DISCHARGE OF METASTABLE NUCLEI DURING MUON CAPTURE: BASIS'S OF NEW NUCLEAR SENSORS

A.V.Glushkov[2] , O.Yu.Khetselius[1] , Yu.V.Dubrovskaya[2]
[1]*I.I.Mechnikov Odessa National University, Dvoryanskaya str.2, Odessa, 65001,*
E-mail: okhetsel@paco.net
[2]*Odessa State Environmental University, P.O.Box 24a, Odessa, 65009*
E-mail: glushkov@paco.net

A negative muon captures by a metastable nucleus may accelerate the discharge of the latter by many orders of magnitude [1,2]. For a certain relation between the energy range of the nuclear and muonic levels the discharge may be followed by the ejection of a meson, which may then participate in the discharge of the other nuclei. These processes can be considered as theoretical basis's for creation of the new type nuclear sensors. Here we present consistent theory of such processes, based on the new, QED energy approach (EA) [3-5] to calculating characteristics for the discharge of a nucleus with emission of γ quantum and further meson conversion, which initiates this discharge. The intensities of satellites (decay probability) are linked with imaginary part of the "nucleolus core+ proton +meson" system. Three channels should be taken into account: 1). radiative purely nuclear 2j-poled transition (probability *P1;* this value can be calculated on the basis of known traditional formula); 2). Non-radiative decay, when a proton transits into the ground state and a meson leaves the nuclei with energy *E=E(p-N1J1)-E(i),* where *E(p-N1J1)* is an energy of nuclear transition, *E(i)* is an energy of bond for meson in the *1s* state *(P2);* 3). A transition of proton into the ground state with excitement of meson and emission of the γ quantum with energy *E(p-N1J1)-E(nl)* (*P3*). Under condition *E(p-N1J1)>E(i)* a probability definition reduces to QED calculation of probability of the autoionization decay of the two-particle system. Numerical calculation is carried out for the Sc nucleus. The probabilities of the meso atom decay for different transitions: $P2(p_{1/2}-p_{3/2})=3{,}93*10^{15}$, $P2(p_{1/2}-f_{7/2})= 3{,}15*10^{12}$, $P2(p_{3/2}-f_{7/2})=8{,}83*10^{14}$. For above indicated transitions the nucleus must transit the momentum no less than 2,4 and 2 according to the momentum and parity rules. If a meso-atom is in the initial state $p_{1/2}$, than the cascade discharge occur with ejection of meson on the first stage and the γ quantum emission on the second stage. To consider a case when the second channel is closed and the third one is opened, suppose: $E(p_{1/2})-E(p_{3/2})=0.92$ MeV. Energy of nuclear transition is not sufficient to transit the meson into the continuum state and it may excite into the 2p state. In this case there is the proton transition pl/2-p3/2 with virtual excitement of meson into states of series nd and γ quantum emission with energy $\hbar\omega=E_p(p_{1/2})+E_\mu(ls)- E_p(p_{3/2})-E_\mu(2p)$.The dipole transition 2p-ls occurs with probability: $P3=l.9*10^{13}$ s^{-1} that is more than probabilities of the $P_{1/2}-P_{3/2}$ and $p_{1/2}-f_{7/2}$ transitions without radiation.

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