Exploring the Island of Stability: Spectroscopic Studies of Superheavy Elements and the Synthesis of New Elements Beyond Z=118"

(PHD THESIS subject)

PHD SUPERVISOR: OLIVIER DORVAUX
INSTITUT PLURIDISCIPLINAIRE HUBERT CURIEN, 23 RUE DU LOESS, 67037 STRASBOURG
TEL : 03 88 10 6591 ; E-MAIL : OLIVIER.DORVAUX@IPHC.CNRS.FR

One of the current challenges in nuclear physics lies in extending the study of elements beyond their limits of existence. Thus, the synthesis of new elements with an increasingly higher number of protons (Z=114,116,118) is motivated by the theoretical prediction of an uncharted 'island of stability'. Indeed, very heavy elements provide a unique laboratory for studying nuclear structure and dynamics under the influence of significant Coulomb forces. The stability of nuclei beyond the "doubly magic" spherical nucleus 208Pb (Z=82, N=126) decreases rapidly into the region of so-called transfermium nuclei (Z>100). Hereafter, stability hinges solely on quantum effects This physics program has resonated in recent years with the completion of Mendeleev's famous periodic table of elements through the validation of the elements nihonium (Z=113), moscovium (Z=115), tennessine (Z=117), and oganesson (Z=118).

A decrease in the level density of single-particle states is evient in deformed nuclei around Z=100 and N=152, which reverses the trend of decreasing stability with increasing nucleus mass. The orbitals involved in this deformed region play a crucial role in predicting the positioning of the ultimate stability gain island corresponding to the region of superheavy nuclei. This has led to a resurgence of activity in spectroscopy scientific programs in this field in recent years. The advent of new types of beams and cutting-edge technology allows the exploration of nuclei that were previously poorly understood. Notably, the study of their isomeric states emerges as a potent tool for unraveling and understanding nuclear structure.

The exploration of superheavy elements is therefore the subject of the thesis. The DNE group is strongly involved in the several experimental sites for the spectroscopic study of such nuclei and the synthesis of new elements. First in RIKEN laboratory (Tokyo-Japan), an extensive program for synthesizing the Z=119 element is already underway. The team will be asosciated to the synthesis of the new element Z=120 a both laboratories, the BNL (Berkeley-USA) and in RIKEN labs. The commissioning of the S^3 separator-spectrometer system is underway, promising unmatched production rates for spectroscopic studies of superheavy nuclei at its focal plane. These studies can also be conducted at the laboratories of Jyväskylä (Finland) and Argonne (USA). Thus, the candidate should anticipate and relish the prospect of extensive travels.

Therefore, the candidate is proposed to take charge of an experiment, perform a comprehensive analysis of experimental data, and interpret them in one of these laboratories.