OPTIMAL LASER IONIZATION SCHEME FOR SEPARATING LONG-LIVED ACTINIDES AND FISSION PRODUCTS IN NUCLEAR FUEL

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Using the modern nuclear-energy cycle is connected with several known serious risks, e.g. content of the dangerous radio nuclides in working nuclear fuel. One of the possible solutions is using gamma-neutron transmutation method. To make more effective transmutation one must usually take into account that the targets should be made of the nuclear isotopes fractions of ^{90}Sr, ^{137}Cs and the iodine fraction too (as a rule, the most radio toxical ^{129}I isotope). It is further necessary to transmute ^{90}Sr,^{137}Cs, ^{129}I isotopes to stable ones. The problem here is separation of the ^{90}Sr, ^{137}Cs and ^{129}I isotopes from the stable ^{88}Sr, ^{133}Cs and ^{127}I. The main purpose of the work is carrying out the optimal laser photoionization schemes for separating long-lived actinides and nuclear fission products, namely, Sr, Cs, I. Though the nuclides fractions of Zr, Pd, Sn, Tc and rare-earth isotopes should not be transmuted as the middle activity nuclear fusion coils, we define optimal isotopes laser separation parameters in this case too. The optimal laser photoionization scheme is based on laser excitation of isotopes into excited Rydberg states and further autoionization (first mechanism) and stochastic collisional ionization (second mechanism). To carry out computer modelling optimal scheme parameters for the ^{88}Sr, ^{133}Cs, ^{127}I, ^{93}Zr, ^{99}Tc, ^{107}Pd, ^{126}Sn, ^{151}Sm, $^{238-242}$Pu, $^{241-243}$Am,$^{242-244}$Cm, Cf, U isotopes separating and detecting we used the optimized perturbation theory code, the Focker-Plank stochastic equation method, density matrices formalism [2,3]. As example let us consider the laser separation scheme for $^{235-238}$U isotopes. It includes the following steps: i). Laser excitation of the ^{235}U isotopes from the ground $5f^3 6d7s^2$-$^5L_6^o$ state and low lying metastable $5f^3 6d7s^2$-$^5K_5^o$ state with energy 620,32 $см^{-1}$; ii). Transition to the autoionization state with doubly excited external shell and then autoionization (laser field). A scheme for sensing the nuclear reaction products is considered on example of the spontaneous fusion ^{252}Cf isotope on the unsymmetrical coils (Cs). Laser ionization sensing Cs isotopes is based on resonant excitation Cs ($6^2S_{1/2}$-$7^2P_{3/2}$,4555Å;$6^2S_{1/2}$-$7^2P_{1/2}$,4593Å) and further autoionization.

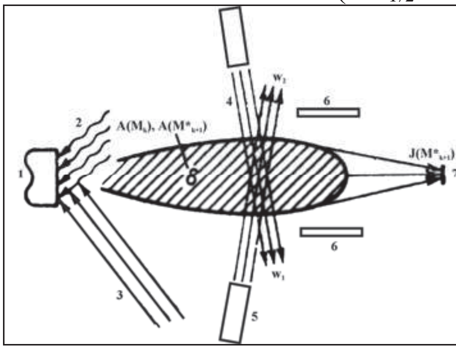

Fig. The laser photoionization sorting excited nuclei M^*_{k+1} with electric field and autoionization mechanisms: 1 – target of atoms M_k; 2- flux of slow neutrons; 3 – laser ray for evaporation of target; 4 – laser ray for the first step excitation of atoms with excited nucleus $A(M^*_{k+1})$; 5 – laser ray for 2-step excitation to Rydberg states and autoionization or ionization by external electric field; 6 – collector system; 7 - atoms with excited nucleus $A(M^*_{k+1})$; 8–flux of evaporated atoms;

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