EFFECT UPON CHARACTERISTICS OF NUCLEAR ISOMERIC STATES BY SYNCHROTRON RADIATION

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The excitation and decay of nuclear isomeric states in the synchrotron radiation field are theoretically investigated. In the calculations of the probability of these processes a radiation from the synchrotron of the third generation (Spring-8, Japan) is used. This synchrotron produces electromagnetic waves with the photon energies up to 300 MeV. Such radiant energy range assumes a research of the direct action of a radiation on the nuclear state characteristics. In addition the synchrotrons of the third generation produce high-power radiation of the frequency continuous spectrum (from the wiggler) or even more high-power radiation of the frequency line spectrum (from magnetic undulators). These properties of the synchrotron radiation make much more effective its influence on nuclear characteristics than the laser emission action.

We investigated the excitation and decay of isomeric states in nuclei having two lower excited states. One of them is the isomeric state having the E^* energy and J^* total spin. The other one is the excited state which has the E energy in less than 250 MeV. Besides the J total spin of this state is such one that the electromagnetic transitions of the low multipolarity in the ground state and isomeric state are probable. These nuclei with the reliable values of the experimental characteristics are: ^{58}Co (the total spin of the ground state is $J_0=2^+$; $E^*=24.95$ keV, $J^*=5^+$; $E=53.15$ keV, $J=4^+$), ^{94}Nb ($J_0=6^+$; $E^*=40.89$ keV, $J^*=3^+$; $E=58.71$ keV, $J=(4)^+$); ^{96}Tc ($J_0=7^+$; $E^*=34.23$ keV, $J^*=4^+$; $E=45.28$ keV, $J=5^+$); ^{144}Pr ($J_0=0^-$; $E^*=59.03$ keV, $J^*=3^-$; $E=99.95$ keV, $J=2^-$); ^{171}Lu ($J_0=7/2^+$; $E^*=71.13$ keV, $J^*=1/2^-$; $E=73.01$ keV, $J=5/2^-$); ^{189}Os ($J_0=3/2^-$; $E^*=30.81$ keV, $J^*=9/2^-$; $E=69.54$ keV, $J=5/2^-$); ^{191}Os ($J_0=9/2^-$; $E^*=74.38$ keV, $J^*=3/2^-$; $E=131.94$ keV, $J=5/2^-$); ^{235}U ($J_0=7/2^-$; $E^*=0.0765$ keV, $J^*=1/2^+$; $E=51.71$ keV, $J=5/2^+$). The rates of the excitation processes of the nuclear isomeric states are calculated by using the Breit-Wigner formula and well-known forms of the electromagnetic spectra of the Spring-8 synchrotron [1]. Single-particle estimations of the radiation widths of the transitions are used. It is obtained that the quantities of these rates are in the $(10^{-11}–10^{-9})$ c^{-1} range. Only the ^{171}Lu isotope with a very small energy of the $5/2^-\rightarrow1/2^-$ transition is an exclusion. In this case the rate of the isomeric state excitation is the 2.3×10^{-19} c^{-1}. Sometimes the experimental widths of the radiation transitions were known. The rates of the excitation processes of the isomeric states calculated by using these widths were differed from the average by one order of the magnitude from the rates received by using single–particle widths.

1. http://www.spring8.or.jp