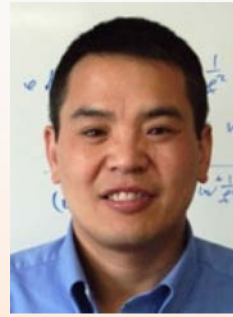
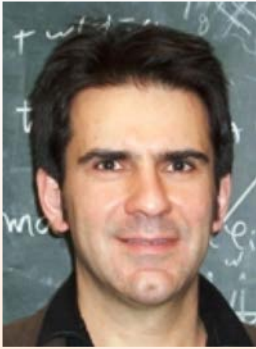




MARYLAND CENTER FOR FUNDAMENTAL PHYSICS

Theoretical Particle Physics, Nuclear
Physics, Gravity and Cosmology



Particle, Nuclear and
Gravity Theory Faculty
+ ~ 10 postdocs
~ 20 students



Particle Theory

Kaustubh Agashe

Phenomenology; extra-dimensional theories; model building, dark matter at colliders; composite leptogenesis

Chacko

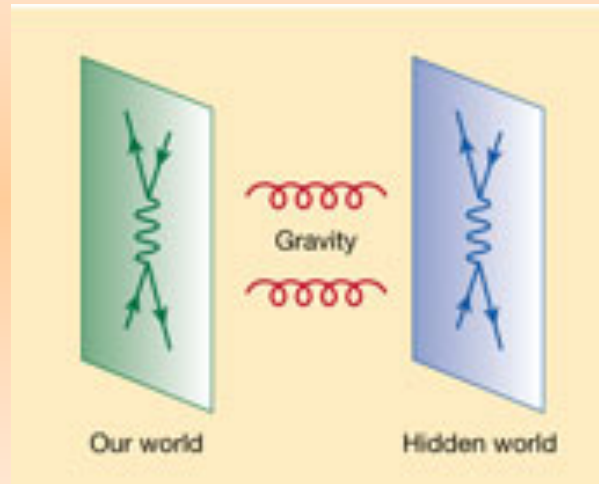
Model building; Twin Higgs models; mediation of SUSY breaking; dark matter, quirks; particle astrophysics

Anson Hook

Phenomenology and model-building; new experiments for dark matter, axions; new symmetries; cosmology

Raman Sundrum

Models; extra dimensions; Compositeness; SUSY; Dark Energy; QFT; AdS/CFT; cosmology



Rabi Mohapatra

neutrino masses and mixings; GUTS; Leptogenesis, dark matter, model building

Nuclear Theory; QCD

Xiangdong Ji

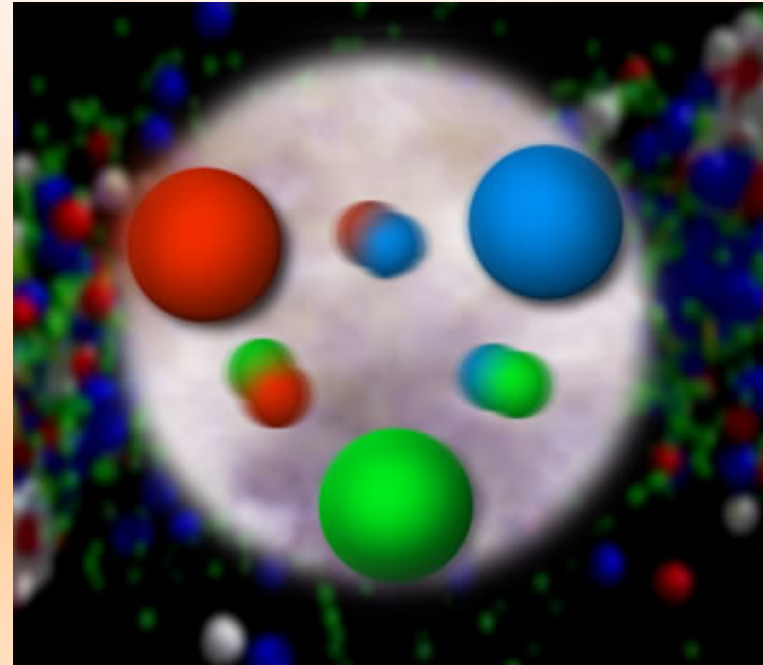
Hadron structure and electron-ion collider physics. Perturbative QCD. Neutrinos. GUTS. Leptogenesis. Dark matter experiments

Paulo Bedaque

Nonperturbative QCD. large N_c QCD. Effective theories. Lattice QCD. Neutron stars. Quantum computing and machine learning for nuclear physics

Tom Cohen

Nonperturbative QCD. Heavy-ion collisions. large N_c . Effective field theories



Zohreh Davoudi

Nuclear physics and SM tests via lattice QCD simulations and effective field theories. Quantum simulation for strongly interacting theories and interface with AMO simulator technologies.

