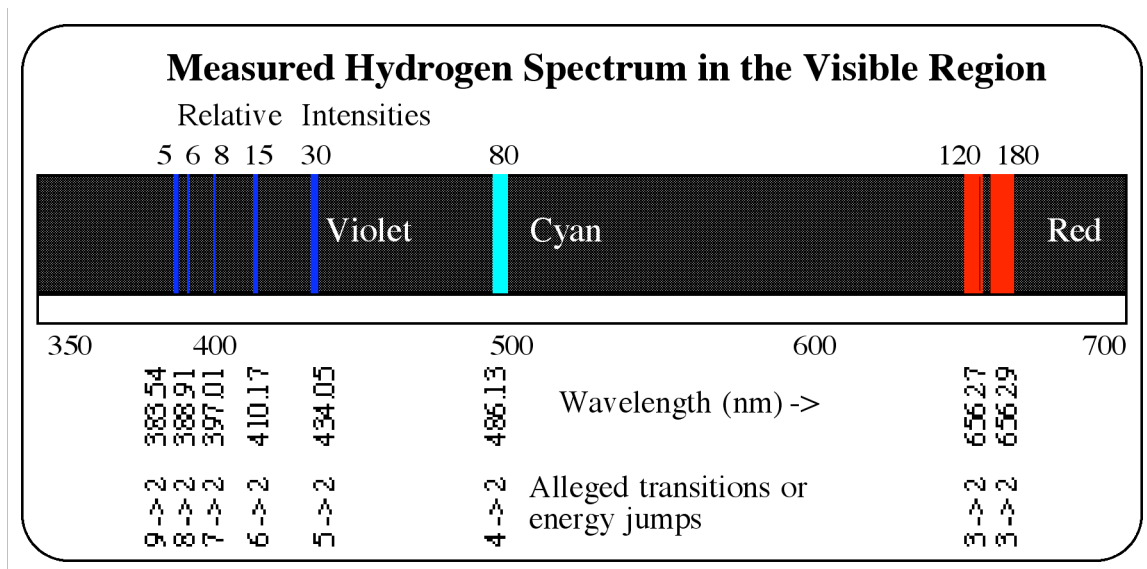


QUANTUM MECHANICS CANNOT EXPLAIN INTENSITIES OF HYDROGEN SPECTRUM

The hydrogen line spectrum explained as Raman shift

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Excited atoms of monoatomic gases cause radiation that is concentrated at a number of discrete wavelengths. Hydrogen is the almost simple atom. The graph shows the measured spectrum in the visible region and the alleged corresponding quantum jumps of the electron between quantized energy levels according to Bohr's atomic model. [hy]

Does the hydrogen spectrum indicate some features of the atomic structure? Indeed, physicists observed patterns or series of spectral lines of hydrogen. The spacing between adjacent lines shows a decrease with decreasing wavelength until it converges at a limit. For the lines in the visible region, Balmer found a law-like pattern. In 1890 Rydberg found an empirical formula that describes the series of all wavelengths known at that time.

Rydberg formula: $1/\lambda = R_H(1/n^2 - 1/m^2)$, where λ = the wavelength, $R_H = 10973731.55 \text{ cm}^{-1}$ is the Rydberg constant for hydrogen and n, m are integers. For the Balmer series in the visible region the formula is as follows: $1/\lambda = R_H(1/4 - 1/m^2)$, $m = 3, 4, 5, \dots$

Because the velocity of light is: $\lambda\nu = c$ (ν being the frequency), we can rewrite the formula for frequencies:

$\nu = \nu_H \left| 1/4 - 1/m^2 \right|$, where ν_H is the hydrogen Rydberg frequency $3.289 \cdot 10^{15} \text{ sec}^{-1}$

So, every spectral line represents also a frequency of a specific vibration. That vibration has electromagnetic energy. Is it possible to calculate the vibration energy solely with the measured wavelength (or frequency $\nu = c/\lambda$)? Quantum theory claims that this vibration energy is proportional to frequency: $E = h\nu$, where h is the famous *Planck* constant. Therefore each spectral line represents radiation energy. According to quantum theory, this energy is the energy of an emitted photon. The birthplace of this photon is the excited atom.

Intensity in terms of quantum theory

The brightness of spectral lines is different, the brighter the line the more photon shots of this energy value!

