

Title: All Lyman, Balmer, Paschen and Brackett lines are in superresonance

*It could be that perhaps I've found out a little
about the structure of atoms,*

Neils Bohr 1912

**Author: Marek Suder ORCID iD: 0009-0008-0407-1961, Independent researcher, retired
from AGH University of Science and Technology in Kraków**

Email: mareksuder@agh.edu.pl

Abstract

The paper presents an extended analysis of the structure of the hydrogen atom spectral lines, based on the concept of superresonance - a phenomenon in which all Lyman, Balmer, Paschen and Brackett resonances (for $n \leq 7$ and $m \leq 4$) exhibit complete harmonic relations with respect to the λ_0 wave.

The frequency values form a discrete raster with a constant spacing of ~ 18.64 GHz. The results indicate the existence of a universal harmonic structure in the hydrogen spectrum, opening up new possibilities in spectroscopy and the theory of atomic interactions.

Based on this, the concept of *a subquantum* (sQ) was introduced, defined as the smallest unit of photon energy with a value of $\epsilon_0 \approx 7.71 \times 10^{-5}$ eV, equal to $1/3969$ of the $H(5 \rightarrow 4)$ transition energy. This unit allows the construction of a resonance grid in which all analyzed transitions are arranged in integer multiples of the fundamental frequency. This method not only explains the structure of known spectral lines but also enables the prediction of previously unobserved ones.

The proposed approach suggests that the hydrogen spectrum is governed by a simple harmonic system, extending the classical Bohr–Rydberg model with a deeper level of discretization. This method reduces measurement uncertainties and opens up new possibilities for precise spectroscopic calibration. This interpretation enables not only the precise description of known transitions but also the prediction of previously unobserved line parameters.

This model allows us to treat the subquantum as an elementary unit of energy and proposes its use in further analysis of spectroscopic data.

Entry

For over a century, the spectrum of the hydrogen atom has been a cornerstone of research into the structure of matter and the development of quantum mechanics. From the

classical Balmer formula and Rydberg formula,¹ through Bohr's postulates,² to full quantum theory, analysis of spectral lines has provided successive evidence for the discrete nature of electron energies in atoms. Despite these remarkable achievements, questions remain about the internal structure and possible deeper regularities governing these transitions.

Since a quantum, as the smallest portion of energy,³ has a different value for each spectral line, a natural question is whether the quantum was also created from building blocks with a defined energy.

Chapter 1: Research Proper

The energy, frequency and wavelength dependencies of all lines from the Lyman, Balmer, Paschen, Brackett series were investigated for $n \leq 7$ and $m \leq 4$ (where n - higher orbit, m - lower orbit).

Electron transitions for the Hydrogen atom

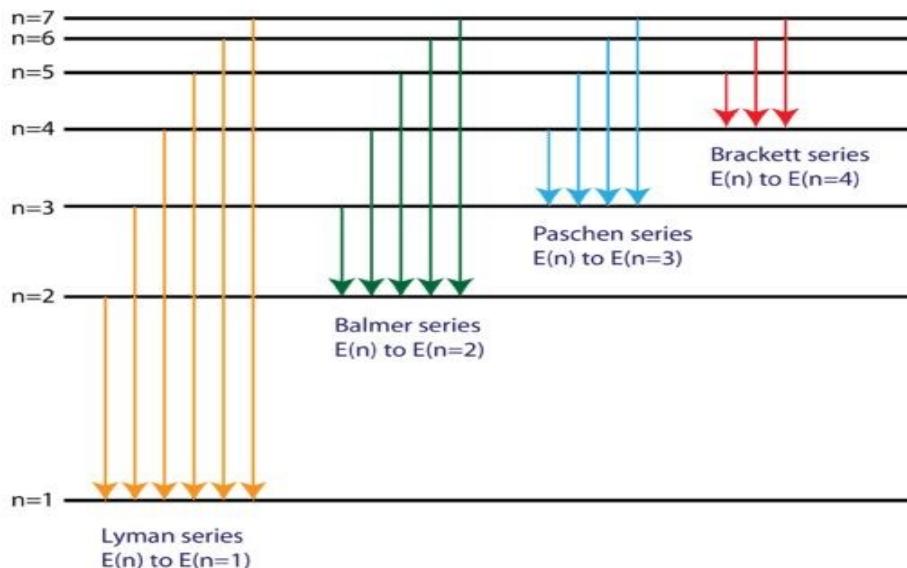


Figure 1. Electron transition for the Hydrogen atom (source <https://libretexts.org>)

It was found that all the lines tested are integer harmonics of the main resonance wave :

¹Rydberg, J. R. On the Structure of the Line-Spectra of the Chemical Elements. Philosophical Magazine, 1889.

