

Krishna Kalluri

Oral Qualifying Exam Syllabus

3/11/2025

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Major: Quantum Field Theory on Curved Spacetimes

1. Quantum Mechanical Preliminaries

- Classical Dynamics of Particle Systems
- Quantum Mechanics
- Harmonic Oscillators

2. Quantum Fields in Flat Spacetime

- Basic Construction
- Reformulation
- Particle Interpretation

3. Quantum Fields in Curved Spacetime

- Curved Spacetimes; Global Hyperbolicity
- Construction of Quantum Field Theory in a Curved Spacetime
- Quantum Field Theory in Stationary Spacetimes
- Unitary Equivalence; the S-Matrix

Minor: Functional Analysis

1. Hilbert Spaces

- The Geometry of Hilbert Space
- The Riesz Lemma
- Orthonormal Bases
- Tensor Products of Hilbert Spaces

2. Banach Spaces

- Definition and Examples
- Duals and Double Duals
- The Hahn-Banach Theorem
- Operations on Banach Spaces
- The Baire Category Theorem and its Consequences

3. Locally Convex Spaces

- General Properties
- Functions of Rapid Decrease and Tempered Distributions

4. Bounded Operators

- Topologies on Bounded Operators
- Adjoints
- The Spectrum
- Compact Operators

- The Trace Class and Hilbert-Schmidt Ideals
- 5. The Spectral Theorem
 - The Continuous Functional Calculus
 - The Spectral Measures
 - Spectral Projections
- 6. Unbounded Operators
 - Domains, Graphs, Adjoints, and Spectrum (Definitions Only)
 - The Basic Criterion for Self-Adjointness (One Theorem on Basic Criterion for Self-Adjointness Only)
 - The Spectral Theorem (Statement and Examples Only)
 - Stone's Theorem (Theorem Statement Only)

References

- Robert M. Wald, Quantum Field Theory in Curved Spacetimes and Black Hole Thermodynamics, The University of Chicago Press, 1994
- Michael Reed, Barry Simon, Methods of Modern Mathematical Physics I: Functional Analysis, Academic Press, Inc., 1980