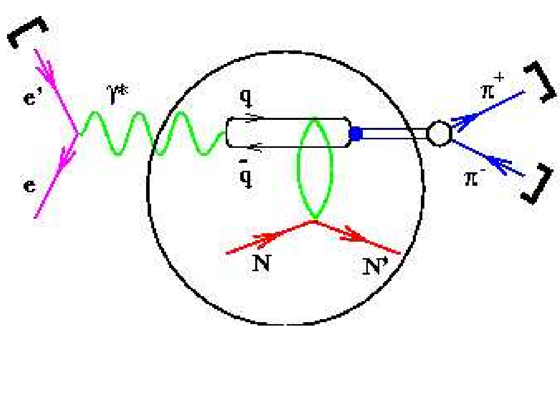
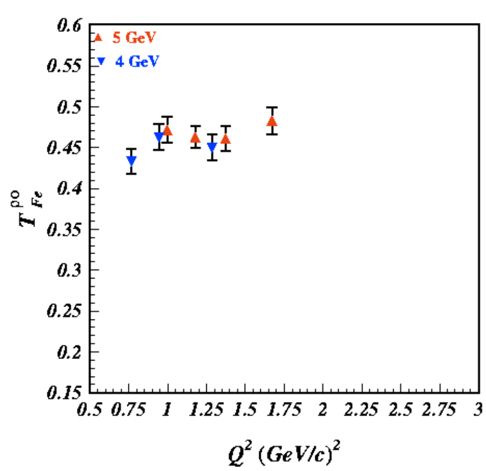
Color Transparency in ρ^0 Electroproduction

The nature of strong interaction makes it hard for a hadron to cross a nucleus without being absorbed. Yet Quantum-Chromo-Dynamics (QCD) the fundamental theory of strong interaction predicts that for a short time the quarks forming the hadron can be very close to each other. In such compact configuration the hadron becomes invisible to the nuclear medium. This so-called Color Transparency (CT) phenomenon has been observed at high energies above 50 GeV, where QCD is relatively easy to calculate. Results of the investigations at moderate energies are at the most suggestive due to the lack of statistics and/or the complexity of the reaction mechanism. Because of the simplicity of the production mechanism, ρ^0 electroproduction off nuclei is a tool of choice for the study of CT. The virtual photon that the incident electron exchanges with a nucleon from a nucleus fluctuates into a pair of $q\bar{q}$ which materializes into small size ρ^0 meson (pre-hadron) then later evolves to full size ρ^0 (See figure on the left). The highest the space-time resolution (Q^2) of the virtual photon is, the smallest is the size of the produced pre-hadron. The interaction of the pre-hadron, which is a colorless object with the nuclear medium, is proportional to its size squared. Therefore, the smallest the pre-hadron is, the more transparent the nuclear medium is. Experimentally, the nuclear transparency (T_A) is measured as the ratio of the observed ρ^0's (through their $\pi^+\pi^-$ decay product) produced on a nucleus (A) relative to the ones produced in deuterium where no absorption is expected. The signal of CT would be the increase of T_A with Q^2. A recent CLAS experiment, led by the MEP group at Argonne, measured the nuclear transparency in diffractive ρ^0 electroproduction for 4 and 5 GeV beam energies. The measured T_{Fe} is found constant as a function of the photon virtuality (Q^2) consistent with no CT onset (see figure on the right). This result is indicating that although we reach Q^2 values of 2 GeV^2, which is probably sufficient to produce small size hadron, this hadron evolves rapidly to its normal size. Therefore we do not get the chance to see its interaction or more precisely "lack of interaction". Higher energy transfer is needed and will be available with JLab 12 GeV upgrade.





Left: Diagram for the electroproduction of ρ^0 meson off a nucleus.
Right: The nuclear transparency for iron as a function of Q^2 for two beam energies.