Quantum Computing for Heavy-Quark Fragmentation (QC4HQ)

First quarterly report
Jan 21, 2025

Funded participants:

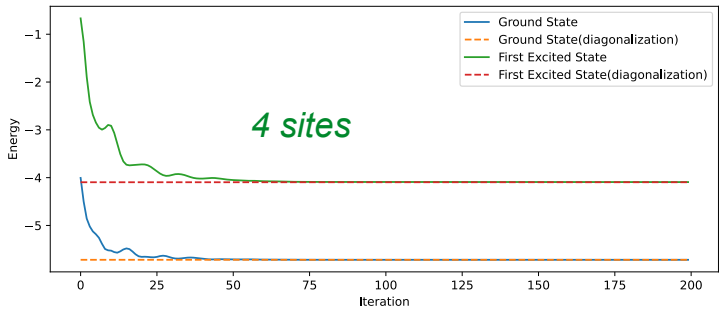
Kostas Orginos
David Richards
Nobuo Sato
Marco Zaccheddu
Jia-Yue Zhang

Progress in First Quarter

Derived the (discrete) Hamiltonian of (multi-flavor) Schwinger + NJL models

- Implementation through Jordan-Wigner transformation

Objective number	Milestone	FY25		FY26	
		H1	H2	H1	H2
1	Construction of Schwinger Hamiltonian; investigation of other QCD-like models				
2	State preparation and its implementation in QisKIT				
3	Construction of a SIHO appropriate to the Schwinger model in 1+1 dimensions				
4	Investigation of fragmentation in the Schwinger model using Qiskit, and the approach to the continuum limit				
5	Systematic Study of Fragmentation Functions with one heavy and one light flavor				



Low-energy spectrum of NJL and one-flavor Schwinger within *Penny Lane*

- *multi-flavor in progress*
- *Small (discrete) spatial volume*

NB Penny Lane more general than IBM-specific QisKit

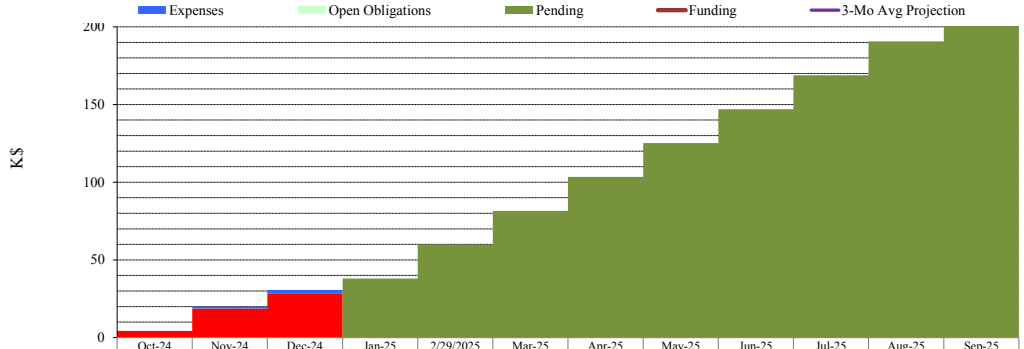
- Collaborators meet weekly: progress, focused presentations, resolving discrepancies
- Documentation and minutes in overleaf project
- Have setup github page as common repository for future work.
- Web page?

Starting to investigate the two *extant* approaches for fragmentation operator

- arXiv:2406.05683
- arXiv:2406.01819

Funding

Quantum Computing for Heavy-Quark Fragmentation
D. Richards (LD2511)
WBS 1.02.LD.010 (Loaded $k)



	Oct-24	Nov-24	Dec-24	Jan-25	2/29/2025	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25
YTD Spending	4	20	31	38	60	82	103	125	147	169	191	212
Pending	0	0	0	38	60	82	103	125	147	169	191	212
Open Obligations	0	0	0	0	0	0	0	0	0	0	0	0
Expenses	0	1	2	0	0	0	0	0	0	0	0	0
Labor	4	19	29	0	0	0	0	0	0	0	0	0
Funding	240	240	240	240	240	240	240	240	240	240	240	240
3-Mo Avg Projection												

Two JLab post-docs in place:

Marco Zaccheddu (0.5FTE)

Jia—Yue Zhang (0.5FTE)

They are both making essential contributions to the project!

Critical role of *unfunded external* participants:

Jack Araz (SUNY, but (was) sited at JLab)

Zhongbo Kang (UCLA)

Funding (and progress) on track

Funding Opportunity!

National Quantum Information Science Research Centers

DOE National Laboratory Program Announcement Number:
LAB 25-3530

Announcement Type: Initial

Announcement Issue Date:	**January 15, 2025**
Submission Deadline for Pre-Proposal:	**Wednesday, March 12, 2025, at 5 PM Eastern Time** **A Pre-Proposal is required** Pre-Proposals must be submitted by an authorized institutional representative
Pre-Proposal Response Date:	**Wednesday, April 9, 2025, at 11:59 PM Eastern Time**
Submission Deadline for Proposals:	**Wednesday, June 4, 2025, at 5 PM Eastern Time**