Department of Physics and Materials Science

SEMINAR

Measurements of Proton Structure by the Drell-Yan Experiment SeaQuest at Fermilab

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Abstract: The proton, once deemed a fundamental particle forming the nucleus with a positive charge, has unveiled its intricacies, revealing the composition of quarks, antiquarks, and gluons through experimental investigations. The challenge lies in quantifying these elements within the proton's intricate structure. As the simplest particle bound by strong interactions, the proton's structural elucidation contributes to a deeper comprehension of Quantum Chromodynamics (QCD), the theory governing strong interactions. Parton Distribution Functions (PDFs) have been instrumental in detailing the proton's internal structure. While quark PDFs have been accurately measured, precise measurements of antiquark PDFs remained elusive. Addressing this gap, the SeaQuest experiment at Fermilab focused on measuring antiquarks, elucidating their distributions via the Drell-Yan process — an interaction of a quark in one hadron and an antiquark in another, leading to the creation of a lepton pair through a virtual photon. Our critical findings on antiquark PDFs, published in Nature, signify a substantial advance in understanding the proton structure. Yet, mysteries persist within the proton that PDFs alone cannot unravel. In recent decades, the investigation of proton structure has shifted towards three-dimensional parton distributions, incorporating two additional dimensions beyond PDFs to unveil the complete picture of the proton. SeaQuest, in addition to the antiquark PDFs measurements, has also measured the angular distribution of the Drell-Yan process, probing the Boer-Mulders function — one of the three-dimensional parton distributions. I released the preliminary results of the angular distribution last year. In this seminar, I will delve into the underlying physics of the SeaQuest experiment, providing details of the analyses and insights into our findings.

Bio: Dr. Kei Nagai is currently a research scientist at Duke University. He obtained his BS, MS, and PhD from the Tokyo Institute of Technology. Following his PhD, he has held postdoctoral research fellowships at Academia Sinica in Taiwan and Los Alamos National Laboratory, before joining Duke University.

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