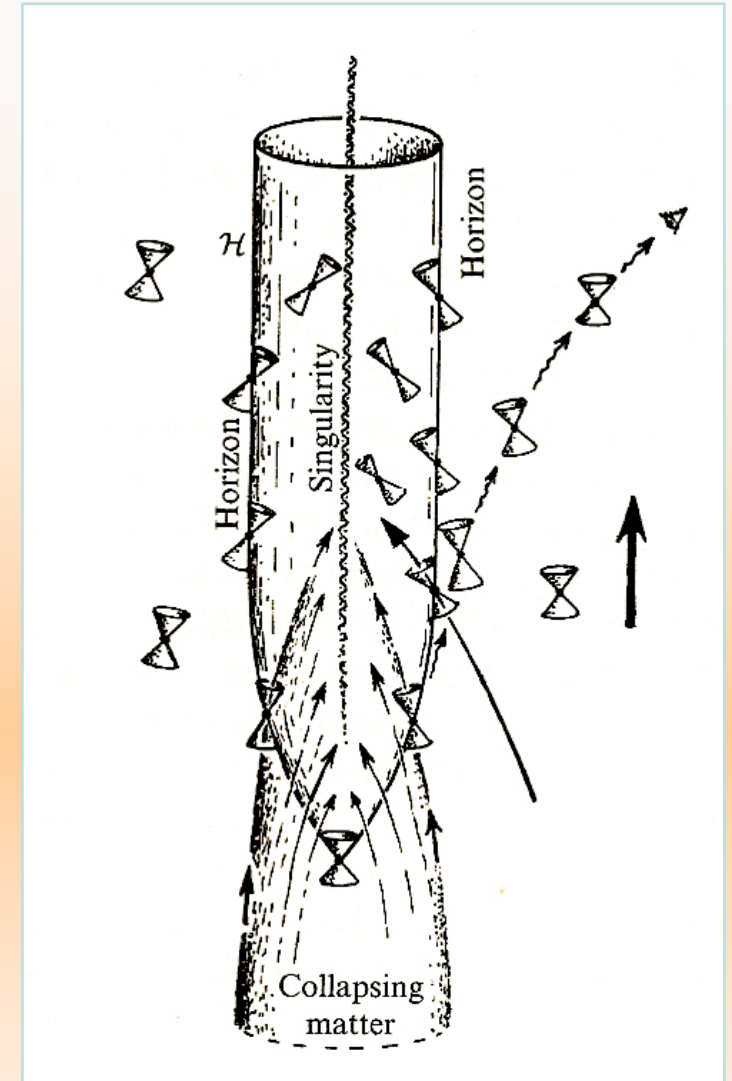
Gravity; GR

Alessandra
Buonanno MPI
Potsdam & 15% at
UMD

Gravitational wave analyses and modeling of astrophysical sources; test of GR; black holes & neutron stars

Ted Jacobson

Quantum gravity; black hole thermodynamics; BEC analogs of Hawking radiation and cosmological QFT

