An introduction to Lattice Quantum Chromodynamics

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Abstract

1 Introduction

The aim of this paper is to give a hand-on introduction to the how one can go from a rudimentary understanding of quantum mechanics and quantum field theory, to simulating quantum chromodynamics on the lattice. In order to kick this is of, let us begin by discussing our end-goal, Quantum Quantum Chromodynamics(QCD).

QCD is the theory for interacting quarks and gluons. It has since its inception gotten a reputation notoriously difficult to work with, much because it is not linear due to its three- and four-vertex gluon self interactions.

2 Refreshing quantum mechanics

3 The path integral formalism

Wick rotation.

4 The Metropolis algorithm

5 Statistical analyses

What is autocorrelation? Autocorrelation versus correlation?

5.1 Bootstrapping

5.2 Jackknife method

5.3 Blocking

6 Quantum Field Theory and its fundamentals

6.1 Observables

6.2 Action

7 Lattice Quantum Chromodynamics

7.1 Making a theory gauge invariant

7.2 The Plaquette

7.3 The Wilson gauge action

7.4 Notes on a Lattice QCD simulation

7.4.1 Updating matrices

7.4.2 Generating random $SU(3)$ matrices

7.4.3 Generating random $SU(2)$ matrices