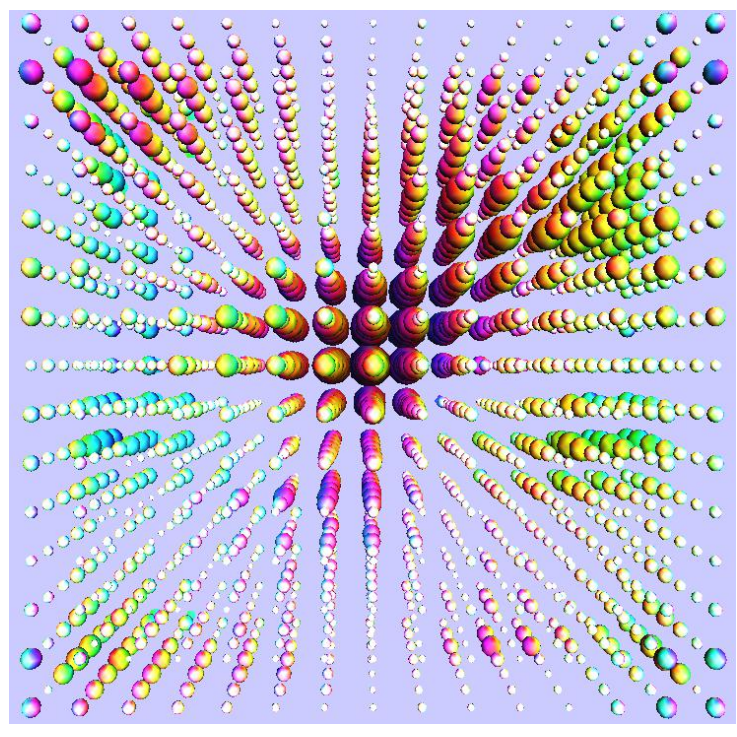


Research Context: Lattice field theory

www.davidschaich.net

Quantum field theory (QFT) { governs fundamental constituents of the universe and how they interact
 combines quantum mechanics + special relativity



Replace continuous space & time → discrete **lattice** of points

- ⇒ Formal mathematical definition
- ⇒ Numerical predictions from supercomputing
- Crucial tool for **strongly interacting** systems

