SATBIR KAUR
BSc (Department of Physics), Panjab University, 2010
MSc (Department of Physics), Panjab University, 2012

DEPARTMENT OF PHYSICS AND ATMOSPHERIC SCIENCE

TITLE OF THESIS: DETERMINATION OF PROTON RADII OF NEUTRON-RICH OXYGEN ISOTOPES FROM CHARGE-CHANGING CROSS SECTION MEASUREMENTS

TIME/DATE: 2:00 pm, Monday, July 16, 2018

PLACE: Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Remco Zegers, Department of Physics and Astronomy, Michigan State University (External Examiner)

Dr. Adam Sarty, Department of Astronomy and Physics, Saint Mary's University (Reader)

Dr. Daniel Labrie, Department of Physics, Dalhousie University

Dr. Rituparna Kanungo, Department Astronomy and Physics, Saint Mary's University (Co-Supervisor)

Dr Scott Chapman, Department of Physics, Dalhousie University (Co-Supervisor)

DEPARTMENTAL REPRESENTATIVE: Dr. Stephen Payne, Department of Physics, Dalhousie University

CHAIR: Dr. Alex Speers, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

The nuclear charge radius is an important bulk property of the nucleus for investigating nuclear structure. The nuclei lying close to the boundaries of the nuclear chart (the drip lines) have revealed new exotic features like the halo and skin. Another new phenomenon that has emerged in the neutron-rich region is the changing or vanishing of magic numbers. The systematic study of the proton radii along an isotopic chain is crucial for understanding the halo and skin formation and also the shell evolution in neutron-rich nuclei near the drip-line. We present the first determination of the proton radii of neutron-rich oxygen isotopes. The proton radii of $^{16,18-24}$O were measured using the charge-changing cross sections, σ_{cc}, which is the total cross section for the change of the atomic number of the projectile nucleus due to any interaction with the protons in the projectile nucleus. The experiment was performed at the fragment separator (FRS) at GSI, Germany, at a relativistic beam energy of around 900*A* MeV. The proton radii were extracted from the measured σ_{cc} using the finite-range Glauber model analysis. The measured proton radii of stable isotopes of oxygen, ^{16}O and ^{18}O, are consistent with the proton radii derived from the electron scattering experiments. A decrease in proton radii of ^{22}O and ^{24}O was observed, showing signatures of the unconventional shell closures at N = 14 and N = 16. This thesis also reports the first determination
of neutron skin thickness (ΔR) in neutron-rich oxygen isotopes, determined using the measured proton radii reported in this work and measured matter radii available from the literature. ΔR rapidly increases from $^{22-24}$O approaching the neutron drip-line, establishing a thick neutron surface for the neutron-rich oxygen isotopes. We have compared the measured proton radii to the predictions reported using various *ab initio* approaches with different interactions. The experimental proton radii presented have challenged these predictions.