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Isotope production in ^{209}Bi photoactivation induced with a laser-driven photon source.

Photonuclear reactions are a powerful tool to probe the quantum structure of the atomic nucleus by inducing single-particle and collective excitations [1], and also played a significant role in the first moments of our universe or later in stellar nucleosynthesis processes [2]. These reactions are also of great interest because of their many societal applications, such as national security, γ -ray imaging or the production of isotopes for medical applications [3]. The study of these reactions has traditionally been carried out using broadband energy bremsstrahlung sources driven by linear electron accelerators [4]. More recently, laser Compton backscattering has been used to produce quasi-monochromatic gamma beams [5]. The development of high-power lasers offers new possibilities for the study of photonuclear reactions [6], especially at energies beyond the giant dipole resonance (GDR) region, which are mostly covered until now by existing technologies. γ -beams above tens of MeV up to a few hundred MeV would open up the possibility of studying the photon-nucleus interaction in a poorly understood regime [7], but also provide access to isotope production at energies well above the nucleon emission threshold.

In this contribution we will present one of the first attempts to study the isotope production in multi-nucleon emission reactions induced by a laser-driven photon source. The experiment was carried out at HZDR-Rossendorf. The 4.5 J laser pulses delivered by the 150 TW DRACO system hit a gas-jet target and produced 1 nC electron pulses with energies above 350 MeV. A tantalum converter was then used to produce bremsstrahlung photons with energies up to about 350 MeV. Photoactivation reactions induced by these electrons on a ^{209}Bi target were studied using γ -spectroscopy techniques. 23 different isotopes of bismuth, lead, tantalum and mercury have been unambiguously identified and the production yields measured for many of them. The identification of final isotopes such as ^{191}Hg , produced after the emission of three protons and fifteen neutrons, demonstrates that photonuclear reactions have been induced in the energy regime well above the GDR. These results open up the possibility of using high power lasers to produce isotopes of interest with a large difference in neutron and proton content with respect to the closest stable isotopes in the chart of nuclides.

[1] N. Pietralla, J. Isaak, and V. Werner, Eur. Phys. J. A 55, 237 (2019)

[2] T. Raucher, Nucl. Phys. News 28, 12 (2018)

[3] A. Zilges, et al., Prog. Part. Nucl. Phys. 122, 103903 (2022)

[4] U.S. DOE, 2015 NSAC Report, <https://www.osti.gov/biblio/1298983>.

[5] K. Aoki et al., Nucl. Instrum. Meth. A, 516, 228 (2004)

[6] K.A. Tanaka et al., Matter Radiat. Extermes 5, 024402 (2020)

[7] B.S. Huang et al., Phys. Rev. C 95, 034606 (2017)

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