In Bohr's model of the hydrogen atom, an electron is moving in a certain (allowed) orbit around the nucleus, which is the proton. An energy input excites the atom as follows: The electron gains energy and its orbit is grows. But for the energy only certain energy levels are allowed which correspond to quantacized values of angular momentum. The electron will only have angular momentum values that are an integer times $h/2\pi$.

Now emission of a photon results when an electron drops from one allowed angular momentum state to a lower one. The dropping electron obviously is the birthplace of the photon. The energy of the emitted photon is the difference of the two allowed energy levels. An electron jumps down to the second lowest level ($n = 2$) creating photons that we perceive as visible light. Especially, the **electron jump from level 3 to level 2 is the cause for the red line in the spectrum.**

Precise measurements at very high resolution showed later that spectral lines are in reality closely spaced doublets. This splitting is called *fine structure*. The splitting of the familiar red H-line for example is about 0.016 nm.

According to the formula $E = h\nu$ this should correspond to an energy difference of only 0.000045 eV! In order to explain this feature, quantum theory had to extend *ad hoc* its ontology. The orbiting electron has allegedly 2 spin states (spin up or spin down), which explain the minute energy difference... But the intensity ratio of 2:3 of the lines is not explicable, see below !

Intensity of light according to QM erroneous...

QM claims that the energy of the alleged photon depends only upon frequency: $E = h\nu$, and that the photon-wave (the photon in the *wave picture*) has no amplitude! According to classical electrodynamics the intensity of the electromagnetic wave is proportional to the square of the amplitude: $I \propto E^2$, and not proportional to the frequency! The photon is allegedly the quantum of EM radiation, but its energy is $E = h\nu$. Till now an unresolved contradiction!

Recall the QM explanation for different intensities of emitted light: ensembles of atoms generate myriads of photons. What then accounts for the relative intensities? The causes are allegedly the

different probabilities associated with the different transitions (or quantum jumps). Therefore, if there is a large probability of a jump the result is a bright line! (What is the cause for different probabilities? Unknown...)

According to QM only the number of photons causes the brightness of the light beam, whereas the frequency of the light determines the energy of each individual photon. So QM claims that the intensity depends on the number N of photon hits:

$$I \propto N h \nu$$

But if you have tuned a *laser* to a certain frequency, you can generate a more intense ray when you increase the laser power (W). For example an argon ion laser may be tuned for a wavelength $\lambda = 514,5 \text{ nm}$ (green). Suppose a single line operation. Now increase the power from 1,2 to 1,7 W or more. The result is a brighter line. If the laser produces a wave then higher intensity associated with the same frequency means a wave with a greater amplitude! This has nothing to do with any probability.

The concept of a photon cannot explain the amplitude dependency of the intensity. At this point QM gets embarrassed to explain amplification of laser waves without one of the essential qualities of a wave, namely its amplitude!

The despairing attempt to explain amplification of a wave without taking into consideration amplitudes is the theory of

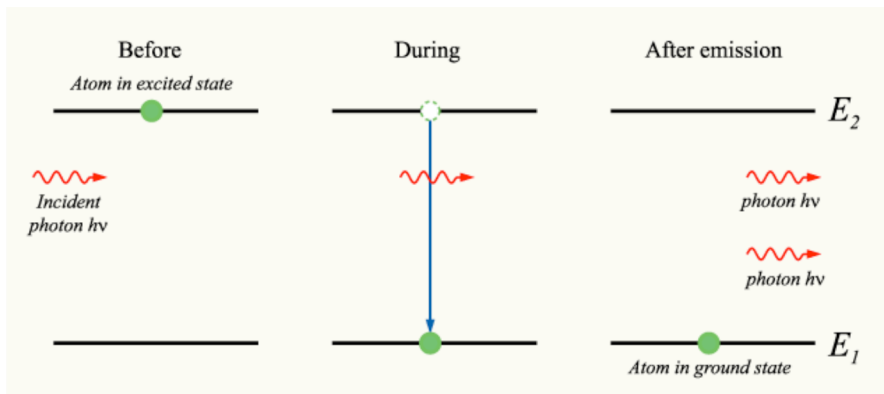
stimulated emission of photons or cloning photons

Assume an atom in an excited state. Now wikipedia 2006

http://en.wikipedia.org/wiki/Stimulated_emission

explains and illustrates:

if the excited-state atom is perturbed by the electric field of a photon with frequency ν , it may release a second photon of the same frequency, in phase with the first photon. The atom will again



decay into the ground state. This process is known as stimulated emission.

