THE THEORY AND DIRECT OBSERVATION OF CONTROLLING (BREAKING) SPONTANEOUS GAMMA-DECAY OF RADIOACTIVE NUCLEI

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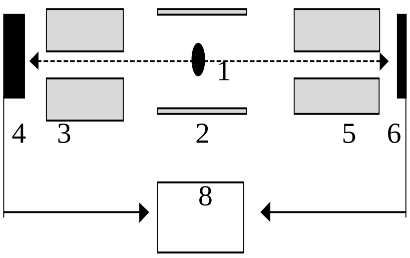
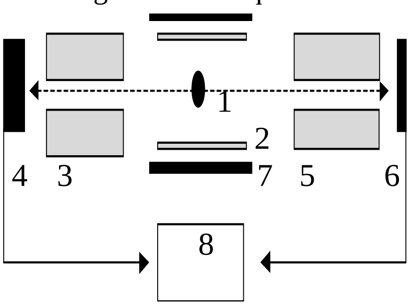
The paper discusses the theory of controlling gamma-radioactivity of nuclei and results of direct experimental investigation of the phenomenon of controlling the probability of spontaneous gamma-decay and life-time of radioactive $Co^{57}(Fe^{57*})$ source. For the first time we have created the theory of influence on the probability of spontaneous radiation and life-time of gamma-radioactive nuclei [1]. We have considered the general system which included the gamma-radioactive source (excited nuclei), the system of these nuclei electrons, the system of zero-energy (in vacuum state) electromagnetic modes and the system of resonant or non-resonant atoms (screen) situated at the large distance $L>>\lambda_{eg}$ from the excited nucleus. The phenomenon of spontaneous nucleus decay controlling is a result of interaction of the excited nucleus with zero-energy electromagnetic modes and interaction of these modes with controlled and controlling screen.

It is shown that the decay parameters greatly depend on the sign and magnitude of the radiation shift (radiation correction) of the resonance level position. This shift is determined by processes of nucleus interaction with all zero-energy electromagnetic field modes. It was shown that the resonant screen effect in all cases appears to be more significant than for the nonresonant one. It was shown also for the first time that the most influence on the nucleus spontaneous decay process will be realized in the case when the modes of the electromagnetic field in the zero-energy state, which interact with the nucleus, occur to be mutually synchronized. For this case the radiative life-time may be increased by many orders of magnitude.

In our previous investigations the phenomenon of controlled decay was studied by the indirect methods both intensity [2] and spectral width [3] measurements of the emitted gamma-radiation. The aim of the present experiment was to investigate the law of controlled gamma-decay of radioactive $Co^{57}(Fe^{57*})$ nucleus by the direct method of delayed gamma-gamma coincidence.



A $Co^{57}(Fe^{57*})$ radioactive isotope with energy $h\omega_{21}$=14,4 KeV was used as a source of controlled (suppressed) Mossbauer gamma-radiation 1. In the first case the source was put in the center or near the edges of the thin resonant screen 2, had a form of cylinder made of stable Fe^{57} isotope. In the second case another thick cylinder 7 made of lead was put around the resonant absorber cylinder. It totally absorbs both resonant and non-resonant radiation in the range of energies close to $h\omega_{21}$=14,4 KeV. Behind the diaphragm 3 there was an amplitude detector 4 (thick NaJ(Tl) crystal) for detecting of first quantum of decay gamma cascade with energy E_{32} = 122 KeV. Behind the diaphragm 5 there was another amplitude detector 6 (thin NaJ(Tl) crystal) for detecting the second quantum of decay cascade with energy E_{21} =14,4 KeV. The law of gamma-decay of the second transition of the cascade in the final ground state of Fe^{57} nucleus was the object of our investigation. Two signals from the detectors 4 and 6 were used for measuring of time-dependent law of gamma-decay in the processing system 8. In the experiments we have discovered the change (increase) of radiative life-time of radioactive nucleus Fe^{57*} by 10-40 % (in relation to resonant Mossbauer gamma-channel of decay) and total life-time (including non-controlled non-Mossbauer gamma-radiation and non-controlled electron conversion channels of decay of an excited nucleus) by 1 %. For the first time the magnitude $\Delta\omega_0 \approx 10^{11}$ s^{-1} and positive sign of the radiative shift of first excited nuclear level of Fe^{57} nucleus (nuclear analogy of the electron Lamb shift) were founded in these experiments. The outcomes of the experiment correspond to the predictions of the controlled gamma-decay theory [1].



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