Popular summary of the project

There are more than 300 natural isotopes on Earth. Additionally, about 3000 radioactive isotopes can be created by a human, using particle accelerators and nuclear reactors. All these isotopes are a subject of nuclear physics investigations. The aim of the investigations is to learn about the principles of the interactions of protons and neutrons. In spite of the fact that the radioactivity was discovered more than 100 years ago (in 1911), the processes which take place inside the atomic nucleus still hide many mysteries.

Some of the known isotopes create a special opportunity to check certain specific aspects of our knowledge of the structure of nuclear matter. Most of the heavy atomic nuclei contains more neutrons than protons. Within the present project, we will study very special nuclei in which numbers of protons and neutrons are identical or similar. In such systems, very special conditions exist, in which non-ovservable in other nuclei interactions of protons and neutrons can be seen.

Some of the nuclei which we plan to study contain about 50 neutrons and 50 protons. The number 50 is one of the so called "magic numbers" of the nuclear physics. Nuclides containing magic numbers of protons and neutrons (counted separately) are especially strongly bound. Properties of the neighbouring nuclei (those which have only slightly different numbers of protons and neutrons) can be described in rather simple manner. It is often assumed that these nuclei are build of out a rigid, magic core and a few nucleons outside the core. By comparing properties of such nuclei measured in experiments with the predictions of theoretical models, very precise verification of selected parameters of these models can be achieved. The nucleus containing exactly 50 neutrons and exactly 50 neutrons is called ^{100}Sn (tin-100). This the heaviest doubly magic nucleus which contains equal number of protons and neutrons. We will thus investigate nuclei in the vicinity of tin 100.

In our study, we will use accelerators which will accelerate some specific nuclei to velocities of about 10% of the speed of light. Such accelerated nuclei (the beam) will heat a "target", which contain another selected isotope. As a result of the interaction of the beam with the target, new nuclei will be created. These nuclei will be highly excited, and they will release this excitation energy by emitting high energy electromagnetic radiation, which is called γ-ray radiation. We will register emitted γ rays and from their properties we will deduce properties of the nuclei.

We use sophisticated sets of detectors. The γ rays will be registered in the co-called germanium detectors. These devices give the most precise information on the energy of γ-ray radiation. In the reaction many different nuclei (isotopes) will be produced, and the production of the nuclei which we are interested in will in fact be rare. So we will need to use special methods to select the rare events. For this purpose we will use detectors of charged particles and neutrons emitted in the reaction. A part of our project concerns building and modifying the neutrons detectors which are used in such investigations. Our experiments will be performed in one of the leading European nuclear physics laboratories: the GANIL laboratory in Caen, France. The preparatory work, as well as the analysis of the data collected in the experiments, will be performed in the Heavy Ion Laboratory in Warsaw.