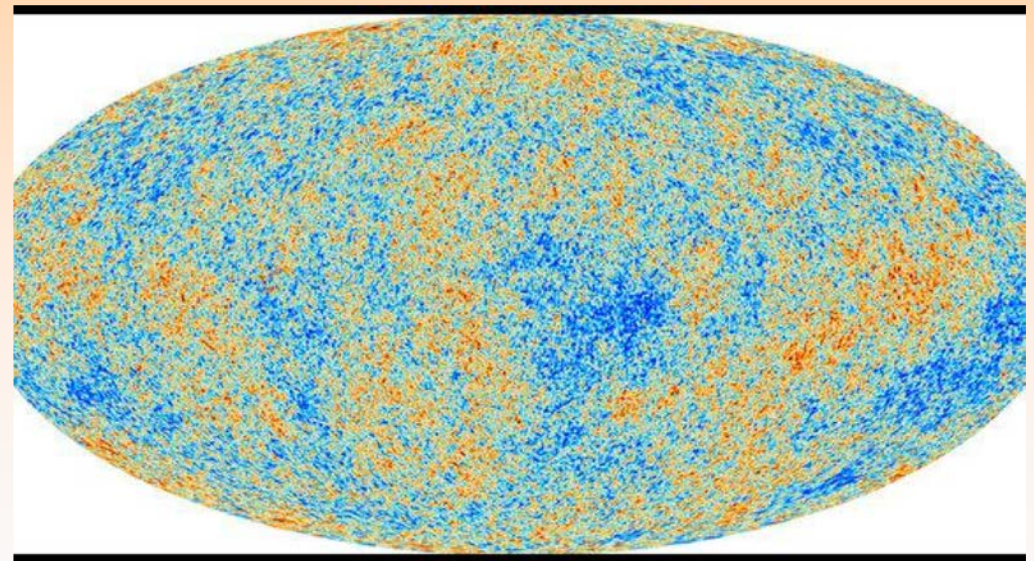
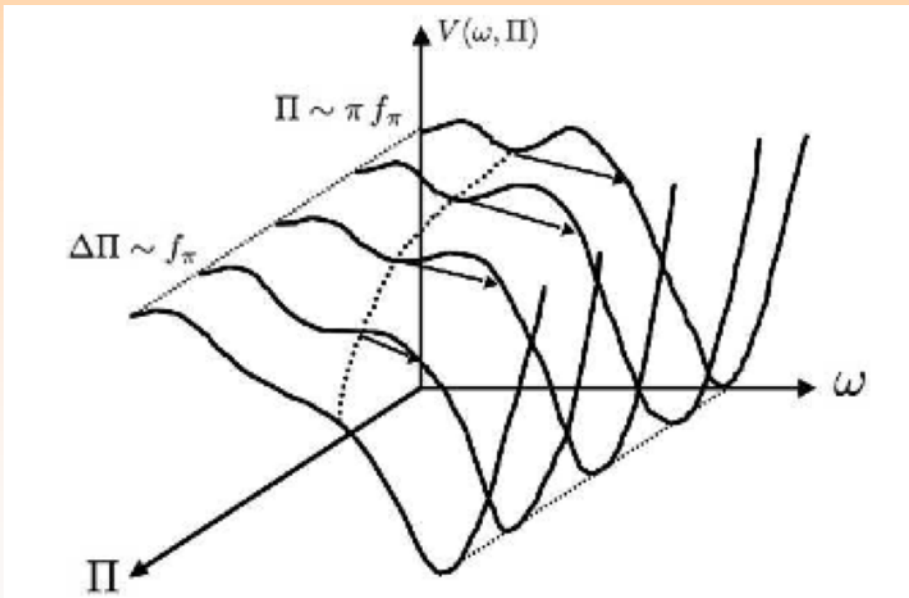


