Modeling the nS1/2 Lamb shifts in atomic hydrogen as magnetic monopole phenomena

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Abstract

Relativistic quantum mechanics fails to provide an explanation for the Lamb shift. It is proposed that a point-like magnetic monopole associated with the proton interacts with the magnetic dipole moment of the electron, causing Zeeman energy shifts of the nS1/2 levels. If the 1S1/2–2S1/2 transition in atomic hydrogen, defined as the 15-digit frequency 2 466 061 413.187 01 MHz, is taken as a reference, the model predicts 2 922 743 278.669 71 MHz for the 1S1/2–3S1/2 transition, and 770 649 350.463 33 MHz for the 2S1/2–8S1/2 interval without the application of the constants m_e, h, or c defined by CODATA.

Keywords: Relativistic quantum mechanics, Lamb shift, magnetic monopole, atomic hydrogen, proton structure.

In [1], the author presented a self-consistent mathematical formalism to characterize the atomic hydrogen spectrum, revealing that, considering the margins of error, the spectroscopic fine structure constant α aligns with $\alpha_{geom} \equiv 2^{-6}\pi^{-\frac{2}{3}} \approx 0.00\,72\,843\ (\alpha_{geom}{}^{-1} \approx 137.28)$. Throughout the text, including the tables and formulas that follow, the fine structure constant α is an exact parameter, and the symbol α always denotes the number constant α_{geom}.

The most recent data from Table 1 was used to supply the algorithm outlined in [1]. Only the measured values and uncertainties listed in Table 1 were used to estimate the parameters in Table 2. Other data, such as the electron mass m_e, the Planck constant h, or the speed of light in vacuum c, have no impact. They are embedded within the scaling factor γ_{zero}, which also adjusts for the recoil correction coming from nuclear motion.

Relativistic quantum mechanics fails to provide an explanation for the Lamb shift. It is interpreted through quantum field theory, which constitutes a fundamentally different paradigm. Assuming that a point-like magnetic monopole μ of the proton interacts with the magnetic dipole moment of the electron μ_e, causing Zeeman energy shifts of the nS1/2 levels due to the proton magnetic monopole field. If the magnetic field is attributed to a magnetic charge and originates from a scalar potential, meaning the source of magnetism is a type of spherical bar magnet, then the factor (−1/2) must be taken into account [4]. Electrons that are confined circulate due to the monopole field and create an induced magnetic field that opposes the monopole field, as per Lenz's law, indicating the presence of local diamagnetic shielding characterized by the factor $\gamma_{diamag\_shielding}$. With all these aspects in mind, it is theorized that the dimensionless Lamb shift constant $B(\gamma_{zero})$ equals

$$B(\gamma_{zero})^{theo} = \frac{\mu}{\mu_B} \cdot \left(-\frac{1}{2}\right) \cdot \gamma_{diamag\_shielding} \cdot (2\alpha)^2 \tag{1}$$

where μ signifies an intrinsic magnetic moment of the proton, which needs to be defined so that the difference from the precisely estimated value $B(\gamma_{zero})$ in Table 2 is as small as possible. Simple numerical testing [2:p.175] gives

$$\frac{\mu}{\mu_B} = \frac{5}{\left(\frac{\lambda_{e\_bar}}{L_2(L)} + 3\right)} \approx 0.023025$$

$$\frac{\lambda_{e\_bar}}{L_2(L)} = 2^{16}\pi^{-5} \qquad (2)$$

and

$$\gamma_{diamag\_shielding} \equiv \frac{1}{3}\left(1 + 2\sqrt{1-(3\alpha)^2}\,\right) \approx 1 - \frac{(3\alpha)^2}{3} \approx 0.999\,841 \qquad (3)$$

being consistent with the relativistic adjustment to the magnetic moment for a central electric potential of charge $Z = 3$ and a uniform magnetic field of arbitrary strength [5: p. 213, eq. 47.2]. The energy building block $\frac{1}{L_2(L)}$ in the energy unit $\frac{1}{\lambda_{e\_bar}}$, where λ_{e_bar} corresponds to the reduced Compton wavelength of the electron, is also connected to the saturation density of matter established through elastic electron scattering experiments [6]. Furthermore, the phenomenological expression (1) is consistent with the concept that symmetries in quantum theory result in simple mathematical equations that include integers or fractions of integers.

