

Student Friendly QFT Website Topics

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The files listed below entail additional material to help with the SFQFT texts and pedagogic aids to a number of other topics. They can be found in subdirectories of the present directory, as well as at the website above. Some are stand-alone documents. Others are best used as auxiliary material, to help with particular textbooks.

For example, the Quantum Fields in General Relativity files help with the Mukhanov & Winitzki text and among other things, provide detailed steps the authors omitted in their derivations. (In two cases, the detailed steps entail over a page and a half, whereas the authors did it all in one line.) The String Theory Pedagogic Summary is best used with the Zwiebach text and includes similar details for many derivations. Those and other files include wholeness chart overviews of material presented by authors (but, of course, without the wholeness charts).

Other files, such as The Cosmic Microwave Background, are stand-alone and can be used without an accompanying text.

Note: Below links to topics work in the Word version of this document, but not in the pdf version.

Auxiliary Material (Augments Volume 1. All downloadable.)

[Glossary of book symbols](#)

[Summary of Special Relativity](#). A wholeness chart of the key relations/equation in special relativity theory along with explanatory notes on how they were arrived at.

[Pedagogic Aids to Chap 2 of SFQFT](#). Some background info to help with Chap. 2 for those who may not be well versed in certain concepts from quantum mechanics taken for granted in that chapter.

[Box2_2_comments](#) My purpose in this box was to give a derivation of (B2-2.3) that was much simpler than that in other books. There are some subtleties involved, but it is best not to worry about them until after you have mastered QFT. If at that time, you feel up to it, check out this link.

[Summary of operators, fields, and states in different QFT vector spaces](#). A summary of the different ways (fields vs states) one can think of a vector space in QFT and the operators acting on it. Helpful near the end of Chap. 3.

[Subtleties for eq \(3-47\)](#)

[Dirac delta function forms](#). A summary chart of different forms for the Dirac delta function depending on whether the volume is infinite (with no boundary conditions) or finite (with boundary conditions) for both 4D spacetime and 4D momentum space.

[Solution to text Prob. 6-14.](#)

[Spins, Spinors, and Boosts](#). How the change in spinor basis vector amplitudes can be determined when a general case spinor is boosted.

[Symmetries Summary External vs Internal](#). A wholeness chart summary of symmetries comparing and contrasting internal vs external symmetries and what is conserved in each case. Probably best after digesting Chap. 6 in Vol. 1. The second page is for superstring theory and should be ignored until, and if, you study that. (Revised Jan 13, 2023).

[Continuous Solutions Creation and Destruction Operator Derivation](#) A derivation and explanation of creation/destruction operators for the continuous solution form of the field equations shown in Chap. 10. Scalars only, though spinor and vector derivations are parallel.

[Vacuum overview slides](#). Slide show overview of Chap. 10 on the vacuum.

[Vacuum Fluctuations Update \(Added Appendix F for Chap 10\)](#). Overview of recent experimental results on vacuum fluctuation detection, a new theoretical paper on the Casimir plate effect, and the role of the vacuum in spontaneous emission.

[Solution to text Prob. 17-7.](#)

[Spreadsheet for text Fig. 18-3](#)

[Alternative derivation for Sect. 18.9.2](#). Thanks to Luc Longtin (not by R. Klauber).

[Non Eigen States, Wave Packets, and the Hamiltonian in QFT](#) (Updated with corrections June 1, 2016.) A look at states in QFT which are not eigenstates of three momentum \mathbf{k} , and additionally, wave packet states in QFT. The action of the QFT Hamiltonian on these states is investigated. This material does not seem to be available in QFT texts.

Auxiliary Material (Augments Volume 2. All downloadable.)

[Derivation of \(2-25\)](#) and [Derivation of \(2-28\)](#) from general principles for those who really want to get into the math. Thanks to Luc Longtin (not by R. Klauber).

[Summary of operators, fields, and states in different QFT vector spaces](#). A summary of the different ways (fields vs states) one can think of a vector space in QFT and the operators acting on it. Helpful with Chap. 2.

[Spinor Lorentz transformation](#). An elaboration on the Lorentz transformation of spinors, pg. 153

[Proofs of gamma matrix trace relations \(5-87\)](#). Thanks to Luc Longtin.

[Flavor vs Mass Eigenstates Summary](#). The treatment of mass vs flavor eigenstates from page 225 to page 238 is summarized in this wholeness chart.

[Overview of the Standard Model Chart by Boyle](#). A terrific summary chart of the standard model by Latham Boyle. Included in July 2025 revision.

[Addendum to Appendix A of Chap. 8](#) An aide to understanding polarization bases for vector fields, with particular focus on massive vector fields. Helps with Appendix A of Chap. 8. Added to June 2022 revision.

