

Update on C12-15-006: Measurement of Tagged Deep Inelastic Scattering

J.-W. Qiu & I. Balitsky

This is a jeopardy proposal by using the tagged deep inelastic scattering (TDIS) to probe the mesonic content of the nucleon via the Sullivan process, and was C1 conditionally approved with an A- scientific rating in 2015. By tagging the scattered hadron at a small scattering angle, the lepton-hadron DIS could be thought as the lepton scatters off a virtual mesonic state of invariant mass t with $-t \ll Q$, the hard scale of DIS. When the $|t|$ is sufficiently small, it was argued that the TDIS could be thought as a DIS off a virtual single meson state, such as a pion. That is, TDIS provides another way to allow us to measure partonic structure of a meson, including DIS structure functions (SFs) of the meson.

Since then, the interest in the TDIS program has significantly increased. From experimental side, two run group proposals to measure kaon SF and neutron SF by using TDIS have been approved. From theory side, the JAM collaboration performed the first global QCD analysis of parton distribution functions (PDFs) in the pion by combining hadronic $\pi - D$ Drell-Yan data with data from leading neutron production in deep inelastic lepton-proton scattering at HERA, which was approximated as a Sullivan process with a DIS process off a virtual π^+ . The analysis indicates some consistencies between the partonic content of a real pion in the $\pi - D$ scattering and that of a virtual pion in the Sullivan process, and a set of PDFs in the pion was extracted from the first global analysis of data from TDIS. The extracted PDFs indicate that the valence PDF in a pion prefers to have a $(1-x)$ dependence in the large- x region within the accuracy of the current data, which is different from the pQCD expectation at $(1-x)^2$ dependence.

In summary, the interest for the physics of this jeopardy proposal is significantly increased, and is now more timely to carry out the proposed measurements. The data from the proposed TDIS experiments at JLab can provide better test of the validity of Sullivan process for extracting partonic structure of mesons. The projected accuracy of the data at the large- x region can be critically important for determining the behavior of valence PDF in a pion as the momentum fraction x approaches to 1. The knowledge to be learned from this and the two other approved TDIS experiments could impact the TDIS effort for the future EIC.

Since treating the virtual exchange mesonic state as a single meson state is an approximation, the quantification of such approximation during the data analysis is very important for extracting reliable mesonic structure information from TDIS.