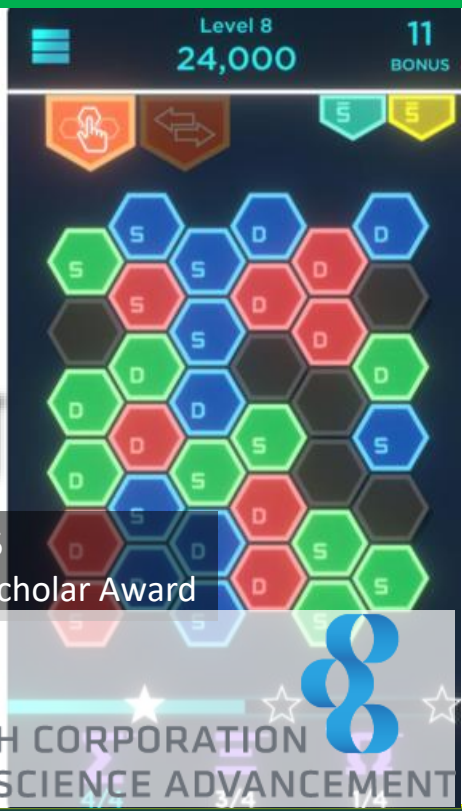
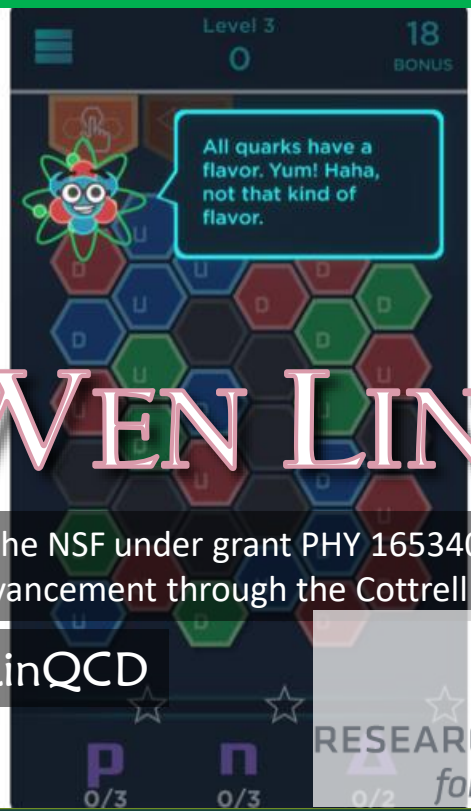
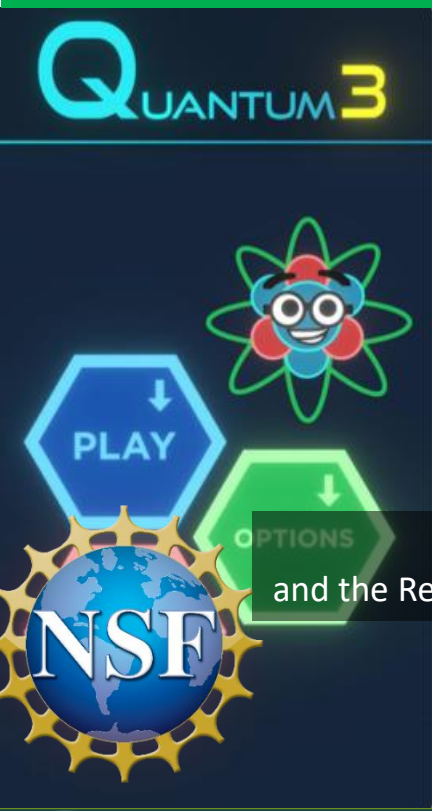


# LaMET 2022 Day-2 Discussions



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This work of HL is supported by the NSF under grant PHY 1653405 and the Research Corporation for Science Advancement through the Cottrell Scholar Award

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# Background: Snowmass Report

## § Long-term planning exercise for the particle-physics community

- ☞ Develop community long-term physics aspirations.”
- ☞ “Communicate opportunities for discovery in particle-physics to broader community and to the (US) government.”
- ☞ (Young-Kee Kim, DPF Chair, Town-Hall Meeting, 2020 April APS meeting)

## § Physics-driven effort.

- ☞ Covers all areas of particle physics and facilitates cross-cutting.
- ☞ Develop overarching physics studies.

## § Lattice effort relevant to this workshop

- ☞ “Lattice QCD Calculations of Parton Physics”,  
[M. Constantinou](#), [L. Del Debbio](#), [X. Ji](#), [H.-W. Lin](#), [K. Liu](#), [C. Monahan](#), [K. Orginos](#),  
[P. Petreczky](#), [J.-W. Qiu](#), [D. Richards](#), [N. Sato](#), [P. Shanahan](#), [C.-P. Yuan](#), [J.-H. Zhang](#), [Y. Zhao](#)  
[arXiv:2202.07193](https://arxiv.org/abs/2202.07193) [hep-lat]

# Background: Challenges

## § Large momentum is essential

- ↪ With sufficient statistics it may be possible to reach 5 GeV

## § Signal-to-noise improvement

- ↪ Gluonic observables; new ideas for large momentum
- ↪ Physical pion mass

## § Renormalization of linear divergence

- ↪ Wilson-line operators contain linear divergences that must be subtracted

## § Inverse problems PDF extraction in SDF

- ↪ Remove the model/pre-condition choices dependence

## § Reaching long-range correlations in LaMET

- ↪ For small- $x$  physics, new methods for calculating longer range correlations must be developed

# Computational Challenges

§ Proposed wanted lattice calculations in the next few years for isovector nucleon PDFs [arXiv:2202.07193](https://arxiv.org/abs/2202.07193) [hep-lat]

∞  $a = 0.05$  fm (corresponding to  $a^{-1} \approx 4$  GeV)

∞  $M_\pi \approx 139$  MeV with at least  $M_\pi L = 3$   
( $L = 4.5$  fm ,  $L/a \approx 90$ )

∞ We need nucleon momenta of  $P \approx 2.6$  GeV

§ Even unpolarized isovector nucleon can be interesting

∞ Anti-quark contribution is not well known; we need better precision for this

§ Flavor-dependent PDFs will be more challenges to overcome

∞ Where are we on this?

∞ Need better determination of the gluon PDF

# HotQCD Model?

§ Common theme: we need more statistics

§ Would it be so crazy to consider the HotQCD model

- ∞ A collaboration of collaborations to gain big resource
- ∞ Let's collaborate on one physical pion ensemble with finer lattice spacing & larger momentum than what we individually calculated so far, and
- ∞ One really great set of lattice data that really beat the errors in large- $x$  and anti-quark regions
- ∞ Remove the bias: blind the correlators and only unrevealed it when all systematics is included

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The graphic features the text "DIS23" in a large, dark green serif font. The letter "I" is replaced by a silhouette of a Gothic tower. Below "DIS23" is the text "MICHIGAN STATE UNIVERSITY" in a smaller, dark green serif font, with a registered trademark symbol. To the right of the text is a diagram of a particle interaction: a blue wavy line (photon) enters from the top right, hits a red circular target, and two black arrows (leptons) emerge from the target. The background is a stylized green and blue landscape with silhouettes of Michigan State University buildings, a statue, a dome, and a tree. A QR code is located in the bottom right corner of the graphic area.

<https://pa.msu.edu/conf/DIS2023>