The Solid Polarized Target Research at the University of Virginia Physics Department

Dustin Keller

March 20, 2018

1 Research Statement

I have a broad interest in Nuclear Spin Physics research. In the following I mention a few of the present and future projects centered around Spin Physics and the use of polarized target research.

I have ongoing analysis projects in the spin physics of photoproduction hadronic spectroscopy using Jefferson Labs (Hall B) CLAS6 and have a keen interest in trying to understanding the nature of confinement using the spectrum of resonances and the search for exotic states. I am also involved in the development of machine learning algorithms to use in conjunction with polarized observables where a broad phase-space can be exploited using multilayers of classification giving a great deal more information on the contributing partial waves. I also believe the next phase of nuclear physics analysis evolution will entail the use of increasingly sophisticated pattern recognition techniques to use in signal extraction. Incorporating experimental covariance information into these types of analyses can improve resolving power even further. Recently, I have published work on U-Spin symmetry tests of the strange sector electromagnetic decays, and have extracted transition magnetic moments, branching ratios, and cross sections with the use of these types of covariance sensitive tools using photoproduction data from CLAS6.

I will be migrating this effort to Hall D of Jefferson Labs with the hope of expanding the GlueX project to use polarized target observables in the search for exotic mesons created by the excitation of the gluonic field. Such an expansion to the GlueX experiment would allow clear determination of the single spin (beam or target), double spin (beam-target, beam-recoil, target-recoil) and tensor polarized asymmetries in pseudoscalar and vector meson production. Spin dependent measurements will complement the existing GlueX program by allowing for the determination of complete isospin amplitudes and assisting in the search for exotic mesons.

I am also involved in Nucleon Tomography and using processes like Deeply Virtual (DVCS), Time-like (TCS), and Wide-angle Compton scattering (WACS) to explore the internal nucleon structure. I am involved in exploring ways to impose more theoretical, analytical, and experimental constraints on the extraction framework with the intention of improving the resolution of the 3D nucleon picture as well as to improve and expand the method of proposing experiments to add to this picture. This work involves deep study on the phenomenological level but also exploiting all components of the helicity amplitudes for each type of process at higher twist. Once this has been achieved it will be possible to propose experiments that are sensitive to each of these components with greater precision in less experimental run time.

At the moment the goal for DVCS and TCS is to run future experiments in Hall A and C with polarized beam and target. I have also proposed, with collaborators, an experiment to study the initial state helicity correlation in WACS in JLab Hall C. The measured longitudinal polarization transfer parameter is inconsistent with predictions of pQCD, yet consistent with calculations of the handbag mechanism. The WACS experiment will be able to discriminate between the various models and help to clarify the role of the power suppressed helicity flip contribution and hopefully confirm the method of factorization and connection to the generalized parton distributions. In order for this experiment to be feasible a high intensity photon beam (well over $10^{12}\gamma/sec$) had to be developed to work in combination with a new rotating target (raster) to maximize luminosity and reconstruction resolution. Our high intensity photon source collaboration is working on a publication of this configuration. There are many more photon beam, and photon beam with polarized target physics ideas of this nature that I would like to explore.

I am in a leadership role in several polarized target experiments and assist on a contributing level on several others. I am highly involved in all aspects of a major experimental effort at Fermilab in the SeaQuest polarized Drell-Yan experiment E1039. This project has received full funding and is the first experiment to measure not only the sign, but also the magnitude and shape of the Sivers function with sub-percent precision directly using the dynamics of the sea quarks. E12-13-011 is an experiment to measure the deuteron tensor structure function b_1 and E12-15-005 is proposed to measure the quasielastic tensor asymmetry. Both of these experiments are approved conditional upon achieving at tensor polarization of 30%. I have recently developed an optimized solid tensor polarized target along with a polarization measurement technique which will remove the conditional status and allow the experiments to run. This advancement required a completely new type of target that rotates in the holding field while receiving RF irradiation to optimize quadrupole polarization in the target material. The new technology will increase the figure of merit for tensor polarized experiments by nearly a factor of 4 allowing previously inaccessible asymmetry measurements at Jefferson Lab.

There are additional observables to explore using a tensor polarized target, such as the three additional spin-1 structure functions. The generalized deep inelastic tensor spin structure of the deuteron can only be obtained from deeply virtual Compton scattering and meson production experiments on a tensor polarized target. There are interesting connections to the total quark angular momentum sum rule for a spin-1 hadronic system within a gauge invariant decomposition of hadronic spin. In addition, polarized protondeuteron Drell-Yan processes can be explored by studying the tensor-polarized antiquark distributions accessible only by a tensor polarized target. I am highly motivated to work on problems that will open the door to new types of experiments that can access information not otherwise obtainable.

2 Current Polarized Target Experiments and Proposals

The dirction for the next five year in research can be seen in the polarized target proposals listed below for experiments to run in the near future at Jefferon Labs, TUNL, and Fermilab.

- E12-06-109 *The Longitudinal Spin Structure of the Nucleon (JLab Hall B)*
  (Full Approval) Spokespersons: K. Griffioen, M. Holtrop, D. Keller, S. Kuhn, Y. Prok, T. Forest

- HIGS-P-12-16 *Tensor Analyzing Power in Deuteron Photodisintegration (Duke TUNL)*
  (Full Approval) Spokespersons: D. Keller (Contact), P. Seo, B. Norum

- E1039 *SeaQuest with a Transversely Polarized Target (Fermilab SeaQuest)*
  (Full Approval) Spokespersons: A. Klein, D. Keller

- E12-13-011 *The Deuteron Tensor Structure Function b1 (JLab Hall C)*
  (C1 Approval) Spokespersons: J.P. Chen, N. Kalantarians, D. Keller, E. Long, K. Slifer, P. Solvignon

- E12-14-006 *Initial State Helicity Corellations in WACS (JLab Hall C)*
  (Full Approval (withdrawn)) Spokespersons: D. Day, D. Keller (Contact), J. Zhang

- E12-15-005 *Tensor Asymmetry Quasielastic Region (JLab Hall C)*
  (C1 Approval) Spokespersons: D. Day, D. Higinbotham, D. Keller, E. Long, K. Slifer, P. Solvignon

- E12-17-008 *Polarization Observables in WAC Scattering (JLab Hall C)*
  (C1 Approval) Spokespersons: D. Day, D. Hamilton, D. Keller, G. Niculescu, B. Wojtsekhowski, J. Zhang