C1. DESCRIPTION FOR THE GENERAL PUBLIC

1. State the objective of the project

The main aim of the project is to evaluate the optimal conditions for a detailed knowledge of the nuclear excitation by electron capture (NEEC) process for selected nuclear isomers (i.e. metastable exited states of atomic nuclei) of a few elements. The part of planned studies focuses on the especially interesting and important case of NEEC process for the ^{93m}Mo isomer ($T_{1/2}$ ~ 6.8 h), for which the NEEC process has been registered for the first time, with a significant contribution of Principal Investigator, on the world's most powerful Digital Gammasphere Spectrometer, installed in the linear accelerator (ATLAS) at Argonne National Laboratory in the USA.

2. Describe the research to be carried out

In order to detailed knowledge of the NEEC processes for selected nuclear isomers of a few elements it is necessary to comprehensively take into account all atomic and nuclear processes, which are essential for observation of these processes. Therefore, in the framework of this project will be realized the following detailed research tasks:

- **(i)** determining the energy released by electron capture into different subshells of the L shell for ^{93m}Mo isomer in the dependence on the ionization degree and assumed electronic excited configuration;
- **(ii)** obtaining the dependence of the equilibrium charge state for ^{93}Mo ions from their kinetic energy during the penetration through different solid targets;
- **(iii)** evaluation of the NEEC resonance window widths for ^{93m}Mo isomer in the case of electron capture into L shells for the assumed electronic excited configurations;
- **(iv)** selecting other effective reactions for the production of the ^{93m}Mo isomer;
- **(v)** evaluation of the resonance conditions for NEEC process in the case of electron capture into L, M and N shells of the ^{93m}Mo isomer for assumed electronic configurations and various stopping targets;
- **(vi)** comprehensive analysis and theoretical interpretation of registered NEEC process for the ^{93m}Mo isomer on Gammasphere spectrometer for various scenarios, i.e. the types and energies of beam;
- **(vii)** designing the optimal conditions of the NEEC process observation for ^{242m}Am isomer on Gammasphere spectrometer for various types and energies of beam;
- **(viii)** designing the optimal conditions of the NEEC process observation for isomers of few other elements than ^{93m}Mo and ^{242m}Am isomers for different beam scenarios.

3. Present reasons for choosing the research topic

The pioneering character of the above issues and the difficulties in observing for 40 years the NEEC process, encouraged the Principal Investigator of this project to begin the study for ^{93m}Mo isomer, which has led to a close cooperation with the J. J. Carroll group, from the U. S. Army Research Laboratory. The multitude of aspects, which have to be considered during the designing of such experiments make it necessary to perform an advanced, systematic study from fields such as atomic and nuclear physics. Our selected results of the precise studies concerning the NEEC processes for the ^{93m}Mo isomer have been published by us very recently in ***Physical Review C*** journal. It should be underline that these results and a unique experimental configuration proposed by Principal Investigator and co-workers (for which the crucial elements were: using the Gammasphere spectrometer, optimal construction of the target and the appropriate ion beam energy of ^{90}Zr ions), have allowed the first observation of the NEEC process for ^{93m}Mo isomers, i.e. identify a new physical phenomenon (what has been detailed presented in our article submitted to ***Nature*** journal on 26th May 2017).

Planned within this project studies are concentrated on the comprehensive knowledge and understanding of nature of the NEEC processes for nuclear isomers of a few elements, what have an impact on the development of the theory describing the structure, formation and evolution of high-spin states of nuclei. This knowledge allow to understand the processes occurring in the Universe, and in particular to provide a fundamental information concerning the survival of the nuclei of different isotopes of the elements in stellar environments. The results of the studies will be a starting point for applied research, which aim will be to allow the controlled release of energy stored in the nuclear isomer of selected elements. Moreover, these studies will also contribute to the development of the concept of new, unconventional and ultraefficient nuclear batteries that can be used to propel power vehicles (ships) used in hard-to-reach locations on Earth (at the bottom of oceans and volcanic craters) and in cosmic space.