

Study of photonuclear reactions with the charged particles emission for the zirconium-89 production

Thursday 23 September 2021 17:20 (25 minutes)

Zirconium-89, with a half-life of 3.3 days, is one of the most promising radioisotopes for nuclear imaging based on monoclonal antibodies (Immuno-PET). Immuno-PET studies require that the half-life of the diagnostic radioactive isotope coincide with the biological half-life of the carriers (monoclonal antibodies), which exceeds 24 hours and averages 2-6 days. Thus, the half-life of ^{89}Zr ideally matches the half-life of antibodies, and the average positron energy of 395 keV allows for high-resolution PET images.

Currently, the production of Zr-89 is carried out mainly in reactions with protons and deuterons. Accelerators of these particles are complex and expensive to maintain. A promising method for obtaining zirconium-89 is the use of widespread and economic electron accelerators.

However, it is tough to obtain the required radionuclide from the $^{90}\text{Zr}(\gamma, n)^{89}\text{Zr}$ reaction. It is difficult to isolate the Zr-89 from an irradiated zirconium matrix. Therefore, we have carried out studies of reactions with the emission of alpha particles. We studied $(\gamma, \alpha n)$ and (γ, α) -reactions on natural molybdenum, molybdenum enriched in the ^{94}Mo isotope, natural zirconium, and natural niobium.

The experimental weighted average yields of the reactions under study at the boundary energy of bremsstrahlung gamma quanta of 20 MeV are as follows:

$^{90}\text{Zr}(\gamma, \alpha n)^{85}\text{Sr}$: 0.030 ± 0.015 mbn

$^{96}\text{Zr}(\gamma, \alpha n)^{91}\text{Sr}$: 0.15 ± 0.05 mbn

$^{93}\text{Nb}(\gamma, \alpha n)^{88}\text{Mo}$: 1.16 ± 0.12 mbn

$^{93}\text{Nb}(\gamma, \alpha n)^{88}\text{Mo}$: 0.97 ± 0.10 mbn

$^{94}\text{Mo}(\gamma, \alpha n)^{89}\text{Zr}$: 1.04 ± 0.09 mbn

$^{100}\text{Mo}(\gamma, \alpha n)^{95}\text{Zr}$: 0.03 ± 0.01 mbn

$^{99}\text{Mo}(\gamma, \alpha)^{88}\text{Zr}$: 0.081 ± 0.009 mbn

The obtained data are discussed.

The reported study was funded by RFBR according to the research project 20-315-90124.

Primary author: ZHELTONOZHSKAYA, Marina (Lomonosov Moscow State University)

Co-authors: Prof. ZHELTONOZHSKY, Viktor (Lomonosov Moscow State University); Mr REMIZOV, Pavel (Lomonosov Moscow State University); Prof. CHERNYAEV, Alexandr (Lomonosov Moscow State University)

Presenter: Mr REMIZOV, Pavel (Lomonosov Moscow State University)

Session Classification: Section 2. Experimental and theoretical studies of nuclear reactions

Track Classification: Section 2. Experimental and theoretical studies of nuclear reactions.