Bei-lok Hu

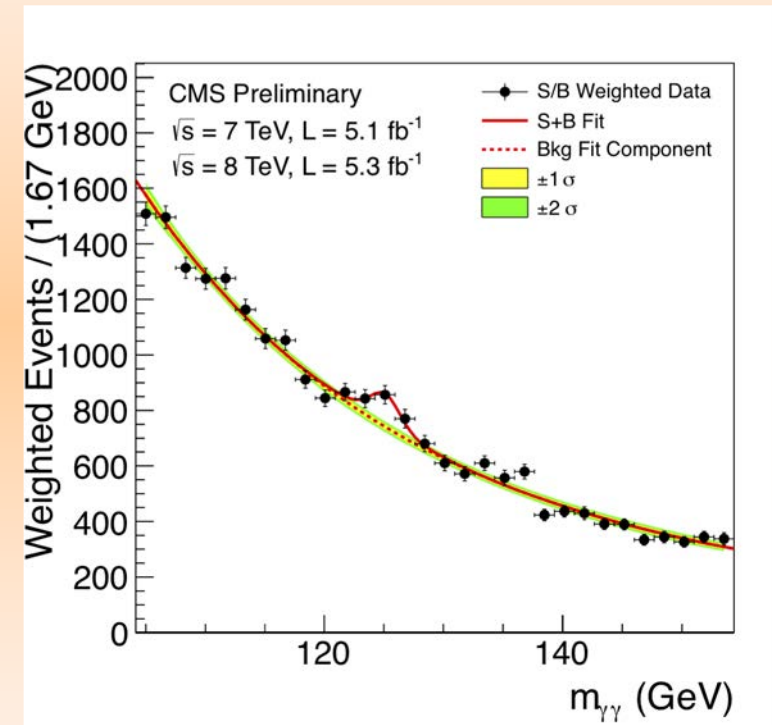
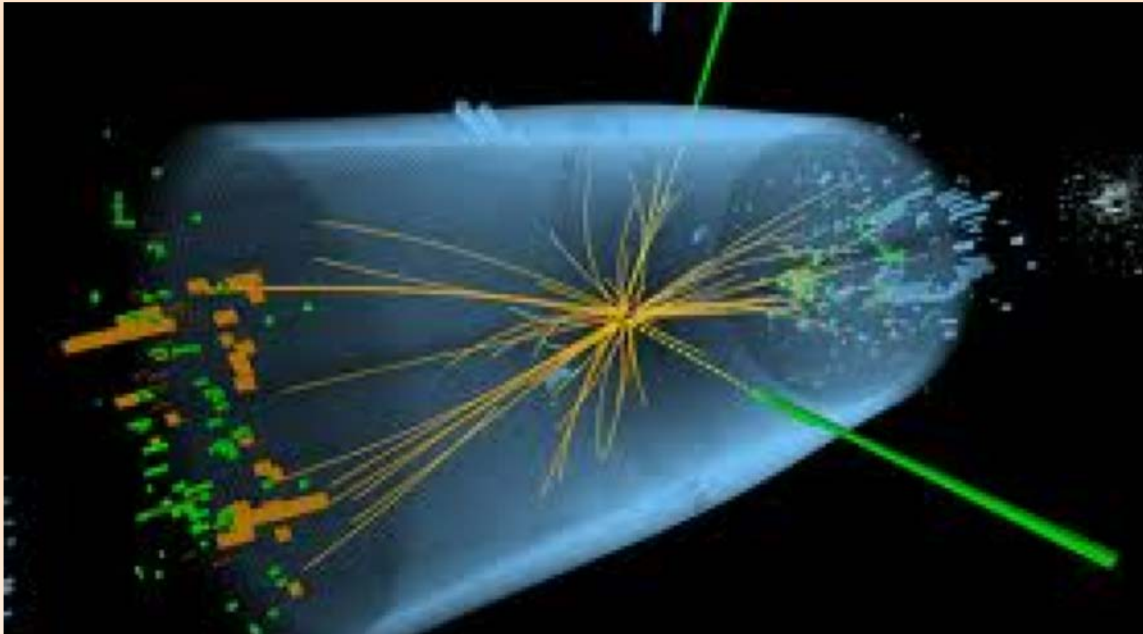
Quantum field theory in curved space, out of equilibrium

Cosmic Microwave Background

- as seen by Planck Satellite
- Temperature fluctuations contain “quantum fossils” of Cosmic Inflation



