

## Research Summary for M. Engelhardt

### Research Projects

#### - Hadron Structure from Lattice QCD

I am a member of the Lattice Hadron Physics Collaboration (LHPC), which is pursuing a comprehensive program of calculating hadronic properties in lattice QCD, and I am the coordinator and spokesperson for the Lattice TMD Collaboration (TMDs = Transverse Momentum Dependent Parton Distributions). I furthermore take part in a current DOE Topical Collaboration on TMDs. My TMD efforts have also branched out into investigations of quark orbital angular momentum in the nucleon. I moreover pursue calculations of electric polarizabilities of the neutron.

#### - Vortex picture of the QCD vacuum

This project deals with modeling the infrared gluonic degrees of freedom of QCD in terms of chromomagnetic vortices, and investigating properties such as confinement and spontaneous breaking of chiral symmetry in such models.

### Research funding

DOE grant DE-FG02-96ER40965; current funding period extending up to March 2022, at a volume of \$170,000/year. This grant is held jointly with Prof. M. Burkardt.

DOE Topical Collaboration on TMDs, NMSU portion of grant \$237,279, to support bridged faculty position of M. Schlegel, January 2018 – July 2020.

Lattice QCD computing resources, obtained together with Lattice QCD collaborators: Current allocations at ALCC, BNL, NERSC amounting to a total of 87M cpu core hours + 700k gpu card hours.

### Research Personnel

Graduate Students: Osamah Alkasasbeh, Alejandro Salas, Wajdi Al-Smadi

### Major Collaborators

Lattice Hadron Physics Collaboration (LHPC), Lattice TMD Collaboration, TMD DOE Topical Collaboration

### Publications in the past year

Hasan, N., Green, J., Meinel, S., Engelhardt, M., Krieg, S., Negele, J., Pochinsky, A., Syritsyn, S., “Nucleon axial, scalar, and tensor charges using lattice QCD at the physical pion mass.” preprint arXiv:1903.06487.

Engelhardt, M., Green, J., Hasan, N., Krieg, S., Meinel, S., Negele, J., Pochinsky, A., Syritsyn, S., “Quark orbital angular momentum in the proton evaluated using a direct derivative method.” PoS, SPIN2018, 047.

Engelhardt, M., Green, J., Hasan, N., Krieg, S., Meinel, S., Negele, J., Pochinsky, A., Syritsyn, S., “Quark orbital angular momentum in the proton evaluated using a direct derivative method.” PoS, LATTICE2018, 115.

Kallidonis, C., Syritsyn, S., Engelhardt, M., Green, J., Meinel, S., Negele, J., Pochinsky, A., “Nucleon electromagnetic form factors at high  $Q^2$  from Wilson-clover fermions”, to appear in the Proceedings of the 36<sup>th</sup> International Symposium on Lattice Field Theory (Lattice 2018), East Lansing, MI, July 22-28, 2018.

Rajan, A., Engelhardt, M., Liuti, S., “Lorentz Invariance and QCD Equation of Motion Relations for Generalized Parton Distributions and the dynamical origin of proton orbital angular momentum.” Phys. Rev. D, 98, 074022.

Lin, H.-W., Nocera, E., Olness, F., Orginos, K., Rojo, J., Engelhardt, M., et al., “Parton distributions and lattice QCD calculations: a community white paper.” Prog. Part. Nucl. Phys., 100, 107.