Current and Pending Support

Alexei Bazavov

Current

Sponsor:	Department of Energy
Award Number:	DE-SC0012704
Project/Proposal Title:	SciDAC-4: Computing the Properties of Matter with Leadership Computing Resources
Total Award Amount:	$550,000
Person-Months:	0
Total Award Period Covered:	9/1/17 – 8/31/22
Location of Project:	Multi-institutional, led by Jefferson Laboratory, MIT and Brookhaven National Laboratory; subcontract at MSU
Brief Description of Project:	Code development for lattice QCD calculations
Overlap with Proposed Research:	none

Sponsor:	National Science Foundation
Award Number:	PHY-1812332
Project/Proposal Title:	Heavy Quarkonia as Thermometer of Quark-Gluon Plasma
Total Award Amount:	$240,000
Person-Months:	1 month SUM
Total Award Period Covered:	8/15/18 – 8/31/21
Location of Project:	MSU
Brief Description of Project:	Study of the heavy quark bound states in quark-gluon plasma applying lattice QCD
Overlap with Proposed Research:	none

Sponsor:	Department of Energy
Award Number:	DE-SC0019139
Project/Proposal Title:	Foundations of Quantum Computing for Gauge Theories and Quantum Gravity
Total Award Amount:	$127,325
Person-Months:	0 months
Total Award Period Covered:	10/1/18 – 9/30/20
Location of Project:	Multi-institutional, lead by the University of Iowa, subcontract at MSU
Brief Description of Project:	Foundational aspects of quantum computing as applied to quantum field theories and quantum gravity, study of tensor renormalization group methods with applications to quantum computing
Overlap with Proposed Research:	none

Pending

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem

Total Award Amount:	$1,000,000
Person-Months:	0.12 academic
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Current and Pending Support

Scott Bogner

Current

Sponsor:	National Science Foundation
Award Number:	PHY-1713901
Project/Proposal Title:	Ab-Initio Nuclear Theory: From Nuclei to Neutron Stars
Total Award Amount:	$600,000
Person-Months:	2 summer
Total Award Period Covered:	8/1/17 – 7/31/20
Location of Project:	Michigan State University
Brief Description of Project:	Ab-initio many-body theory for nuclear structure calculations
Overlap with Proposed Research:	Shares common many-body methods (IMSRG/CC theory), but the focus is very different (the proposed research focuses on algorithms to be employed on quantum computers.)

Sponsor:	Department of Energy
Award Number:	DE-SC0015376
Project/Proposal Title:	Nuclear Theory for Double Beta Decay and Fundamental Symmetries
Total Award Amount:	$150,000
Person-Months:	0.12 academic
Total Award Period Covered:	5/1/16 – 4/20/21
Location of Project:	Michigan State University
Brief Description of Project:	Develop reliable ab-initio calculations of neutrino less double beta decay nuclear matrix elements.
Overlap with Proposed Research:	None

Sponsor:	Department of Energy
Award Number:	DE-SC0018083
Project/Proposal Title:	Nuclear Computational Low Energy Initiative (NUCLEI)
Total Award Amount:	$1,821,000
Person-Months:	0.12 academic
Total Award Period Covered:	9/1/17 – 8/31/21
Location of Project:	Michigan State University
Brief Description of Project:	Develop microscopically based energy density functionals for nuclei.
Overlap with Proposed Research:	None

Pending

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000

Person-Months:	0.12 academic
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Current and Pending Support

Patrick Coles

Current

Sponsor:	LANL LDRD
Award Number:	20180628ECR
Project/Proposal Title:	Machine learning of quantum computing algorithms
Total Award Amount:	$416,000
Total Award Period Covered:	10/01/18 - 09/30/20
Person-Months:	5
Brief Description of Project:	Develop quantum computing algorithms using machine learning
Overlap with Proposed Research:	Both proposals use machine learning, but for different purposes (general toolbox versus finding quantum simulation algorithms)

Sponsor:	LANL LDRD
Award Number:	2019065DR
Project/Proposal Title:	Taming Defects on Quantum Computers
Total Award Amount:	$4,710,000
Total Award Period Covered:	10/01/18 - 09/30/21
Person-Months:	2.5
Brief Description of Project:	Develop techniques to mitigate defects on quantum computers.
Overlap with Proposed Research:	Both proposals use machine learning, but for different purposes (taming defects versus finding quantum simulation algorithms)

Sponsor:	DOE, Office of Science
Award Number:	0000022066
Project/Proposal Title:	Topological phases of quantum matter and decoherence
Total Award Amount:	$3,489,000
Total Award Period Covered:	10/01/18 - 09/30/21
Person-Months:	1
Brief Description of Project:	Work on quantum algorithm to study topologically ordered systems.
Overlap with Proposed Research:	No significant overlap with current proposal.

