PROPOSAL FOR EXPERIMENT AT RCNP

March 4, 2018

TITLE:
Determination of proton distribution radii of p-sd shell nuclei by Charge Changing Cross Section measurements. (Revised proposal)

SPOKESPERSON:

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EXPERIMENTAL GROUP:

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T.T. Nguyen	PNT Univ. of Medicine/VNU-HCMUS	D3
Y. Ayyad	LBNL	Researcher
W. Lin	Sichuan Univ., China	Assoc. Researcher

RUNNING TIME:

Installation time without beam	5 days
Detector, DAQ startup and beam tuning	1.5 days
Data runs	10.5 days
Total beam	12 days

BEAM LINE: Ring : EN course

BEAM REQUIREMENTS:

Type of particle	^{40}Ar
Beam energy	65A MeV or highest

	Beam intensity	$\geq$ 10 pnA

BUDGET:

	Construction cost of mini MUSIC	1 Myen

SAFETY CONTROLLED ITEMS:

- PR10 gas
- Beryllium

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SUMMARY OF THE PROPOSAL

We propose to measure the charge-changing cross sections (σ_{CC}) of N, O and F isotopes on a carbon target using radioactive beams of energy $\sim$50A MeV. The CCCS, which is the total cross section of all processes that reduce the proton number of a projectile nucleus, is closely related to the proton distribution in a nucleus. The interaction cross sections (σ_I), which is the total cross sections of all processes that change the mass number of a projectile nucleus, have been measured extensively and used to extract the mass radii of stable as well as unstable nuclei. Recently, we have developed a global parameter set for the Glauber model calculation of the σ_{CC} to extract the proton distribution radii of neutron rich nuclei in a wide range of incident energy. Applying our Glauber model to the measured σ_{CC}'s for neutron-rich carbon isotopes, we have shown that the extracted proton distribution radii for $^{12-14}$C are consistent with those from the electron scattering. We have also obtained evidence for a sub-shell closure at Z=6 in the neutron-rich carbon isotopes.

In this proposal, we plan to study the systematic change of the proton distribution radii as well as the neutron-skin thicknesses of neutron-rich N, O and F isotopes. Such experimental data are important to understand the evolution of the shell structure in the p-sd shell nuclei where the clustering effect is also expected to play a substantial role. Besides, these data will also provide important test for the nuclear structure model, especially the *ab-initio* type theoretical models that employ the realistic or chiral effective nucleon-nucleon and three-nucleon forces. It is also important as a part of the developments for the future study on heavier nuclei where we can discuss the relation between neutron skin thickness and EOS of asymmetric nuclear matter.

We plan to use the EN course to produce beams of the radioactive nuclei. The σ_{CC}'s will be measured using the transmission method. The incident beam will be measured by a mini MUlti-Sampling Ionization Chamber (MUSIC) and a plastic scintillator, while the unreacted particle (with the same Z as the beam) exiting the reaction target will be measured by a MUSIC and a NaI(Tl) detector. Measurements will be performed with and without the carbon target to eliminate the effects of reactions in the detector material. Several technical improvements to experimental setup will be implemented to achieve 1% uncertainty in the σ_{CC}'s. The proton distribution radii of N, O, F isotopes will be extracted from the measured σ_{CC} using our Glauber model calculation.