According to the compact algebraic formula (1), the calculated value $B(\gamma_{zero})^{theo}$ is about **−2.443 049 ppm**, which is comfortably within the error limits of the experimental result −2.443 049(17) ppm presented in Table 2. The parameter $B(\gamma_{zero})^{theo}$ can also be utilized to establish a scaling factor γ_{zero}^{ref} based on a metrological reference in accordance with

$$\gamma_{zero}^{ref} = \frac{\Delta E_{1S-2S}^{meas}}{X + B \cdot Y} \quad with \quad X \equiv E_D(2,1/2) - E_D(1,1/2) \quad and \quad Y \equiv \frac{E_D(2,1/2)}{2} - E_D(1,1/2) \qquad (4)$$

Using input A7 of Table 1 as the reference ΔE_{1S-2S}^{meas} in formula (4), the resulting value for γ_{zero}^{ref} is ≈1.239 352 998 271 x 10^{20} Hz, which aligns closely with the mean value obtained via least squares calculations presented in Table 2.

When the input A7 of Table 1, defined as the 15-digit frequency 2 466 061 413.187 01 MHz, is used as the metrological reference to determine the scaling factor γ_{zero}, the theoretical dimensionless value $B(\gamma_{zero})^{theo}$ predicts, according to formula (1), **2 922 743 278.669 71 MHz** for the 1S1/2–3S1/2 interval, and **770 649 350.463 33 MHz** for the 2S1/2–8S1/2 transition. For consistency verification, it is essential to experimentally test and confirm these conjectures with accurate optical frequency measurements.

Table 1: Theoretical (exact) and experimental (stochastic) input data.

	value	error	unit	reference	
α	$2^{-6}\pi^{-\frac{2}{3}}$	exact		[2:p.42]	
1S1/2–2S1/2	2 466 061 413.187 03	0.000 01	MHz	Table X, A6	[3]
1S1/2–2S1/2	2 466 061 413.187 01	0.000 01	⋮	**Table X, A7**	[3]
1S1/2–3S1/2	2 922 743 278.659	0.017	⋮	Table X, A8	[3]
1S1/2–3S1/2	2 922 743 278.678	0.013	⋮	Table X, A22	[3]
1S1/2–3S1/2	2 922 743 278.671 5	0.002 6	MHz	Table X, A23	[3]

Table 2: Output values obtained from the input data (Table 1) by means of formula (1) provided in [1]. The least squares solutions $A(\gamma = 1)$ and $B(\gamma = 1)$ were calculated by setting $\gamma = m_e = h = c = 1$. The parameter $B(\gamma_{zero})$ is given by $B(\gamma_{zero}) = B(\gamma = 1) / \gamma_{zero}$ with $\gamma_{zero} = 1+A(\gamma = 1)$. The statistical analysis involved 1000 data sets (Table 1) whose five experimental transitions were randomly varied within the error margins.

parameter	mean value(1σ, random)	unit	rel. std. uncert.
γ_{zero}	1.239 352 998 270(25) x 10^{20}	Hz	2.0 x 10^{-11}
$B(\gamma_{zero})$	**−2.443 049(17)**	**ppm**	7.1 x 10^{-6}
mean abs. dev. of the 5 data sets	0.0048(24)	MHz	
Lamb shift $\mathcal{L}(1S1/2)$	8 032.976(57)	MHz	7.1 x 10^{-6}
Ionization	3 288 086 857.911(9)	MHz	2.9 x 10^{-12}

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