Sponsor:	DOE, Office of Science
Award Number:	0000014775
Project/Proposal Title:	Optimization, Verification and Engineered Reliability of Quantum Computers
Total Award Amount:	$3,489,000
Total Award Period Covered:	10/01/18 - 09/30/22
Person-Months:	3
Brief Description of Project:	Develop noise-resilient algorithms.

Overlap with Proposed Research:	Both proposals use machine learning, but for different purposes (noise resilience versus finding quantum simulation algorithms)

Pending

Sponsor:	LANL LDRD
Award Number:	20200056DR
Project/Proposal Title:	Quantum Chemistry using Quantum Computers
Total Award Amount:	$4,800,000
Total Award Period Covered:	10/01/19--09/30/22
Person-Months:	2
Brief Description of Project:	Develop quantum algorithms to study problems in quantum chemistry.
Overlap with Proposed Research:	Both proposals use machine learning, but for different purposes (chemistry versus finding quantum simulation algorithms)

Sponsor:	DOE, Office of Science
Award Number:	0000025458
Project/Proposal Title:	Quantum computing for fusion energy sciences
Total Award Amount:	$500,000k
Total Award Period Covered:	10/01/19--09/30/21
Person-Months:	1
Brief Description of Project:	Develop quantum algorithms to study problems in fusion energy.
Overlap with Proposed Research:	No significant overlap with current proposal

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.

Overlap with Proposed Research: this is the proposed project

Current and Pending Support

Heiko Hergert

Current

Sponsor:	Department of Energy
Award Number:	DE-SC0018083
Project/Proposal Title:	Nuclear Computational Low Energy Initiative (NUCLEI)
Total Award Amount:	$1,821,000
Person-Months:	0.12 academic
Total Award Period Covered:	9/1/17 – 8/31/21
Location of Project:	Michigan State University
Brief Description of Project:	The SciDAC-4 NUCLEI collaboration brings together experts in theoretical nuclear physics, mathematics and computer science to advance the development of nuclear physics simulations. H. Hergert's group receives support for personnel and resources to perform many-body calculations of high interest to the NSCL/FRIB experimental program, the application of renormalization group methods in nuclear physics, and the continuing improvement of the simulation software (e.g., parallelization, implementation of uncertainty quantification etc.).
Overlap with Proposed Research:	None

Sponsor:	National Science Foundation
Award Number:	PHY-1614130
Project/Proposal Title:	A Novel Many-Body Method for the Description of Open-Shell Nuclei From First Principles
Total Award Amount:	$225,000
Person-Months:	1 summer
Total Award Period Covered:	8/15/16 – 7/31/19
Location of Project:	Michigan State University
Brief Description of Project:	This award supports the reformulation of the Multireference In-Medium Similarity Renormalization Group (MR-IMSRG) with the help of the Magnus expansion techniques, and the development of basic Equation-of-Motion (EoM) technology for calculating excited states and states in odd nuclei.
Overlap with Proposed Research:	None

Sponsor:	Department of Energy
Award Number:	DE-SC0017887
Project/Proposal Title:	Advanced Many-Body Methods for Nuclear Structure
Total Award Amount:	$750,000
Person-Months:	Y1: 1 summer, Y2: 1 summer, Y3-5: 2 summer
Total Award Period Covered:	9/1/17 – 8/31/22
Location of Project:	Michigan State University

Brief Description of Project:	This award supports the development of advanced extensions of the Multireference In-Medium Similarity Renormalization Group (MR-IMSRG) framework: (i) The consistent inclusion of continuum coupling effects in the computation of ground and excited states of nuclei at the limits of stability, (ii) the treatment of nuclei with strong collective correlations, e.g., intrinsic deformation, and (iii) the application of principal component decompositions and tensor factorization to control the memory requirements and computational scaling of the method.
Overlap with Proposed Research:	None

<u>Pending</u>

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12 academic
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Current and Pending Support

Matthew Hirn

Current

Sponsor:	National Science Foundation
Award Number:	1845856
Project/Proposal Title:	CAREER: Understanding invariant convolutional neural networks through many particle physics
Total Award Amount:	$400,000
Person-Months:	0.5 (summer)
Total Award Period Covered:	07/01/2019 – 06/30/2024
Location of Project:	Michigan State University
Brief Description of Project:	This award will facilitate an integrated scientific and educational program at the interface of mathematics, deep learning, many particle physics and data science.
Overlap with Proposed Research:	None

