurements and reduced a probability of systematic error due to high resolution and choice of a light nucleus as a target.

The installation is situated on the IHEP proton accelerator. The main part of the installation is a crystal spectrometer of Cauchios type with a target irradiated by proton beam as a source of kaonic atom X-rays.

The $4f$—$3d$ transition of $K^- - {}^{12}C$ atom selected for measurement has several advantages: the electron screening is negligible, the strong interaction is small and the effect to background ratio is optimal for region near transition energy ($\approx$ 22.1 *keV*). The luminosity of the spectrometer in this region is $2 \cdot 10^{-9}$ and the resolution is 6.3 *eV*.

The accummulation of the kaonic data alternated with the calibration measurements of electronic Ag X-rays and ${}^{182}Ta$ gamma-rays. The energies of the Ag K_α-lines were corrected in accordance with the last adjustment of the physical constants [2]: $E(\mathrm{Ag}K_{\alpha 1})$=22.163022 (30) *keV* and $E(\mathrm{Ag}K_{\alpha 2})$ =21.99043(16) *keV*.

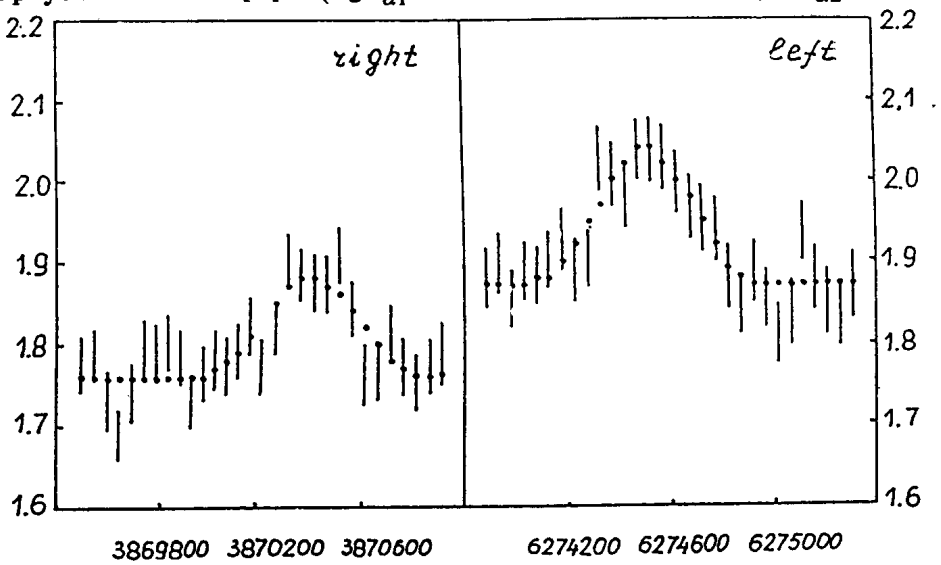

Fig. Right and left reflexes of $4f$-$3d$ transition of $K^- - {}^{12}C$ atom. Interferometer readings are plotted on horizontal axis and count rate per 10^{12} protons is plotted on vertical axis. Experimental points with errors are shown by vertical dashes and fit results are shown by bold points

The two symmetrical reflexes (right and left) of each line have been measured. The instrumental line shape of the spectrometer has been determined by the measurement of the line shape of 67.75 keV gamma-rays from ^{182}Ta. The line shape for fitting has been obtained by convolution of the instrumental line shape with Lorentz distribution. The distribution had the recommended widths for electronic X-rays and the calculated ones for mesic X-rays. The device constant which is a product of a line energy and a distance between its left and right reflex positions in the interferometer readings has been determined by weighting values for $AgK_{\alpha 1}$ and $AgK_{\alpha 2}$ lines. The kaonic line reflexes (see fig.) have been fitted as single peaks because resolution of the spectrometer was at least one order of magnitude smaller than fine and isotopic splitting. The value (22105.61 ± 0.26) eV has been obtained for kaonic transition energy.

The K^--mass has been determined by fitting the calculated transition energy to the measured one. The transition energy has been calculated by numerical integration of the Klein-Gordon equation with a finite size nuclear potential. This potential consisted of Coulomb interaction, vacuum polarization up to third order terms and optical potential of strong meson-nuclear interaction with standard parameters. The Fermi distribution with two parameters has been used to describe nuclear density. The relativistic recoil correction, nuclear polarization correction, electron screening correction, recoil of nucleus and Lamb shift were taken into account. The calculation uncertainty is negligible compared with the experimental error. The result for the mass is $m_{K^-} = (493.6960 \pm 0.0059) MeV$, and this value significantly differs from the world average [3].

As a test the $4d$-$2p$ transition of $\pi^- - {}^{12}$C atom has been measured simultaneously with the K^--atomic transition. The measured energy of the pionic transition is (24828.36 ± 0.15) eV, the calculated one is (24828.3 ± 0.4) eV. A good agreement between these values confirmed the correctness of the method.

References

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3. *Aguilar-Beniyez M. et al. //Phys.Lett.B. 1990. 239. 1.*