3.1: Introduction

Twentieth century physics is dominated by the development of relativity and quantum mechanics, disciplines centered around the universal constants c and h respectively. Historically, the emergence of these constants revealed a socalled breakdown of classical concepts.

From the point of view of our present knowledge, it would be evidently desirable to avoid such breakdowns and formulate only principles which are correct according to our present knowledge. Unfortunately, no one succeeded thus far to suggest a ”correct” postulational basis which would be complete enough for the wide ranging practical needs of physics.

The purpose of this course is to explore a program in which we forego, or rather postpone, the requirement of completeness, and consider at first only simple situations. These are described in terms of concepts which form the basis for the development of a precise mathematical formalism with empirically verified physical implications. The continued alternation of conceptual analysis with formal developments gradually extends and deepens the range of situations covered, without affecting consistency and empirical validity.

According to the central idea of quantum mechanics all particles have undulatory properties, and electromagnetic radiation has corpuscular aspects. In the quantitative development of this idea we have to make a choice, whether to start with the classical wave concept and build in the corpscular aspects, or else start with the classical concept of the point particle, endowed with a constant and invariant mass, and modify these properties by means of the wave concept. Eventually, the resulting theory should be independent of the path chosen, but the details of the construction process are different.

The first alternative is apparent in Einstein’s photon hypothesis, which is closely related with his special theory of relativity.

In contrast, the wealth of nonrelativistic problems within atomic, molecular and nuclear physics favored the second approach which is exploited in the Bohr-Heisenberg quantum mechanics.

The course of the present developments is set by the decision of following up the Einsteinian departure.