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Test QCD symmetries via precision measurement of the neutral pion lifetime[1]

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Symmetries and their dynamical breaking effects play fundamental roles in the nature. In particular, the three light neutral pseudoscalar mesons π^0, η and $\eta\prime$ contain fundamental information about QCD symmetries. While π^0 and η are Goldstone bosons due to spontaneous chiral symmetry breaking, the $\eta\prime$ is not due to the $U(1)_A$ anomaly. There is a second type of anomaly driving the two-photon decays of these mesons. Since π^0 is the lightest meson in the hadron spectrum, the chiral anomaly prediction for the $\pi^0 \rightarrow \gamma\gamma$ decay width is more accurate and is exact in the limit of massless quarks. In the real world, the SU(3) and isospin breaking by the light quark masses lead to important mixing effects among these mesons. Theoretical activities in this field over the past several years have resulted in high precision (1% level) predictions for the decay amplitude of the π^0 into two photons. As a result, the experimental measurement on this quantity with a comparable precision will provide an important test on the fundamental QCD predictions. The present experimental uncertainty of the π^0 decay amplitude, according to the PDG average, is an order of magnitude greater than the theoretical uncertainties. The PrimEx collaboration at Jefferson Lab has recently developed and performed a new experiment to measure the neutral pion life time with high precision using the small angle coherent photoproduction of π^0's in the Coulomb field of nucleus, *i.e.*, the Primakoff effect. A new level of experimental precision ($\sim$2.9% total error) has been achieved by implementing the new high intensity and high resolution photon tagging facility in Hall B at Jefferson Lab and by developing a novel high resolution electromagnetic hybrid calorimeter (HYCAL). The final result of this experiment will be presented. The advent of a 12 GeV electron beam at Jlab will make it possible to extend the program to η and $\eta\prime$. A plan for future η and $\eta\prime$ program will be discussed.

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[2]For the PrimEx collaboration