# A Monte Carlo Study of the Classical, Isotropic, 3D Heisenberg Model

## Numerical Studies of Stochastic Spin Systems

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# Goal and Purpose

- Simulate the classical, isotropic, 3D Heisenberg Model on the simple cubic lattice
- Utilize the Monte Carlo method with the Metropolis Algorithm
- Compare simulation data to literature data

# Brief Overview

We undertook a study of stochastic spin system during the 2013-2014 school year for a PHY 499 Independent Study and PHY 471 Capstone Project. The fields of thermodynamics, statistical mechanics, and numerical methods are applied to compare analytic solutions to Monte Carlo Metropolis simulations of the 3-State Problem, the Ising Paramagnet, and the Heisenberg Paramagnet. Systems without analytic solutions are numerically explored and compared with current research data. The 2D and 3D Ising Model are explored in preparation for simulations of the classical Heisenberg Model. Finally, the classical Heisenberg Model is discussed, simulations presented, and results reviewed.

# Background and Theory

- Equilibrium Statistical Mechanics
- Canonical Ensemble
- Boltzmann Distribution
- Partition Function
- Energy, specific heat, entropy, free energy
- Fluctuations

# Background and Theory

# Background and Theory

- Numerical Analysis
  - No analytic solution or intractable
- Monte Carlo Simulation
  - Estimator
  - Importance Sampling
    - Markov Processes
    - Ergodicity
    - Detailed Balance
  - Acceptance Ratio

# Background and Theory

## Monte Carlo Example

Pi calculation example (?)

# Directly Related Stuff

# Steps in Chronological Order

## A bit more information about this

# Results

# Conclusions to be Drawn

## A bit more information about this

# Ways to Improve/Issues

# Next Steps

## A bit more information about this

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## A bit more information about this