Advanced Material (Beyond, or not in, the SFQFT texts. All downloadable.)

[Cosmic Inflation](#) A pedagogic step-by-step derivation of the basic governing relations for big bang inflation theory. Requires prior knowledge of general relativity applied to cosmology, i.e., familiarity with the 1st Friedman equation and the local energy balance equation for an expanding universe.

[Conformal and Scale Invariant Transformations](#) A simplified explanation of conformal and scale invariance.

[Freeze-out in the Early Universe](#) Description of how particles, like possibly dark matter, “freeze-out” of the particle “soup” shortly after the Big Bang.

[Generalized Coordinates and Metrics: A Pedagogic Intro](#) A simplified, student friendly introduction to generalized coordinates, metrics, their use in curved spaces, and general relativity.

[Quantum Fields in General Relativity](#) A collection of pedagogic notes on quantum fields in gravity and accelerated systems. Includes an introductory wholeness chart for scalar fields in general relativity, quantum fields in expanding universes, the Fulling-Davies-Unruh effect, and Hawking radiation. Also includes the same article whose link is below on vacuum fluctuations as correlation functions, as that is relevant for the early universe and its subsequent evolution. Based on the book by Mukhanov and Winitzki (see full citation at link.)

[Vacuum Fluctuations as Correlation Functions](#) More on “vacuum fluctuations” beyond that of Chap. 10 in Volume 1. Evaluation of correlation functions as a means of measuring vacuum field fluctuations.

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Other Subjects (Pedagogic presentations of topics not directly related to QFT. All downloadable.)

[Pedagogic Aids to Supersymmetry](#). Simplified explanations of some basic concepts in supersymmetry that may be difficult to understand as typically presented. Sect. 6 is a simplified, overview summary of how SUSY is derived.

[String theory pedagogic summaries and notes](#). Introductory level summaries and pedagogic notes on areas of string theory that are typically difficult to understand and/or confusing.

[General Relativity metrics for constant curvature spaces](#) Pedagogic derivation of the metrics for a 2-sphere (3D ball) and a 3-sphere (4D ball). The latter represents the 3D spatial part of our visible universe if it had positive homogeneous curvature. (It actually seems flat, as far as we can tell.)

[Brief Summary of Cosmology](#). A wholeness chart summarizing the most fundamental relations in cosmology, such as the Friedmann and dynamic equations, local energy conservation, critical density relation, travel time, Hubble plots, and acceleration. Comments summarize derivations.

[Different Horizons in Cosmology](#). Wholeness charts, simplified definitions, and simplified math derivations for the Hubble sphere distance, the particle horizon, and the event horizon. First wholeness chart does not require general relativity background. The rest of the article does.

[Cosmic Microwave Background: A Student Friendly Intro](#). An introduction to the cosmic microwave background power spectrum analysis half-way between available website popularizations and a typical cosmology text. Suitable for those with an undergraduate physics background.

[Simplified Guide to de Sitter and Anti-de Sitter Spaces](#). Anti-de Sitter space is a key element in the famous AdS/CFT correspondence. This article explains it and de Sitter space, with almost no math, in the main part of the text at a level suitable for intelligent lay persons. The appendix deals with Einstein's GR field equation and is technical.

[Generators](#). A wholeness chart summary of generators of translation, rotation, and boost. Points out (as shown in virtually no texts) how the classical generator uses Poisson brackets, which are replaced in quantum theory with commutators. Summarizes Sects. 11.5 and 11.6 of Zwiebach (*A First Course in String Theory* 2009).

[Distinguishable vs Indistinguishable Particle Systems](#). A one-page wholeness chart summarizing, comparing, and contrasting two particle systems in NRQM where the particles are distinguishable or indistinguishable.

[The Central Limit Theorem](#). A step-by-step, simplified explanation of the central limit theorem of statistics, with histogram examples at every step.

[Converting Word Documents to LaTeX](#). A guide to using Word to writing technical papers and then converting to LaTeX.

Author's Research Related to Zero Point Energy Cancellation and More (All downloadable.)

[Slide show: Potential solution to vacuum energy and gauge hierarchy](#) A slide show overview of the author's research in articles below.

[Mechanism for Vanishing Zero Point Energy \(2003\)](#). See footnote on pg. 50 of Vol. 1.

This article has been updated, expanded, and improved in the link below.

[Mechanism for Resolving Gauge Hierarchy and Large Vacuum Energy](#) (Feb 2018, original title: A Symmetry for Resolution of Gauge Hierarchy, Null ZPE, and Null Higgs Condensate Energy). Use of alternative forms for solutions to the QFT field equations provides a possible resolution of the gauge hierarchy problem without SUSY, as well as a means to zero out troubling large theoretical vacuum energy densities.

[Supplemental Solutions Background](#). Derivations of key relations used in the above two articles.