

Quantum Tunnelling and Instantons

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Teaching assistant:

Texts:

Course text: Aspects of Symmetry: S. Coleman

Lecture Notes: Instanton Calculus: M. B. Paranjape

Lecture Notes: Path Integrals: R. B. MacKenzie

Other texts: Solitons And Instantons, R. Rajaraman
The Principles Of Instanton Calculus, J. Zinn-Justin
Techniques and Applications of Path Integrals, L. Schulman
Quantum Mechanics and Path Integrals, R. Feynman and A. Hibbs
Instantons in Gauge Theories, M. Shifman

Subjects to be covered:

1. Quantum mechanics and path integrals
2. Instantons in quantum mechanics
 - (a) Tunneling phenomena: Double well and Periodic potentials
 - (b) Decay of meta-stable states
3. Quantum field theory and the functional integral approach
 - (a) Tunneling in field theory
 - (b) Decay of the false vacuum
4. Instantons and large orders in perturbation theory
5. Instantons and quantum electrodynamics - the abelian case, 1+1 dimensions
6. QCD-Overview
 - (a) Topological considerations
 - (b) Instantons in nonabelian gauge theories - the case of unbroken gauge symmetry
 - (c) The effects of the $\theta F_{\mu\nu}\tilde{F}_{\mu\nu}$ term
 - (d) The effects of fermions
 - (e) The axial anomaly and the $U(1)$ problem