“Search for New Physics via η Rare Decays”

Liping Gan

University of NC Wilmington

The Standard Model offers no insight into experimental facts such as the dominance of matter over anti-matter, nor the nature of dark matter and dark energy which are associated with the rotation curves of galaxies and the accelerated expansion of the universe. Searching for physics beyond the Standard Model is therefore a well-motivated and important task for physicists. A good way to search for new physics is through tests of fundamental symmetries in different interactions, such as chiral symmetry, charge conjugation C, parity P, and time reversal T, as well as CP and CPT. Enormous investments have been made in flavor-changing decays in K and B mesons, as well as weak decays of the lightest mesons, the pion and muon, with no uncontroversial evidence found for new physics. The sector of flavor-conserving non-weak decays, however, has not been as thoroughly exploited, and this presents an opportunity for JLab’s Hall D with its high intensity, high energy tagged photon beam. The η meson has the interesting feature that all its strong and electromagnetic decays are forbidden in lowest order due to conserved symmetries. This makes measurements of branching ratios or upper limits for various rare and forbidden η decays about 5 orders of magnitude more sensitive to new interactions, all other things being equal. We are developing an experimental program with a state of the art PbWO4 forward calorimeter to study η rare decays in Hall D. Rate estimates suggest that the title of “η factory” is warranted, and simulations show the small pitch and high resolution of the calorimeter will reduce backgrounds by almost 2 orders of magnitude compared to a traditional Pb glass calorimeter. The flagship channels will be the all neutral final states $\eta \to \pi^0\gamma\gamma$, 3γ, and $\pi^0\pi^0$ to investigate chiral symmetry breaking, C violation, and CP violation, respectively. We anticipate that a large number of ancillary channels will also be studied, each requiring its own careful treatment of backgrounds. This program will provide a great opportunity to understand the symmetry structure of QCD and search for new physics in flavor-conserving, non-weak decays.