In this *gedankenexperiment* the two photons are thought of as totally coherent, i.e. they have the same frequency, phase and polarization. This process is supernatural.

And the two photon-waves cannot interfere with each other! If two coherent waves interfere constructively, the amplitude of the resultant wave is greater. The wikipedia figure above shows photon waves with amplitudes but amplitudes do not exist. The photon is like a woman without abdomen.

Obviously there is no QM wave interference. Amplification in QM does not work by amplitude amplification but it is the result of the *multiplication* of photon hits. The figure above shows a duplication of the intensity of EM radiation by duplication of photons, i. e. cloning a photon!

Conclusion:

Increase of intensity in terms of QM means multiplication of incident photons. A second photon means a 100% increase of the incident intensity.

This QM light intensity theory is experimentally disproved, see the article Photoelectric effect disproves the existence of photons that carry energy $E = hf$.

Also different intensities of adjacent lines show that $E = h\nu$ is not a natural law

Consider the measured wavelengths of hydrogen radiation. For the familiar **two red lines** the splitting is about 0.016 nm. According to quantum physics the lines have a corresponding minute energy difference of only 0.000045 eV because energy is allegedly $E = h\nu$. If this were the case, the relative intensity difference of 50% for the two red lines is not explicable.

Remember that in terms of quantum theory the intensity of a line means the number of photon shots and that all photons assigned to a line have the same energy. So, when the brighter hydrogen red line is caused by 50% more photon shots than the less bright one, there is only one explanation for this difference: When the 2 spin states (spin up or spin down) of the orbiting electron occur in a ratio of 1 : 1.5 then the ratio of the produced photons with the energy difference of 0,00045 eV is the same. For this quantum behaviour QM offers no explanation. Therefore, in terms of QM the different brightness of adjacent lines is not explicable!

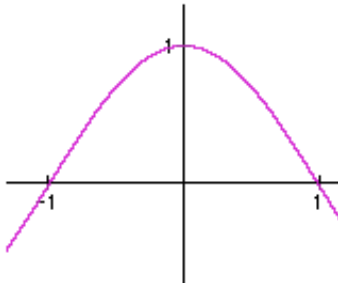
There is also no explanation why intensities decrease with increasing frequencies! In the Balmer series for example, relative intensities decrease from 180 for the red line to 5 for a violet line. The photon shot ratio is therefore 180: 5. What is the cause for the fact that there are fewer excitations into energy levels $n = 5 - 9$ than into levels $n = 3, 4$? QM fails to explain this behaviour.

In my opinion this has nothing to do with the atom itself:

In the article on the *Raman atomic spectrum*

the Balmer series of frequencies for instance were explained as the forced vibrations of an EM medium due to a natural frequency oscillation of the hydrogen atom. It is reasonable that intensities of the radiation decrease with increasing frequencies because the corresponding decrease of wavelength must be accompanied by lower amplitudes. See below an excerpt of this article.

For elastic media (for instance in acoustics) the intensity is given by the formula $I = K A^2 v^2$, where K is a constant and A is the amplitude of the vibration. Let us apply tentatively the formula $I = K A^2 v^2$ for light:



Take again for example the red H_{α} lines: Their wavelength is nearly the same, so their frequency is also nearly the same. But the intensity is not the same. Red line $H_{\alpha 120}$ has the relative intensity 120, red $H_{\alpha 180}$ the relative intensity 180.

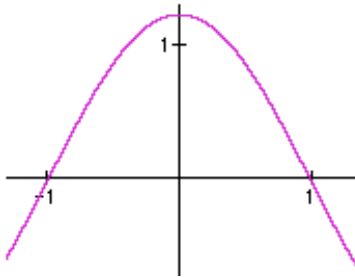
So, intensity $120 = K A_{120}^2 \nu^2$;

Intensity $180 = K A_{180}^2 \nu^2 = 1.5 K A_{120}^2 \nu^2 \Rightarrow A_{180} = 1.225 A_{120}$

Thus for relative intensities 120 and 180 the relative amplitudes are 1.0 and 1.225, respectively. Obviously, the higher the amplitude of a wave of given frequency is, the greater the energy.

