

# Lattice Gauge Theory

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## 1 Introduction

The essential idea of lattice gauge theory is to numerically evaluate the path integral for a quantum theory in order to determine correlation functions. From these correlation functions, we can get the physics.

## 2 Basic Definitions

Instead of working with gauge connections  $A_\mu(x)$ , the fundamental gauge fields that we work with are the parallel transporters  $U(x, y)$ . When quantized, we call these fields  $U_\mu(n)$  the **link fields**. Under a gauge transformation  $\Omega(n)$ , the fields transform as:

$$\psi(n) \mapsto \Omega(n)\psi(n) \tag{1}$$

$$U_\mu(n) \mapsto \Omega(n)U_\mu(n)\Omega(n + \hat{\mu})^\dagger \tag{2}$$

This allows a nice definition of the **gauge covariant derivative**. We consider both the forward difference and the backwards differences:

$$\vec{D}\psi(n) = \frac{1}{2a} \left( U_\mu(n)\psi(n + \hat{\mu}) - U_\mu(n - \hat{\mu})^\dagger\psi(n - \hat{\mu}) \right) \tag{3}$$

$$\overleftarrow{D}\psi(n) = \frac{1}{2a} \left( \overleftarrow{\psi}(n + \hat{\mu})U_\mu(n)^\dagger - \overleftarrow{\psi}(n - \hat{\mu})U_\mu(n - \hat{\mu}) \right) \tag{4}$$

We generally will consider the difference between these two operators:

$$\overleftrightarrow{D} := \vec{D} - \overleftarrow{D} \tag{5}$$

## 3 Lattice Units

## 4 Clover Improvement

## 5 QLUA Snippets