Preface

The preparation of these notes began in 2008 when I taught the first offering of a newly designed class, *Particles and Symmetries*. This class was created to give undergraduate physics students, early in their studies, an introduction to the fundamental constituents of matter and the symmetries which characterize their interactions. The presentation begins with an overview of special relativity, and then moves into an examination of the building blocks of the current Standard Model of particle physics. The material, by design, takes advantage of the fact that a remarkable amount of particle physics may be understood quantitatively using relatively few basic concepts. Students are assumed to have had introductory physics and at least one quarter of quantum mechanics introducing state vectors (bars and kets), quantum time evolution, observables and expectation values, spin-1/2 and related two-state systems, quantized angular momentum, and quantized harmonic oscillators. Facility with calculus, linear algebra, and basic mathematical methods is also assumed. Prior exposure to special relativity, or particle physics, is not required.

This version of these notes incorporates or adapts a number of suggestions due to my colleague, Stephen D. Ellis, who has taught *Particles and Symmetries* multiple times starting in 2011. His contributions are gratefully acknowledged.

Some words regarding conventions: Arrows are used to indicate three-dimensional spatial vectors, such as $\vec{x}$. Components of spatial vectors are written as x^i, with a Latin index (such as i) which runs from 1 to 3. Four-dimensional spacetime vectors, which are introduced in chapter 2, are not marked with a vector sign, but their meaning should be clear from context. Components of a spacetime vector are written as x^μ, with a Greek index (such as μ) running from 0 to 3. Sadly, there are two different conventions in common use in the physics community for defining the dot product of spacetime vectors, differing by an overall minus sign. These notes use the only sensible choice (in the opinion of this author), which makes the dot product of spacetime vectors having vanishing time component the same as the usual three-dimensional dot product, and allows plane waves in space and spacetime to have the same $e^{ik\cdot x}$ form. Pay no attention to anyone urging use of the other convention!

Laurence G. Yaffe
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