Sponsor:	National Science Foundation
Award Number:	1620216
Project/Proposal Title:	Three-dimensional deep wavelet scattering for quantum energy interpolation
Total Award Amount:	$191,775
Person-Months:	1.0 (summer)
Total Award Period Covered:	09/01/2016 – 08/31/2020
Location of Project:	Michigan State University
Brief Description of Project:	The goal of this project is to understand the mathematical theory underlying multiscale, multilayer machine learning architectures for quantum many body physics.
Overlap with Proposed Research:	None

Sponsor:	Defense Advanced Research Projects Agency
Award Number:	D16AP00117
Project/Proposal Title:	Deep wavelet scattering for quantum many body physics (DARPA Young Faculty Award)
Total Award Amount:	$744,297
Person-Months:	1.0 (summer)
Total Award Period Covered:	09/15/2016 – 09/14/2019
Location of Project:	Michigan State University
Brief Description of Project:	The goal of this project is to develop machine learning algorithms for the efficient and accurate estimation of quantum many body energies.
Overlap with Proposed Research:	None

Sponsor:	Alfred P. Sloan Foundation
Award Number:	FG-2016-6607
Project/Proposal Title:	Provable machine learning algorithms for scientific computation (Sloan Fellowship)
Total Award Amount:	$55,000
Person-Months:	0.0
Total Award Period Covered:	09/15/2016 – 09/14/2020
Location of Project:	Michigan State University
Brief Description of Project:	The goal of this project is to develop provably correct machine learning algorithms to facilitate large scale scientific computation.
Overlap with Proposed Research:	None

<u>Pending</u>

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Sponsor:	National Science Foundation (subaward from the University of Michigan)
Project/Proposal Title:	HDR DSC: Midwest immersive data science training program
Total Award Amount:	$216,288
Person-Months:	0.5 (summer)
Total Award Period Covered:	10/01/2019 – 09/30/2022
Location of Project:	Michigan State University

Brief Description of Project:	This proposal develops a data science training program between Univ. of Michigan, MSU, and Ohio State University.
Overlap with Proposed Research:	None
Sponsor:	National Science Foundation
Project/Proposal Title:	Collaborative Research: Data-driven Path Metrics for Machine Learning
Total Award Amount:	$150,000
Person-Months:	0.5 (summer)
Total Award Period Covered:	07/01/2019 – 06/30/2021
Location of Project:	Michigan State University
Brief Description of Project:	This project will investigate data dependent path metrics that are defined by the best possible path through the data, and demonstrate these metrics are both density sensitive and geometry preserving.
Overlap with Proposed Research:	None
Sponsor:	National Institutes of Health
Project/Proposal Title:	Finding emergent structure in multi-sample biological data with the dual geometry of cells and features
Total Award Amount:	$1,599,998
Person-Months:	1.0 (summer)
Total Award Period Covered:	07/01/2019 – 06/30/2023
Location of Project:	Michigan State University
Brief Description of Project:	This project will develop and validate methods for stratifying single-cell samples consisting of single-cell data and will analyze them to find structures emerging at multiple granularities.
Overlap with Proposed Research:	None

Current and Pending Support

Morten Hjorth-Jensen

Current

Sponsor:	National Science Foundation
Award Number:	PHY-1713901
Project/Proposal Title:	Ab-Initio Nuclear Theory: From Nuclei to Neutron Stars
Total Award Amount:	$600,000
Person-Months:	0.12 summer
Total Award Period Covered:	8/1/17 – 7/31/20
Location of Project:	Michigan State University
Brief Description of Project:	This project aims at developing and applying complementary many-body methods to a wide variety of nuclear systems, ranging from stable closed-shell nuclei and homogenous dense nuclear matter to exotic loosely-bound neutron and proton rich nuclei far from shell closures. The proposed research will be built around thoroughly modern\emph{ab initio} many-body methods such as coupled cluster theory and the in-medium similarity renormalization group.
Overlap:	Except for the expertise of Bogner and Hjorth-Jensen that will be used in the new proposal to link with new methods from quantum computing and quantum information theory, there is no overlap.

Pending

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12 summer
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.

Overlap with Proposed Research: this is the proposed project

Current and Pending Support

Dean Lee

Current

Sponsor:	Department of Energy
Award Number:	DE-SC0018638
Project/Proposal Title:	Nuclear Theory from First Principles to Forefront Experiments
Total Award Amount:	$210,000
Person-Months:	0.12 summer
Total Award Period Covered:	5/15/18 – 5/14/20
Location of Project:	Michigan State University
Brief Description of Project:	Lattice simulations based on chiral effective field theory are used to describe nuclear structure from first principles.
Overlap with Proposed Research:	No direct overlap.

