Search for collective effects in neutron-rich isotopes with Z <38

Doctoral thesis summary

Michał Czerwiński

The purpose of this dissertation was to investigate the properties of atomic nuclei in the area of 86<A<92 with the number of protons Z<38. In particular, we looked for the collective effects in rubidium, krypton, selenium and bromine neutron-rich nuclei.

In our study we used the most modern experimental techniques of nuclear spectroscopy. Among other things it was of importance to use the multidetector arrays of high energy resolution and high gamma-registration efficiency. They allowed us to identify weakly populated excited states of the investigated nuclei and establish their decay patterns. We were collecting experimental data using *EUROGAM II* multidetector array in Strasbourg (France) and *GAMMASPHERE* spectrometer in Argonne (USA). With these two systems γ radiation emitted by spontaneous fission products of ^{248}Cm and ^{252}Cf was measured. To complement these experiments we performed a measurement of fission products induced by cold neutrons of ^{235}U, which allowed us to excite the nuclei rarely populated in the spontaneous fission processes. Emitted γ radiation was measured with multidetector *EXILL* spectrometer in the Laue-Langevin Institute in Grenoble (France). To get a more detailed picture of the studied region we extended our analysis to the excited states populated in β decays. For this purpose we used *MCC30* cyclotrone with *IGISOL-4* mass separator, *JYFLTRAP* ion trap (Finland) and a multidetector γ and β radiation spectrometer built by the Warsaw Spectroscopy Group. This research allowed the identification of many new excited states of neutron-rich nuclei near the edge of the nuclei chart, which were poorly investigated before and to assign some particular values of the parameters describing their features. In particular, we established excitation schemes of ^{87,88,89}Br, ^{90}Rb, ^{88}Kr and ^{86,87}Se. Morover, we complemented the experimental data by the large-scale, shell-model calculations using the *ANTOINE* and *NATHAN* codes.

Very significant result of our analysis is the observation of collective effects, which increase with the decreasing number of protons in the nuclei with N=53. The pattern of the excited states in the investigated N=53 isotones (^{87}Se, ^{88}Br i ^{90}Rb), with three neutrons outside the closed core N=50, is typical of the j^3 multiplet and demonstrates the "j-1 anomaly" characteristic of the single-particle excitations coupled with a collective motion. We observed the strongest collective effects in ^{87}Se isotope, for which the intensity of γ transition is equal to B(E2:5/2+→3/2+)=32 W.u., while the deformation parameter is close to β_2~0.2.

During the process of data analysis we developed new software tools that can be applied also in different studies in nuclear physics.