Higgs Boson: Missing Link of Electro-Weak Unification



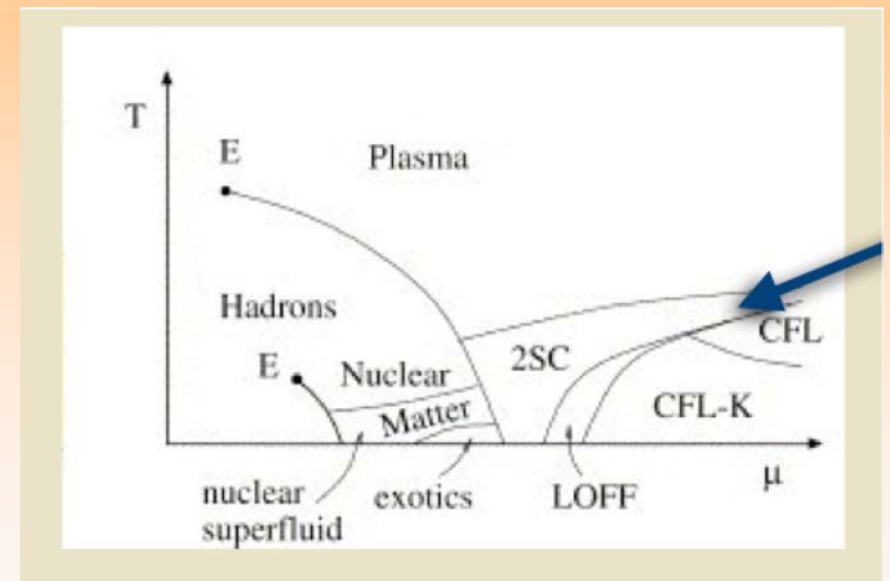
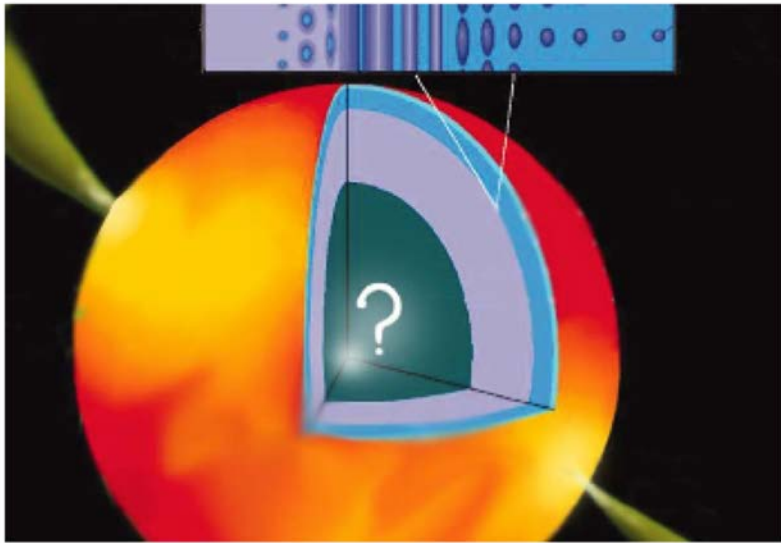
Exotic non-standard Higgs decays?
“Portal” to other sectors beyond standard model?

Dark Matter, Dark Energy, Dark Aethers

- Theoretical Modeling of Universe's most mysterious ingredients
- Proposing new ways of discriminating their properties experimentally

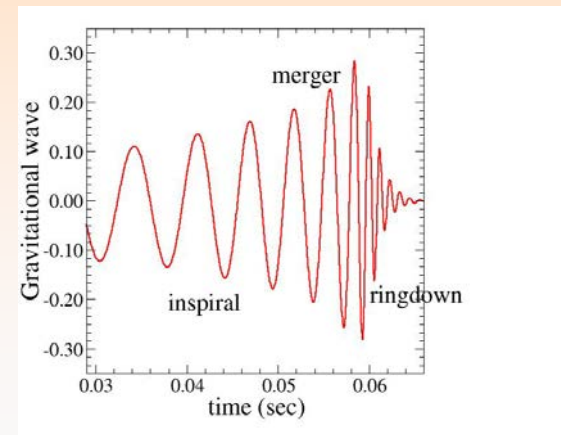
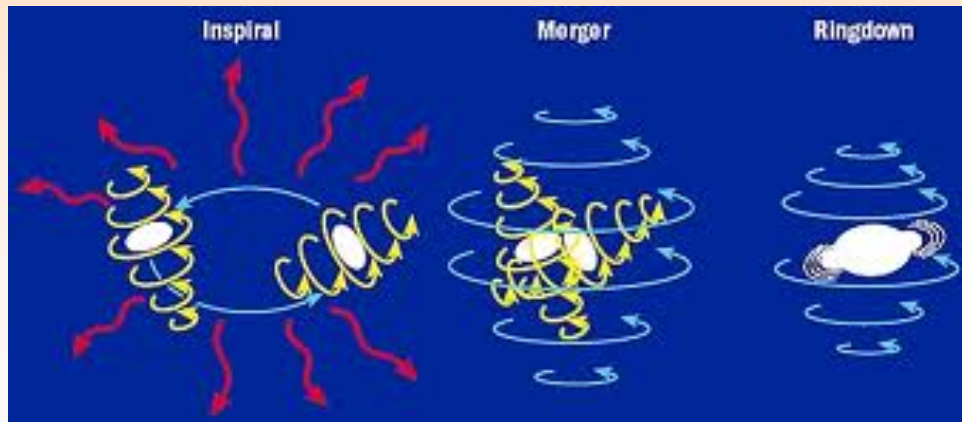


