University of Victoria

PHYSICS AND ASTRONOMY SEMINAR (In-Person & Zoom)

Michael Gennari
TRIUMF

"Modelling electroweak processes in light nuclei: Nuclear Fermi decays and V_ud"

Abstract

Currently, the most precise extraction of the up-down quark mixing element V_ud of the Cabibbo-Kobayashi-Maskawa (CKM) matrix comes from a handful of ft-value measurements for nuclear Fermi decays in light- and medium-mass nuclei. However, a complete extraction of V_ud from hadronic decays requires challenging theory determinations of hadronic-structure-dependent electroweak radiative corrections (EWRC) to said decays. In fact, a novel evaluation of the free-hadron part of the dominant correction to nuclear Fermi decays, i.e., the free-hadron gamma-W-box diagram, has led to tension with the Standard Model expectation of CKM unitarity. Moreover, to reach the current precision goals for the CKM unitarity test via extraction of V_ud from nuclear Fermi decays, a consistent treatment of the hadronic-structure-dependent EWRCs in the nuclear medium is critical. Confirmation of this tension by way of increasingly precise nuclear theory and experiment would point towards a deficiency in the Standard Model (SM) weak sector.

Ultimately, this amounts to requiring a modern evaluation of the nuclear gamma-W-box diagram utilizing the ever-advancing set of tools available in nuclear many-body theory. Targeting an evaluation of the gamma-W-box diagram for the 10C -> 10B and 14O -> 14N Fermi transitions, we apply the no-core shell model (NCSM). The NCSM is a non-relativistic quantum many-body approach for modelling the low-lying bound states of light nuclei starting solely from inter-nucleonic interactions. Augmented by the Lanczos strengths method, the NCSM can be further utilized to target features of the entire many-body spectrum, a capability without which calculations of this kind would not be possible. The approach detailed represents one of the first utilized to compute these corrections in ab initio nuclear theory.

Tuesday, April 1st
1:00pm PST
DSB C126