

A field theoretic approach to the atomic collision problems

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Abstract. It is an endeavour to make field theoretic approach available to the domain of electronic and atomic collision physics. The capacity of QED is demonstrated in explaining atomic collision phenomena in Coulomb gauge and depending on energy, in relativistic Lorentz gauge. Feynman diagrams are used to calculate bound state collision problems in atomic physics.

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1. Introduction

The talk is organized into two parts. In part I we shall discuss field theory in the context of its application in atomic collision problems. Part II will include the calculations of (a) charge signature on ionization-excitation of He by proton and antiproton in Lorentz gauge and (b) radiative recombination of cold electron and proton into hydrogen atom at subzero temperature in Coulomb gauge.

2. Part I – Field theory in bound state problems

Regarding the origin and growth of field theory one can say – where as quantum conditions govern the properties of extremely small bits of matter, relativistic conditions govern the properties of matter travelling at extremely high speed. Their difficult marriage produced what is known as field theory, a sickly child that eventually grew into the robust standard model of elementary particle physics. We are constrained by relativity and quantum mechanics to speak of a funny language of quantum field theory that is used to describe interactions between particles and fields.

In this connection we find that we do not have the right to talk about the complete description of nature. Our description of nature is organized by the distance scale. Newtonian mechanics for instance, is fine to something like billionth of a centimeter. After the advent of QED – we have complete description of nature at distances greater than 10^{-16} cm. After QCD we have complete description of nature below 10^{-16} cm, where elementary particles like proton and neutron begin to show structure. I like to state that *elementarity* of a particle is strongly energy dependent. In the collision theory any matter subjected to the energy opaque to its structure, can be treated as elementary. Thus a nucleus will behave like an elementary particle below its binding energy. One can take