Neutron Stars: Strongly-Coupled Superfluid



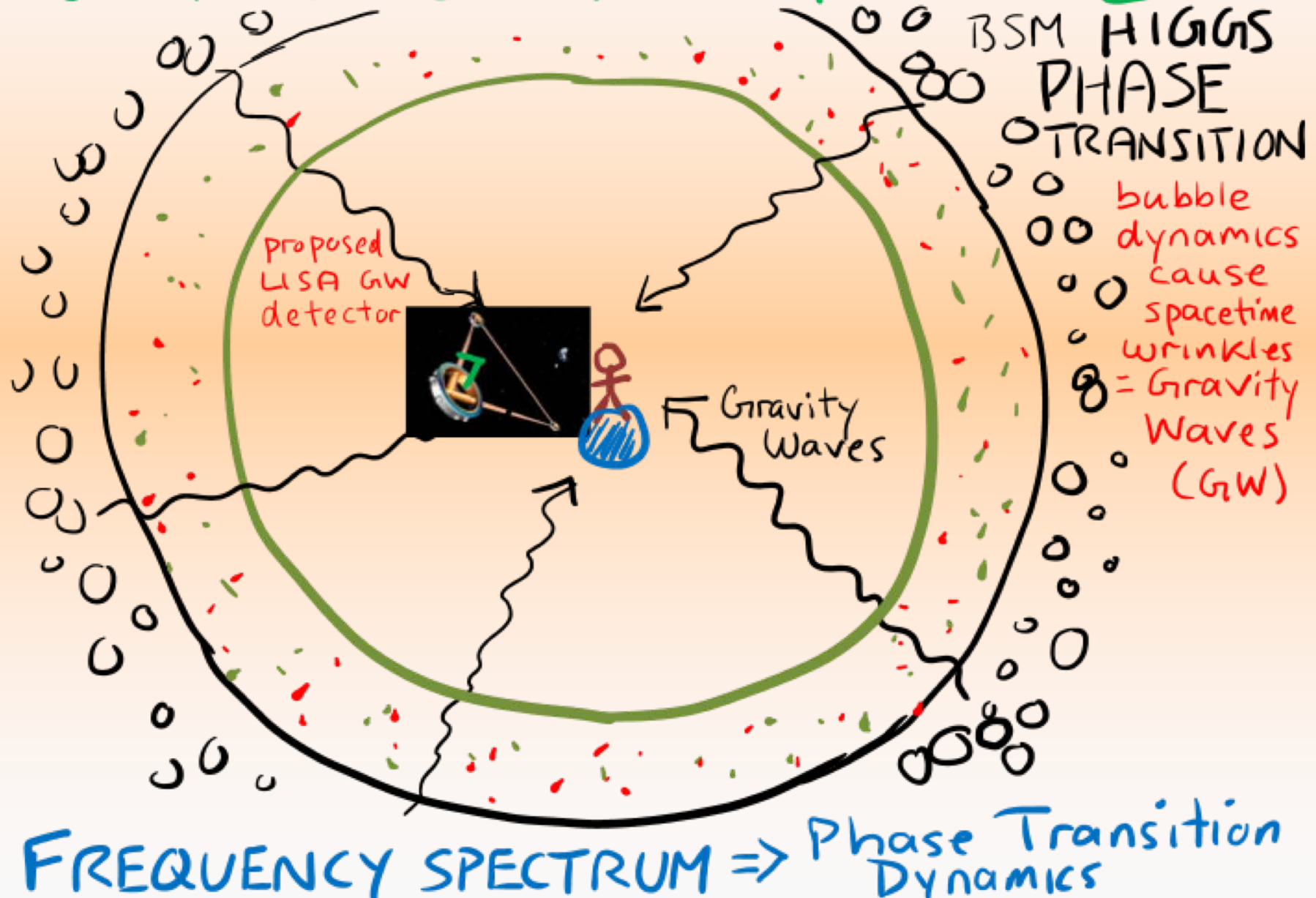
Gravitational Waves

- Theoretical templates for signals by modeling and understanding likely sources
- Testing GR and sensitivity to NEW long-range forces and physics