The graphs show the amplitude ratio for the adjacent red lines. But quantum theory cannot explain why the ratio of the two electron states S up and S down is not 50/50, and so the corresponding output of photons for the two lines of a doublet is not the same!

Now compare the violet line of 383.54 nm and relative intensity 5 with the red line 656.29 nm and relative intensity 180. In spite of the longer wavelength the red line's intensity is about 36 times greater than that of the violet line.



This is the case because the amplitude of the red vibration is about 10 times greater than the amplitude of the violet vibration. A table shows the relationship between wavelength, relative intensities and relative amplitudes:

rel. λ	λ [nm] Balmer	rel. intens.	rel. ampl.
1	383.54	1	1
1	388.91	1.2	1.1
1.04	397.01	1.6	1.3
1.07	410.17	3	1.8
1.13	434	6	2.8
1.27	486.13	16	4.2
1.7	656.27	24	8.4
1.7	656.29	36	10.3

Summary: The two lines of the red line doublet represent two oscillations that are different in amplitude and energy.

The well-known yellow doublet lines of Na are another significant case study. Their wavelengths are 588.995 and 589.592 nm, so the minute difference of about 0.6 nm corresponds allegedly even to a minute energy difference. But the respective relative intensities of the lines are 80.000 and 40.000 or 2 : 1!

According to QM the ratio of the corresponding spin states (spin up or spin down) should obviously be also 2 : 1. Till now no efforts are known to explain this 'quantum' behaviour!

For the wave theory of light different amplitudes cause the difference in intensity for the two nearly equal wavelengths.

In our attempt the intensity ratio 2: 1 corresponds to an amplitude ratio of $\sqrt{2}$: 1.

Now note the doublet lines for Li: both two lines of Li, 670.776 and 670.791 nm have the same relative intensity 3600. Therefore, the two states spin up or spin down exists in the ratio 1:1.

Why do not H and Na atoms have the ratio 1:1 for these states?

To summarize: the Bohr model cannot explain why certain spectral lines are brighter than others.

The hydrogen line spectrum explained as Raman shift

When light waves pass through a transparent medium (for instance a crystal) the incident ray is scattered. In the scattered light one observes not only the frequency of the incident ray (*Rayleigh scattering*) but also sum and difference frequencies of the incident light frequency.

The shifted frequencies show a characteristic pattern that depends on the transmitting transparent medium. The transparent medium is coupled with the all-pervading electromagnetic medium (EM medium) whose vibrations we perceive as light. The Rayleigh frequency represents a natural frequency of the transparent medium, which oscillation causes a forced vibration of the EM medium. Frequencies of the forced vibrations form the Raman spectrum.

The hydrogen line spectrum in the visible region contains some series of lines. The regular pattern of the (shifted) frequencies is obviously expressed in the well known phenomenical Ritz-Rydberg formula for the hydrogen frequencies:

$\nu = \nu_H (1/n^2 - 1/m^2)$, for any $n = 1, 2, 3, \dots$, $m = n + 1$ and goes from $n + 1, n + 2, n + 3, \dots$ to ∞ . ν_∞ is the limit frequency. For $n = 1$ we get the Lyman series, for $n = 2$ the Balmer series, for $n = 3$ the Paschen series, for $n = 4$ the Brackett series and for $n = 5$ the Pfund series. ν_H is the Rydberg frequency.

Now we interpret the Rydberg frequency formula $\nu = \nu_H |1/4 - 1/m^2|$ for the Balmer series as Raman shift: The limit $\nu = \nu_H/4$ is an eigenfrequency of the oscillating atom. This is the analogue to the incident ray of the Raman shift. The term $\nu_H (1/m^2)$ expresses the shifts. Why?

The atoms are coupled with the all-pervading electromagnetic medium whose vibrations we perceive as light. The formula $\nu = \nu_0 |1/n^2 - 1/m^2|$ shows the frequencies of the forced vibrations of that medium. Therefore the first term $\nu_0 (1/n^2)$ represents the eigenfrequencies of the excited specific atom. The second term represents the resonance frequencies of the transmitting medium. The difference frequency (the difference „tone“) is the produced frequency of the transmitting EM medium that we observe as a spectral line.

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