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The Coulomb attraction in hydrogen may not be of long range

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Abstract. A quantum stationary wave has been examined in an exchange field, which induces the force of the form $F(r)=f_2(1/r^2-f_1/r)$. For the Coulomb attraction in hydrogen atom, the inexplicable discrepancy (0.0023 MHz) between the theoretical and experimental frequencies for its ${}^1S_{1/2}$ has been verified. It is found that the tiny f_1 is $7.45\times10^{-12}a_1{}^{-1}$($a_1$ is the 1st Bohr radius). Meanwhile, when such an f_1 is considered in the $n=2$ Lamb shift, it causes -0.034 MHz difference, which is in good agreement with the deviation of -0.039 MHz between the experimental and one of the theoretical predictions. Similar of searchings are made for the Lande g factor for the H_β spectrum. This f_1 contributes a ratio $\Delta g/g=5.58\times10^{-11}$ and makes both the experiment and theory well agreed within the experimental relative uncertainty $\pm4\times10^{-12}$. In other words, these phenomena can be treated as the reliable physical evidences for the existence of the same repulsion. More importantly, they consistently and strongly imply that the maximum radius for the Coulomb attraction in hydrogen atom can not exceed 7.11 m (if extrapolated). In addition, this analysis prompts us similar cases probably occur in the gravitation because it is also an exchange field, and the repulsion at remote distance may be one kind of dark energy that may have been ignored.

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Key words: hydrogen atom, hyperfine structure sectra, Lamb shift, Lande g factor, Coulomb force, gravitation, dark energy

1 Introduction

Hydrogen atom has been well studied as the simplest quantum system. However, there still exist deviations between the carefully corrected quantum electrodynamics (QED)

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predictions and the most precise experiments. The remarkable issues might be the inexplicable frequency discrepancy on the HFS spectrum for the state $1S_{1/2}$ (at 21cm), and the $n=2$ Lamb shift ($2S_{1/2}-2P_{1/2}$) as well as the Lande g factor for electron. This paper will discuss the electromagnetic interaction and try to find out some new results.

2 The prompt from a quantum stationary wave

The Coulomb interaction belongs to an exchange field. Typically, two electrons interact via exchanging the virtual particle (γ) and scattered, as illustrated in Fig. 1.

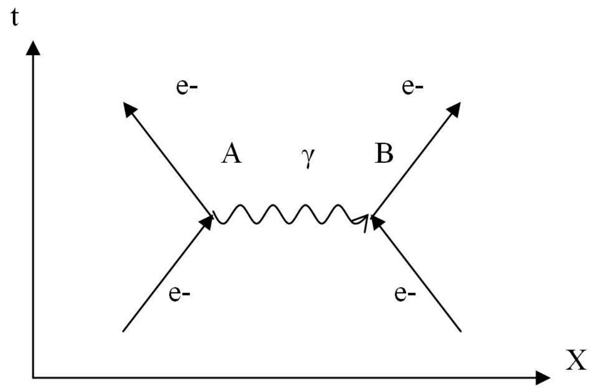

Figure 1: The Feynman diagram for the scattering of electrons in time-space (t-X) plot. The waved line represents the virtual particle γ, which is radiated at A and absorbed at B.

Consider the mode and the number distribution of the exchanger (the virtual particle γ). First, the exchanger is a wave, probably, the simplest mode may correlate to the quantum stationary wave, and each component has an energy $h\nu_n$ (h is the Planck constant). Second, for a stable stationary wave, as we have known, their wavelengths λ_n for the possible components keep the integer relationship: $\lambda_n=\lambda_{max}/n$, in which $\lambda_{max}=\lambda_1=2L$ and $n=1,2,3,\cdots$. Therefore, the frequencies $\nu_n=c/\lambda_n$ must be $\nu_1, 2\nu_1, 3\nu_1, \cdots, n\nu_1, \cdots$

Consider the ratio of the n^{th} component ρ_n, with $\sum_n \rho_n=1$. Note that a transverse wave has two degrees of freedom. So the interactive energy may be written as

$$\begin{aligned} E(L) &= 2\sum_n \rho_n h\nu_n = 2\sum_n \rho_n h(n\nu_1) = 2h\nu_1 \sum_n n\rho_n \\ &= 2h\nu_1 \langle n \rangle \end{aligned} \tag{1}$$

where $\langle n \rangle = \sum_n n\rho_n$ is the average number. Noticing the minimum frequency $\nu_{min}=\nu_1=c/2L$, we may have

$$E(L)=\langle n \rangle hc/L. \tag{2}$$

By considering a particular distribution (e.g., the classical, or Fermi - Dirac, or Bose - Einstein distribution), we can still get a similar relation. As it is valid for arbitrary length