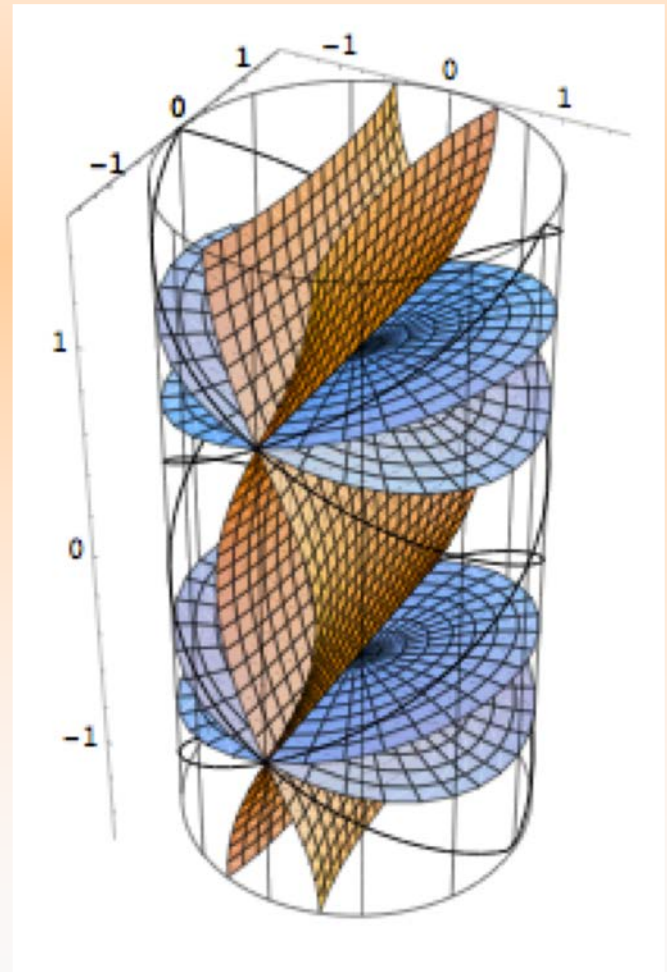
Gravitational Wave Cosmology:

WRINKLES IN SPACETIME



Quantum Mechanics and Black Holes

- Information Paradox
- Quantum Entanglement
- Hawking Radiation
- Black Hole Singularity
- AdS/CFT dualities to other systems



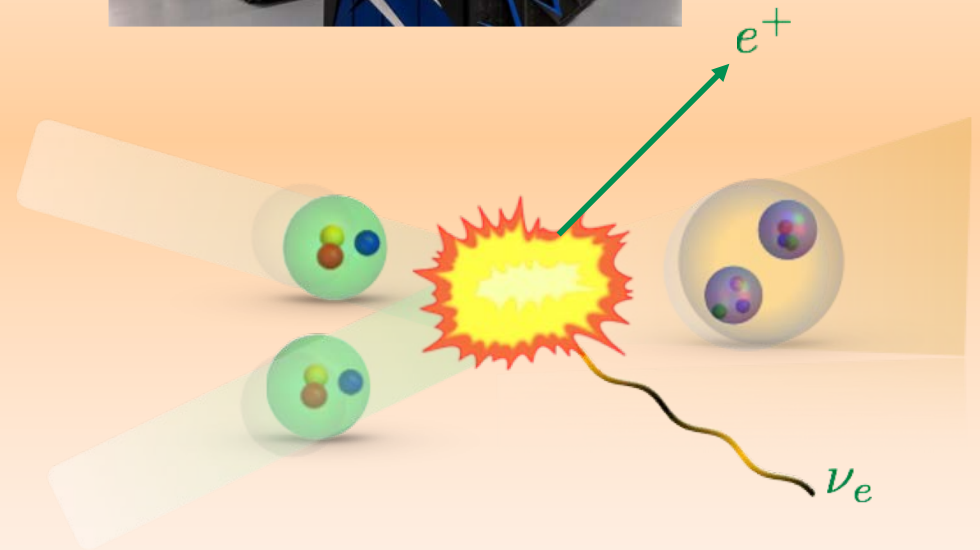
Lattice gauge theory for first-principle studies of nuclei and matter

Lattice QCD for nuclear physics

- Large-scale simulations of structure and reactions
- Theory developments for interpreting the results

