Abstract for the Eurasia-Pacific Summer School and Conference 2012 (Lectures)

Synthetic Gauge Fields in Ultra-cold Atomic Systems

Özgür Müstecaplıoğlu
Department of Physics, Koç University, Istanbul, Turkey

This short set of lectures introduce the basics of how to design optically induced effective electric and magnetic fields to simulate various phenomena of charged particles in electromagnetic fields. Examples to be reviewed include Dirac monopoles, Quantum Hall effect, Spin Hall effect and Topological Insulators. Promise of non-Abelian anyons in fractional quantum Hall effect in the context of ultracold atom systems will be briefly discussed.

Outline:

Part I: Principles

1. Quick Review of Semiclassical Quantum Optical Models of Two and Three-Level Atoms, Dressed states and dark States
2. Adiabatic Theorem and adiabatic approximation, Born-Oppenheimer Approximation, Jahn-Teller Effect, Berry phase, Diabatic and Adiabatic Basis

Part II: Implementations and Applications

3. Synthesis of effective scalar and vector potentials in typical general ultracold atomic schemes
4. Examples of synthetic gauge fields: Monopoles, Hall Physics, Spin-Orbit coupling, Topological Insulators, Anyons