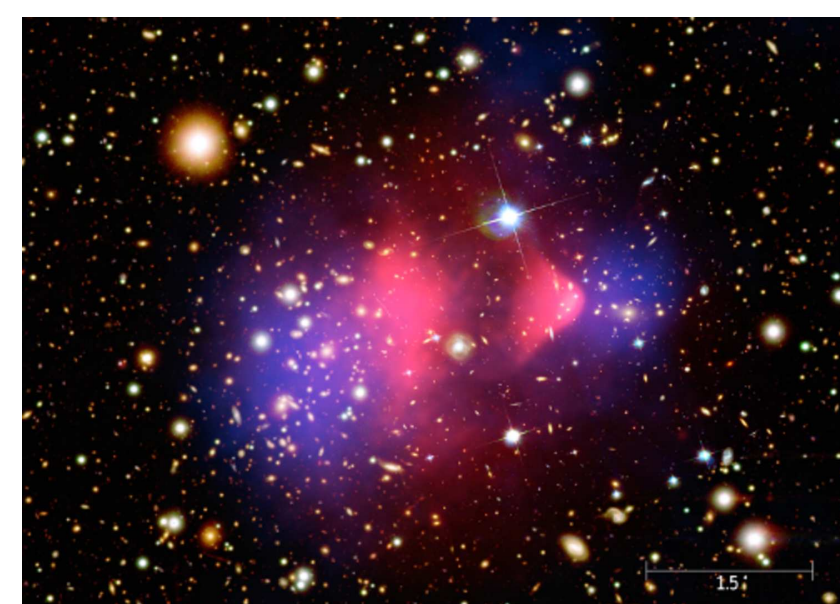


My project applies lattice field theory to three inter-related new frontiers

Frontier: Composite Higgs and composite dark matter

Hypothesize Higgs boson or dark matter
 arise from strongly interacting QFT

Can explain currently mysterious features of these particles



Goal: Predictions for collider experiments & gravitational waves

Recent achievements

Composite Higgs

—arXiv:2007.01810

—arXiv:2106.13534

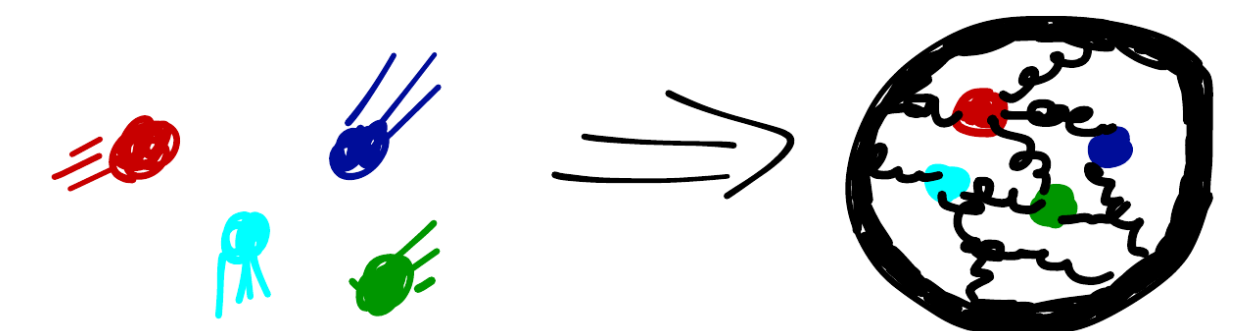
—Seminar (DS)

Composite dark matter

—Hired PGR Felix Springer

—arXiv:2006.16429

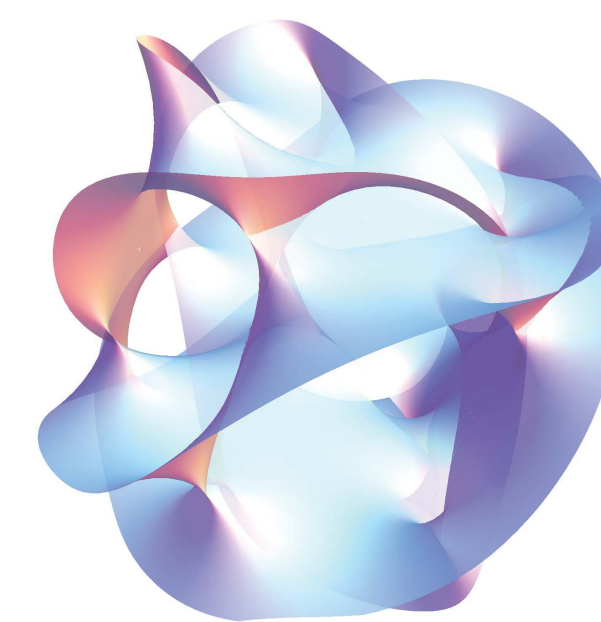
—Conference poster (FS)



Frontier: Supersymmetry and holographic dualities

Holographic duality conjecture

Quantum gravity equivalent to supersymmetric QFT
 → non-perturbative definition from lattice field theory



Challenge: Discrete lattice space-time breaks supersymmetry

Goal: Develop and apply novel lattice methods
 to test holographic duality and investigate quantum gravity

Lattice supersymmetry

—Hired PGR Angel Sherletov

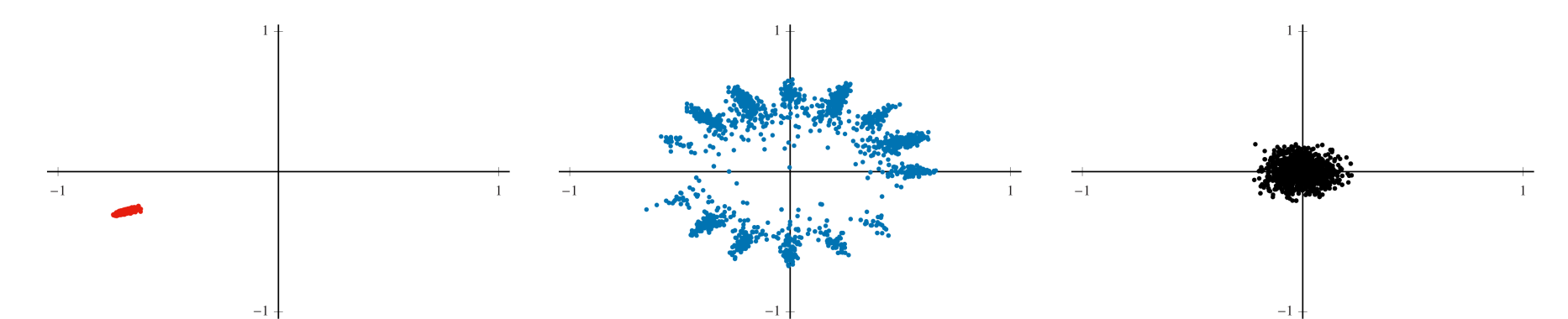
—arXiv:2010.00026

—arXiv:2102.06775

—arXiv:2109.01001

—Conference poster (AS)