New classical algorithms to alleviate the sign problem

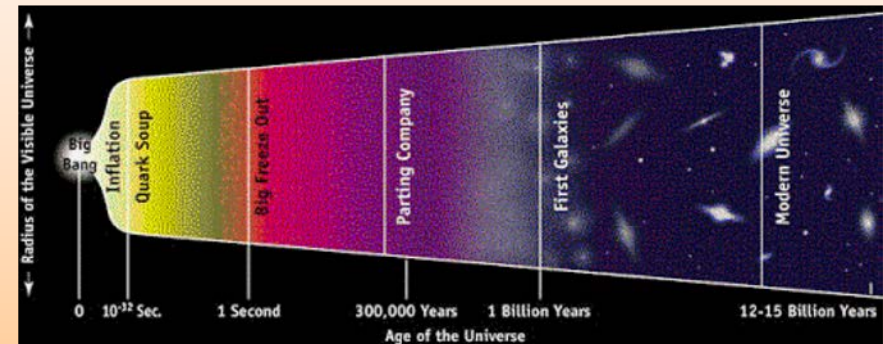
- Thimbles and other ideas
- Machine-learning assisted approaches



Quantum simulation and quantum computing

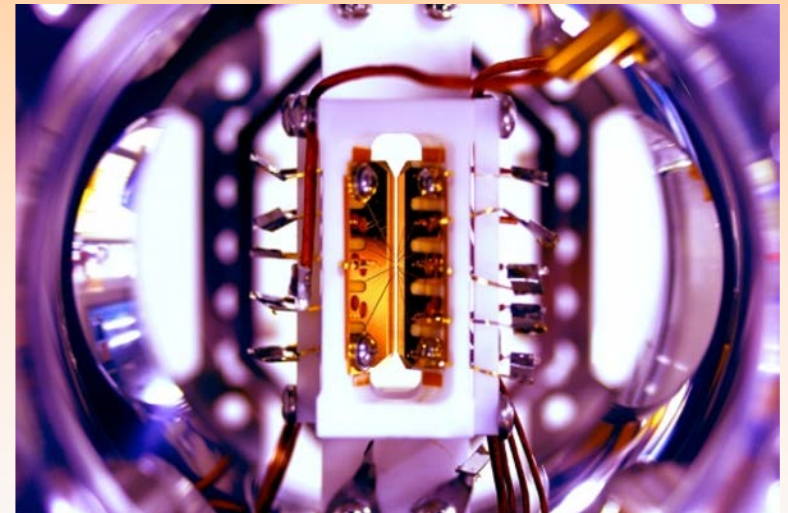
To defeat sign problem in classical simulations of:

- Real-time dynamics after Big Bang and in heavy-ion collisions.
- Phases of matter in universe



Our approach

- Theory and algorithm developments
- Benchmarking on available quantum simulators and quantum computers



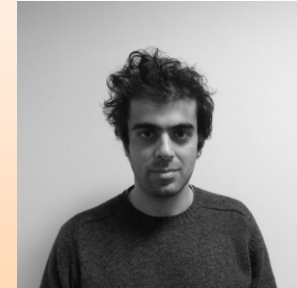
Many of our students and postdocs go on to top postdocs and faculty positions



Aron Wall
Graduated: 2011, Black Holes
Faculty at the University of Cambridge



Srimoyee Sen
Graduated: 2015, Neutron stars
Faculty at Iowa State University



Aleksandr Azatov
Graduated: 2010, particle theory
Faculty at SISSA, Trieste, Italy



Ryan Behunin
Graduated: 2010, non-equilibrium QFT
Faculty at Northern Arizona University



Aleksey Cherman
Graduated: 2010, Nuclear QFT
Faculty at University of Minnesota



Prateek Agrawal
Graduated: 2012, Dark Matter Theory
Postdoc at Harvard, accepted faculty
position at Oxford University

EXPERIMENTS pursued at UMD

- **Large Hadron Collider- Baden, Belloni, Eno, Palmer, Skuja**
- **LHCb- Jawahery, Franco Sevilla**
- **IceCube- Sullivan, Hoffman**
- **LIGO - Shawan**
- **Lux, EXO - Hall**
- **HAWC - Goodman**
- **AMS – Seo**
- **Quantum simulation experiments: Linke**
- **Analog gravity/cosmology experiments in Bose condensates: Campbell, Spielman**

PARTNERS/Nearby Institutions

- **Joint Space Institute (JSI) – Goddard Space Flight Center, UMD Astronomy**
- **Johns Hopkins University Department of Physics and Astronomy – joint particle theory+experiment seminars, joint particle theory postdoc**
- **Hubble Space Telescope Science Institute**
- **Max Planck Institute for Gravitational Physics, Potsdam**
- **Joint Quantum Institute (JQI) and Joint Center for Quantum Information and Computer Science (QUICS), NIST/UMD partnerships**