

PRODUCTION OF HEAVY NEUTRON-ENRICHED NUCLEI WITH THE MAGIC NUMBER $N=126$ IN THE RIB-INDUCED MULTINUCLEON TRANSFER REACTIONS

The report is devoted to the theoretical study of the problem of producing heavy neutron-rich nuclei with the closed neutron shell $N=126$. Data on the lifetime of such new nuclei, as well as mass, decay modes, excited levels, etc., are of great value for testing and developing theoretical models of atomic nuclei. Also, these nuclei form one of the special waiting points in the r-process path, and hence their properties are of great importance in understanding the detailed scenario of the r-process of astrophysical nucleosynthesis.

Nuclei near the region of closed neutron shell $N=126$ were produced in fragmentation reactions of high-energy heavy projectiles on light targets. Currently, the possibility of studying new isotopes in this area using multinucleon transfer (MNT) reactions is widely discussed. One of the most optimal combinations of colliding nuclei, in which multinucleon transfers lead to the formation of heavy neutron-enriched nuclei with high probability, is $^{136}\text{Xe} + ^{198}\text{Pt}$. The calculations performed within the framework of the dynamic model based on Langevin equations [1] describe quite well the available experimental data for this reaction [2,3].

In this work, one of the possible extensions of this method is studied: the use of neutron-rich radioactive ion beams (RIBs) in MNT reactions [4]. On the one hand, more neutron-rich projectile leads to an increase in the production cross section of heavy nuclei with a neutron excess, but on the other hand, lower RIB intensities reduce the final yield of reaction products. In this work, we present theoretical analysis of the yields of heavy neutron-rich isotopes with the magic number $N=126$ obtained in the ^{132}Sn , ^{136}Xe , ^{138}Xe , $^{140}\text{Xe} + ^{198}\text{Pt}$ MNT reactions.

Finally, we have obtained an exponential increase of the cross sections of heavy isotopes with magic number $N=126$ (such as ^{202}Re , ^{200}W) with increasing the N/Z ratio of projectile in combination with the same target. However, the production rate in the RIB-induced reactions is at least an order of magnitude lower than in the reactions with a stable projectile, due to the much lower RIB intensities currently available.

[1] A.V. Karpov, V.V. Saiko // Phys. Rev. C —2017. —Vol. 96. —P. 024618.

[2] Y. X. Watanabe et al. // Phys. Rev. Lett. —2015. —Vol. 115. —P. 172503.

[3] V. V. Desai et al. // Eur. Phys. J. A —2020. —Vol. 56. —P. 150.

[4] V.V. Saiko, A.V. Karpov // Phys. Rev. C —2024. —Vol. 109. —P. 064607.

Section

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