²Bohr, N. On the Constitution of Atoms and Molecules. Philosophical Magazine, 1913.

³Einstein, A. (1917). "On the Quantum Theory of Radiation."

$$\lambda_0 = 3969 * \text{Lambda Brackett-}\alpha (\text{H } 5\rightarrow 4)$$

The individual waves have N full wave periods ⁴(N ∈ Natural) in one wave period λ_0 and after a precisely defined number of periods (172800, 171500, 169344, 165375, 156800, 132300, 40500, 39200, 37044, 33075, 24500, 16000, 14700, 12544, 8575, 7425, 6125, 3969) they all meet in the same phase 0 from which the study started.

These values were described as "Harmonic number" and the unit [Hn] was proposed for them, which functions similarly to the wave unit [cm-1]. The phenomenon of resonance of all 18 Lyman, Balmer, Paschen, and Brackett lines simultaneously was called "Superresonance".

Lambda wavelengths for resonance detection can be calculated using various methods, and the degree of rounding of physical constants is irrelevant – the result is always precisely the same. In this work, lambda values were calculated using the Rydberg formula:

$$1/\lambda = \text{Term difference} * \text{Rydberg constance}^5$$

where $= 1.09677 * 10^7 \text{ m}^{-1}$ (<https://encyklopedia.pwn.pl-haslo/;3970382>)

The figure below shows the algorithm results confirming superresonance.

High orbit	Low orbit	Lambda	Harmonic number	Lambda * Harmonic number
7	1	93,0763362723	172800	16083590,9078476000
6	1	93,7818711828	171500	16083590,9078476000
5	1	94,9758533390	169344	16083590,9078476000
4	1	97,2552738192	165375	16083590,9078476000
3	1	102,5739216062	156800	16083590,9078476000
2	1	121,5690922740	132300	16083590,9078476000
7	2	397,1257014283	40500	16083590,9078476000
6	2	410,2956864247	39200	16083590,9078476000
5	2	434,1753295499	37044	16083590,9078476000
4	2	486,2763690959	33075	16083590,9078476000
3	2	656,4730982795	24500	16083590,9078476000
7	3	1005,2244317405	16000	16083590,9078476000
6	3	1094,1218304658	14700	16083590,9078476000
5	3	1282,1740200771	12544	16083590,9078476000
4	3	1875,6374236557	8575	16083590,9078476000
7	4	2166,1401896091	7425	16083590,9078476000
6	4	2625,8923931180	6125	16083590,9078476000
5	4	4052,3030757993	3969	16083590,9078476000

Figure 2. Table – harmonics of all tested lines meet in the same phase

⁴ Loudon, R. The Quantum Theory of Light. Oxford University Press, 2000.

⁵ Rydberg, J. R. On the Structure of the Line-Spectra of the Chemical Elements. Philosophical Magazine, 1889.

Because $[H_n]$ values are resistant to changes in physical constants, I consider them to be more inherent to atomic forces than conventional units, and I propose that the superresonant wave should serve as a natural unit of energy for describing atomic interactions. I therefore propose the following definitions:

- **Subquantization** – a postulated property of quanta according to which the energy of particles (e.g. photons) is not only quantizable as integer multiples of $E = h \times f$, but can also be expressed as multiples of a more fundamental energy unit $\epsilon_0 = \sim 7.71 \times 10^{-5}$ eV. Figure 2 The table shows that all 18 lowest electronic transitions in the hydrogen atom (series, for $n \leq 7$ and $m \leq 4$) lock into phase after N full-wave periods.

- **Subquantum $[sQ]$** - is the postulated smallest portion of energy in photon processes, with the value $\epsilon_0 = \sim 7.71 \times 10^{-5}$ eV, which is an elementary energy unit in quantum phenomena, defined as one 3969th part of the energy of hydrogen wave emission when an electron jumps from orbit 5 to orbit 4 ($1/3969 H_5 \rightarrow 4$).

- **A wave with energy 1 $[sQ]$** - corresponds to the first superresonance in the electromagnetic spectrum of hydrogen emission - i.e. the basic energy of the wave with length λ_0 , in relation to which all 18 lowest electronic transitions in the hydrogen atom (Lyman, Balmer, Paschen series, etc. for $n \leq 7$, $m \leq 4$) show harmonic dependencies (are integer multiples of its frequency and energy).

