Abstract

We propose high precision measurements of the double polarization ratio of polarization transfer coefficients, P'_x and P'_z, of the quasielastic ^{4}He$(\vec{e}, e'\vec{p})\,^3$H reaction with respect to the elastic ^{1}H$(\vec{e}, e'\vec{p})$ reaction, at a Q^2 of 0.8 (GeV/c)^2 and 1.3 (GeV/c)^2. Recently, measurements of this double ratio at both Mainz and JLab hinted at the need to include medium modifications of the proton form factors predicted by a quark-meson coupling model. The proposed experiment would reduce the statistical uncertainties in the double polarization ratio at each Q^2 by over a factor of two compared to the previous measurement, resulting in roughly equal contributions from statistical and systematic uncertainties. These two Q^2 values were selected since they lie in a region where theoretical calculations are expected to be reliable. This measurement would provide one of the most stringent tests to date of the applicability of conventional meson-nucleon calculations.

1 Introduction

Whether nucleons undergo considerable change of their internal structure when bound in the nuclear medium is a long standing issue in nuclear physics. At nuclear matter densities, ≈ 0.17 fm^{-3}, nucleon wave functions have significant overlap. In the chiral limit, one expects the nucleons to lose their identity altogether and for nuclei to make a transition to a quark-gluon plasma.

Nuclear physics originated with the description of nuclei as consisting of protons and neutrons. These nucleons are held together by a long-range, attractive, strong force mediated by meson exchange, whereas the saturation properties of nuclear matter arise from the repulsive part of the strong interaction [1]. The development of Quantum ChromoDynamics (QCD) as the theory of the strong interaction has turned this historical description into an effective description, that works extremely well due to the QCD property of confinement. Still, at some level, one anticipates a breakdown of this effective description.