Sponsor:	Department of Energy/NNSA
Award Number:	DE-AC52-06NA25396 (subaward from LANL)
Project/Proposal Title:	Large Scale Simulations of Nuclear Reactions
Total Award Amount:	$600,000
Person-Months:	1 summer
Total Award Period Covered:	10/5/18 – 8/30/22
Location of Project:	Michigan State University
Brief Description of Project:	Lattice simulations based on chiral effective field theory are used to describe nuclear scattering and reactions from first principles.
Overlap with Proposed Research:	No direct overlap.

Pending

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12 summer
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites

	researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project
Sponsor:	National Science Foundation
Project/Proposal Title:	Time fractals and discrete scale invariance with trapped ions
Total Award Amount:	$283,508
Person-Months:	0.5 summer
Total Award Period Covered:	5/16/19 – 5/15/22
Location of Project:	Michigan State University
Brief Description of Project:	Investigations of trapped ion systems which exhibit a spectrum with discrete scale invariance.
Overlap with Proposed Research:	No direct overlap. However some test examples in the current proposal will make use of findings from this project.

Current and Pending Support
Huey-Wen Lin

Current

Sponsor:	National Science Foundation
Award Number:	1653405
Project/Proposal Title:	"CAREER: Constraining Parton Distribution Functions for New- Physics Searches"
Total Award Amount:	$425,000
Person-Months:	2 SUM
Total Award Period Covered:	2017-2022
Location of Project:	Michigan State University
Brief Description of Project:	High-performance computing using lattice QCD to study the nucleon parton distribution functions and their applications and impacts on new- physics searches
Overlap with Proposed Research:	None

Pending

Sponsor:	Research Corporation Foundation for Scientific Achievement
Project/Proposal Title:	Unveiling the Three-Dimensional Structure of Nucleons
Total Award Amount:	$100,000
Person-Months:	0.5 SUM
Total Award Period Covered:	2020-2023
Location of Project:	Michigan State University
Brief Description of Project:	High-performance computing with lattice QCD to study the three-dimensional structure of nucleons
Overlap with Proposed Research:	None

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12 SUM
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that spanfrom strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Current and Pending Support

Andrea Shindler

Current

Sponsor:	Michigan State University, Discretionary Funding Initiative
Award Number:	N/A, internal MSU funds
Project/Proposal Title:	Fundamental symmetries from lattice QCD
Total Award Amount:	$50,000
Person-Months:	1 summer
Total Award Period Covered:	12/5/18 – 12/4/19
Location of Project:	Michigan State University
Brief Description of Project:	Software development for the calculation of fermionic disconnected diagrams relevant for the calculation of electric dipole moment and related quantities
Overlap with Proposed Research:	No Overlap

Pending

Sponsor:	Department of Energy
Project/Proposal Title:	From Quarks to Stars; A Quantum Computing Approach to the Nuclear Many-Body Problem
Total Award Amount:	$1,000,000
Person-Months:	0.12 summer
Total Award Period Covered:	10/1/19 – 9/30/22
Location of Project:	Michigan State University
Brief Description of Project:	This proposal aims at studying and applying recent developments of algorithms and methods from quantum computing and quantum information theory to studies of complex and strongly interacting nuclear many-particle systems. The proposal aims at developing new methods for studying systems that span from strong force simulations of quarks and gluons to many-body methods applied to the equation of state of dense matter. The proposal aims at developing interdisciplinary research projects that unites researchers in quantum computing and quantum information theory with theorists working on interacting many-particle methods applied to nuclear physics.
Overlap with Proposed Research:	this is the proposed project

Sponsor:	Department of Energy
Project/Proposal Title:	Fundamental symmetries using lattice QCD with the gradient flow
Total Award Amount:	$649,000
Person-Months:	2 summer
Total Award Period Covered:	5/16/19 – 5/15/22
Location of Project:	Michigan State University

Brief Description of Project:	Calculation, in lattice QCD, using the gradient flow of the nucleon electric dipole moment from all CP-violating source
Overlap with Proposed Research:	No Overlap
Sponsor:	National Science Foundation
Project/Proposal Title:	Fundamental symmetries using lattice QCD with the gradient flow
Total Award Amount:	$679,946
Person-Months:	2 summer
Total Award Period Covered:	5/16/19 – 5/15/22
Location of Project:	Michigan State University
Brief Description of Project:	Calculation, in lattice QCD, using the gradient flow of the nucleon electric dipole moment from all CP-violating source
Overlap with Proposed Research:	No Overlap