LONGITUDINAL POLARIZATION OF β ELECTRONS FROM Au^{198}

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The ratio of the polarization of electrons from Au^{198} and Tm^{170} has been measured for energies of 145 kev and 390 kev. This ratio is equal to 0.8 ± 0.05 at 145 kev; a value 1.07 ± 0.08 has been obtained at 390 kev.

MEASUREMENTS of the longitudinal polarization of β electrons from different elements carried out during the last few years show that in a region in which the β-electron energies are not too low the longitudinal polarization is close to $-v/c$ for all elements investigated. An exception is RaE, for which a deviation from the above value[1,2] of the longitudinal polarization was expected, in view of the fact that its β spectrum differs from the Fermi shape. This deviation was observed shortly afterwards and studied in detail in several experiments.

In the case of Au^{198}, some authors observed complete polarization of electrons ($P = -v/c$ chiefly at medium and high energies,[3,4] and other authors, a considerably smaller polarization, at medium and low energies.[5] We have repeatedly obtained (in reference 4 and earlier) values appreciably less than $-v/c$ for the polarization of low-energy electrons from Au^{198}. But since the apparatus employed was not sufficiently adapted to the strong γ background accompanying the Au^{198} β decay, we were obliged to restrict the measurement of the polarization of electrons from Au^{198} only to energies higher than the maximum energy of the electrons efficiently generated in the apparatus by γ rays from the source. Otherwise, it would have been very difficult in principle to take into account the distortion of the results by the electron background from γ rays.

In the present work, in order to determine the value of the polarization of low-energy electrons from Au^{198}, we used an apparatus constructed on the same principle as that in reference 4, but considerably improved and adapted to work with β sources having a strong γ background.

The polarization was measured in two energy regions — in the low-energy region (145 kev) of interest to us and, for comparison, in the high-energy region (390 kev), where, according to our previous measurements,[4] the polarization is equal to $-v/c$.

The measurements were carried out by the relative method used earlier.[2] Identical samples of Au^{198} and Tm^{170} served, in turn, as the source in the apparatus. The corrections which had to be applied to the measured values were mainly the same for Au^{198} and Tm^{170} samples. Therefore, they compensated each other and were practically eliminated from the relative value of the longitudinal polarization of electrons from Au^{198}.

For β electrons from Au^{198} with mean energy of 145 kev (interval width about ±60 kev), the value of the longitudinal polarization relative to Tm^{170} was $P_{Au}/P_{Tm} = 0.80 \pm 0.05$. In this value, the azimuthal asymmetry of Au^{198} was increased by + 1.8% to compensate for the action of 76, 126, 145, 147 kev unpolarized conversion electrons emitted by Au^{199}, which is formed during the preparation of the source in the reactor from Au^{197} through Au^{198} as a result of the capture of two neutrons.[6] The amount of Au^{199} was determined by a calculation based on the irradiation time of the Au^{197} sample in the reactor, the thermal neutron flux density, and the respective capture cross sections.

The relative longitudinal polarization of 390 kev electrons (interval width of the order of ±100 kev) from Au^{198} turned out to be $P_{Au}/P_{Tm} = 1.07 \pm 0.08$, in agreement with the previous measurements. Here, a correction of + 8% was introduced into the azimuthal asymmetry of Au^{198} in connection with the presence of conversion electrons from the 411-kev γ line of Au^{198}. The contamination from internal conversion electrons in the stream of β electrons which experienced scattering by 90° on the scatterer—transformer was determined by direct measurement on a β spectrometer.

Recent measurements of Spivak and Mikaélyan[7] gave for 240-kev electrons from Au^{198} a polarization equal to $-(0.89 \pm 0.025)\ v/c$.

Analysis of the possible reasons for the deviation of the value of the longitudinal polarization of Au^{198} from $-v/c$ was given by Geshkenbeĭn and Rudik.[8] They showed that in heavy nuclei, one should expect, for the first-forbidden transitions in the β spectrum regions which differ from the Fermi shape, a deviation of the value of the longitudinal polarization of electrons from $-v/c$, since the shape of the β spectrum and the value of the longitudinal polarization are determined by the same combinations of the same parameters. The β-electron spectrum of Au^{198}, according to the data presented in the survey in reference 9, has a Fermi shape for electrons of energy greater than 300 kev and appreciably differs from a Fermi shape for electrons of lower energy.

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