—Conference talk (DS)



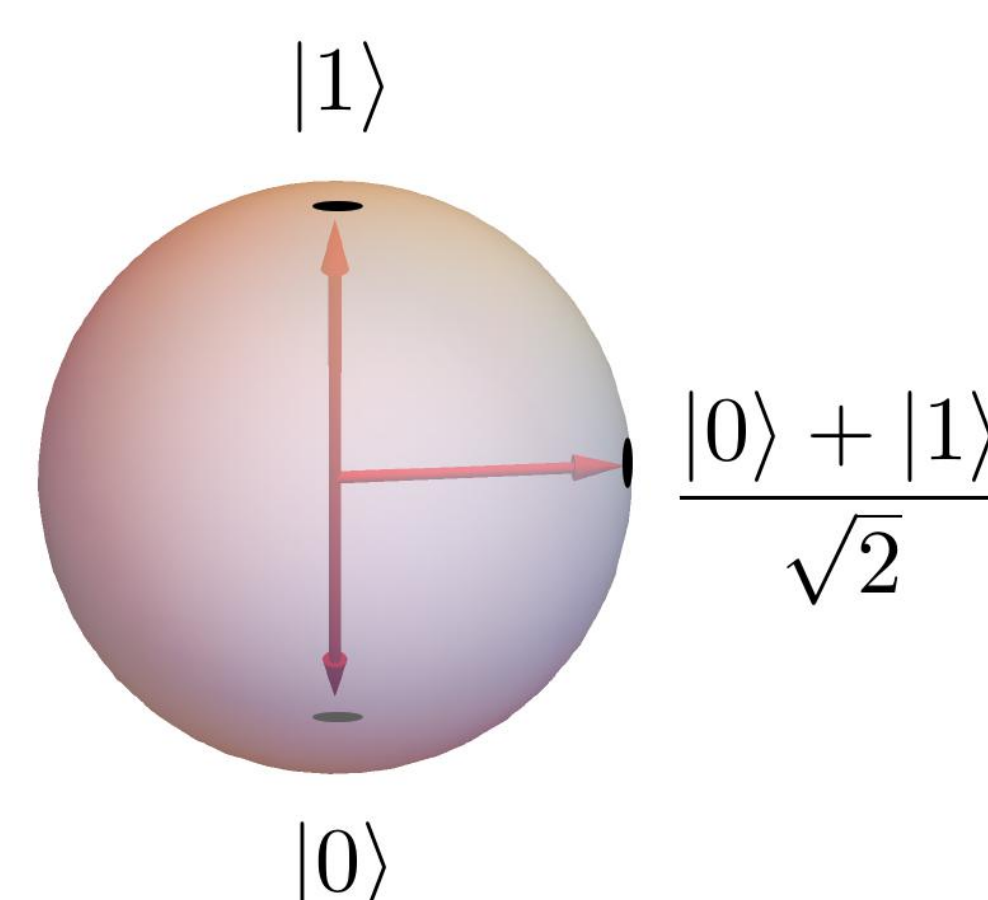
Frontier: Sign problems and quantum computing

Problem: Algorithms encounter negative (or complex) numbers
 where they expect probabilities between 0% and 100%

⇒ Exponentially increasing computational costs
 to analyze quantum systems with non-quantum methods

Goal: Develop and apply quantum methods
 to investigate quantum systems

Requires complicated reformulation
 in terms of entangled **qubits**



Working with emerging UK quantum technologies industry
 to build upon recent progress and advances

Quantum computing

—Hired PDRA Chris Culver

—Conference talk (CC)

—U. Liverpool Quantum
 Computing Network

—IBM Research & Hartree

—Quantum Computing
 & Simulation Hub

—National Quantum
 Computing Centre