All lines examined are arranged in a discrete raster spaced approximately 18.64 GHz apart. The figure below illustrates some hydrogen transitions; this is limited solely by the size of the figure.

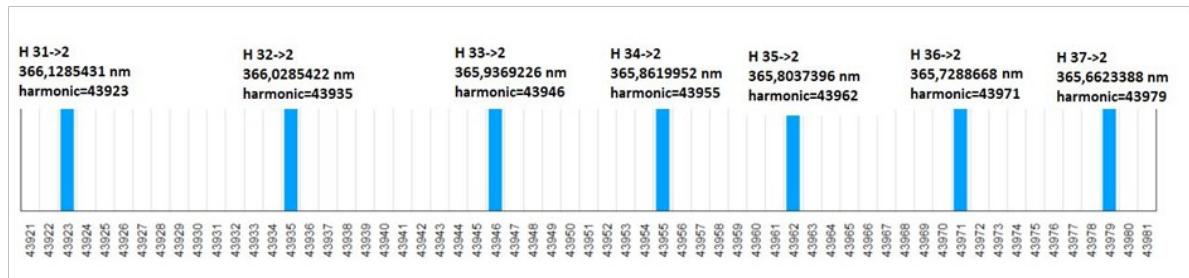


Figure 3 The known spectral lines on the horizontal axis of the $[H_n]$ values occupy discrete locations of integer multiples of $1 [sQ]$.

On the H_n axis, each subsequent wave has an energy greater by 1 $[sQ]$ and a frequency higher by approximately 18.64 GHz than the previous one.

From now on we can calculate wavelength ratios, e.g.:

$$\text{wave energy } H(6 \rightarrow 4) / \text{wave energy } H(5 \rightarrow 4) = 6125/3969$$

or

$$\Lambda H(5 \rightarrow 4) = \Lambda H(6 \rightarrow 4) * 6125/3969.$$

These calculations are free of rounding errors. The free numbers H_n in the graph may be parameters for future discovered lines.

For example, I tried to predict the parameters of a previously undocumented line with the number 43323. My calculations indicated a wave energy of 3.339 eV, corresponding to the transition from the 15th to the 2nd orbit of the hydrogen atom.

At the time of writing, I hadn't yet used the NIST database. After reviewing the data, I found that the hydrogen line for this transition is listed with a measured wavelength of 371.19774 nm—which closely matches my prediction.⁶

It is therefore possible to realistically predict the parameters of yet undiscovered spectral lines, as well as the excited state of the atom that will emit such a line.

Conclusions

- The analysis carried out indicates that in the examined spectral data it is possible to distinguish repetitive harmonic dependencies that are not visible in the classical decimal notation, but are revealed in the fractional representation and in the resonance approach.
- The obtained results suggest that the spectrum of hydrogen and other elements is not a random set of values, but follows a coherent harmonic order, which is an extension of classical quantum theory.
- The proposed concept of subquantization and the [sQ] unit can constitute the basis for redefining the description of atomic interactions, opening new directions of research in spectroscopy, quantum physics and metrology.
- It has been shown that the use of a single fundamental base frequency allows us to organize the observed electronic transitions and explain their regularities within a simple, discrete model.
- The use of the postulated subquantum unit enables a reduction in the uncertainty of the table data and a better representation of the actual spectral structure, which can be the basis for a more precise spectroscopic calibration.
- The presented method can be used in the analysis of high-resolution spectroscopic data, including astrophysics and cosmology, where the highest measurement accuracy is particularly important.
- I believe my work brings new and significant results to this field. All calculations and conclusions presented here can be independently verified by any physicist.

⁶NIST Atomic Spectra Database (Kramida et al., 2023).

Bibliography

- [1] Rydberg, J. R. (1890). "On the structure of the line spectrum of chemical elements."
- [2] Bohr, N. On the Constitution of Atoms and Molecules. Philosophical Magazine, 1913.
- [3] Einstein, A. (1917). "On the Quantum Theory of Radiation."
- [4] Loudon, R. The Quantum Theory of Light. Oxford University Press, 2000.
- [5] Rydberg, J. R. On the Structure of the Line-Spectra of the Chemical Elements. Philosophical Magazine, 1889.
- [6] NIST Atomic Spectra Database (Kramida et al., 2023).