JLab Experiment E99-118

Measurement of the Nuclear Dependence of $R = \sigma_L/\sigma_T$ at low Q^2

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Since the early experiments at SLAC which discovered the nucleon substructure and led to the developement of the quark parton model, deep-inelastic scattering has been the most powerful tool to investigate the partonic substructure of the nucleon. After about 30 years of such experiments with electron, muon and neutrino beams the nucleon structure function $F_2(x, Q^2)$ is known with high precison over about four orders of magnitude in both x and Q^2.

Measurements on a large number of nuclei have determined the x-, $A-$ and Q^2-dependence of nuclear effects on the structure function $F_2(x, Q^2)$. Even though the theorietical explanation is still not unambiguous, the importance of nuclear effects has been clearly demonstrated both in the shadowing region at low values of x and in the region nowadays called the EMC-effect ($x > 0.3$).

In the contrary, little information exists on the second structure function ($R(x, Q^2)$ which relates the longitudinal and transverse structure functions $F_L(x, Q^2)$ and $F_1(x, Q^2)$:

$$\begin{aligned} R = \sigma_L/\sigma_T &= F_L(x, Q^2)/2xF_1(x, Q^2) \\ &= \frac{(1 + Q^2/\nu^2)F_2(x, Q^2) - 2xF_1(x, Q^2)}{2xF_1(x, Q^2)} \end{aligned}$$

Data on $R(x, Q^2)$ are available in a limited x and Q^2 range only and the typical precision of these measurements is only about 20-30%. No data exist for $x < 0.1$ and $Q^2 < 2$ GeV^2 and no evidence for nuclear effects has been found in the kinematic range of the existing measurements of $R(x, Q^2)$.

However, very recently the HERMES collaboration reported the observation of a large nuclear effect in $R(x, Q^2)$ at $x < 0.06$ and $Q^2 < 1$ GeV^2. This surprising result might be interpreted as first experimental evidence for the existence of enhanced quark-gluon correlations in atomic nuclei nuclei and has provoked a lot of interest in the theoretical community.

In this experiment, E99-118, we will measure the deep-inelastic cross section on nucleon and nuclear targets at various beam energies between 2 and 6 GeV. Using the high momentum spectrometer in Hall C at different angles and momentum settings we will perform Rosenbluth separations at x and Q^2 values between 0.2 and 2 GeV^2 in Q^2 and 0.04 and 0.5 in x. This will allow the determination of $R(x, Q^2)$ at low values of Q^2 and the extension of the HERMES measurement of R_A/R_D towards lower Q^2. The large number of nuclear targets from carbon to gold will allow a measurement of the A-depenmdence of the new effect.