Coherent interactions of light with collisionless atomic hydrogen.

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Résumé L'objet de cet article est l'étude d'un système optique théorique constitué de corps noirs sphériques très chauds et distants (appelés étoiles), émettant des protons et des électrons dont le refroidissement par expansion adiabatique produit, sur des "sphères de Strömgren", des atomes d'hydrogène excités. De grands espaces entre ces systèmes élémentaires sont supposés contenir un gaz d'hydrogène atomique à très basse pression dont les interactions avec la lumière sont spatialement cohérentes. L'étude de ce système théorique utilise les règles établies par Einstein en 1917 et largement vérifiées dans l'étude des lasers à gaz. Des comparaisons discutables avec des observations astronomiques sont distinguées de l'étude théorique par des astérisques précédant les titres. De même que les lasers émettent des rayons dans les directions où l'amplification cohérente est maximale, la coquille d'hydrogène atomique excité qui entoure une sphère de Strömgren dessine le limbe de la sphère en un cercle éventuellement ponctué. Cette émission superradiante est associée à une super-absorption de la lumière excitatrce reçue de l'étoile qui par exemple dissimule SN1987A depuis l'allumage de SNR1987A. Un effet Raman impulsionnel stimulé (ISRS) réduit les fréquences des impulsions lumineuses formant la lumière naturelle au bénéfice du rayonnement froid pour accroitre l'entropie. Une excitation des atomes froids principalement dans le niveau 2P est nécessaire à l'ISRS, de sorte que le rougissement s'arrête lorsqu'une raie absorbée atteint la fréquence Lyman alpha, ce qui génère les rougissements remarquables de Karlsson 3K et 4K. La spectroscopie élémentaire remplace big bang, matière et énergie noirs, ne requiert pas de variation de la constante hyperfine, etc. La loi de Hubble évalue la densité de colonne d'hydrogène atomique excité, accroissant les distances dans les zones chaudes (galaxies) donc la taille des galaxies spirales stables sans matière noire, gonflant des bulles dans les cartes des galaxies.

Abstract The aim of this paper is a study of a theoretical optical system made up of distant, very hot spherical blackbodies (named stars) emitting light, protons and electrons cooled into Strömgren's shells of excited H atoms starting on Strömgren's spheres. Long distances between these elementary systems are assumed filled by very low pressure hydrogen atoms whose interactions with light are spatially coherent. This theoretical system is studied using rules of spectroscopy founded on Einstein's theory and laser experiments, widely verified in labs. Questionable astronomical comparisons are clearly distinguished from reliable spectroscopy by an asterisk * at title of sections. Lasers emit light into directions for which amplification is maximum. Likewise limbs of Strömgren's spheres show bright circles possibly split into dots. Superradiant emission is bound to a super-absorption of exciting light so that SN1987A disappearsed when its rings appeared. Impulsive Stimulated Raman Scattering (ISRS) shifts frequencies of light pulses to increase entropy. Theory shows that H atoms excited to 2P state shift very weakly frequencies of pulses making ordinary light. Lyman alpha absorption produces these atoms until absorbed lines are shifted to alpha frequencies, which produces remarkable Karlsson's redshifts 3K and 4K. Ordinary spectroscopy replaces big bang, dark energy and mater, variation of hyperfine constant, and so on. Hubble's law evaluates column densities of excited atomic hydrogen, increasing sizes of galaxies, so that spiral ones are stable without dark matter, and inflating bubbles in their maps.

Keywords: 52.25.Os Emission, absorption, and scattering of electromagnetic radiation — 52.38.Dx Laser light absorption in plasmas (collisional, parametric, etc.)— Super-emission/absorption — Impulsive Stimulated Raman Scattering (ISRS).

1 Introduction.

After publication of Einstein's 1917 paper, a long time was necessary to build lasers, and understand spatially coherent interactions of electromagnetic waves with matter, for instance, how energy provided by a super-absorption is transferred to the superradiant beam of a ruby or dye laser. Here, we study interaction of light with the simplest matter, collisionless atomic hydrogen.

Astrophysicists are suspicious because a lot of absurd experiments and theories were developped to understand astronomical observations. Menzel [1] wrote "It is easily proved that so-called "stimulated" emissions are unimportant in the nebulae", but, in his demonstrations, he confounds radiance and irradiance. Here, we use only theories deduced from Einstein's discovery, and consequences of which are observed every day in labs of spectroscopy (or chemistry to follow fast evolutions of chemical reactions).

To avoid a confusion between spectroscopy and its questionable applications to astronomical observations, titles of questionable (sub)sections start with an asterisk.

All interactions of light with assumed low pressure gas are spatially coherent.

Dipolar and quadrupolar interactions are very different, so that they will be studied separetely.

2 Dipolar, spatially-coherent gas-light interactions.

2.1 Einstein's and laser theories.

Thermodynamics provides two equations, one for conservation of energy, the other for stability or increase of entropy. Einstein could only show that variation dI of spectral radiance I of a single, monochromatic, plane, spatially coherent light (electromagnetic) beam along a path dx is dI=BIdx, where he introduced spectral coefficient B depending on medium state and frequency. Assuming a constant B, variation of I is exponential, so that a non-zero solution requires an initial non-zero radiance, possibly zero Kelvin radiance.

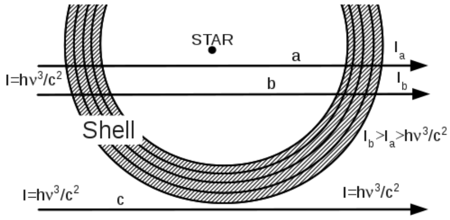

Figure 1: Rays a and b cross the same number of sub-shells making Strömgren's shell of excited hydrogen. The path is, for each sub-shell, larger for more external b ray: The most amplified ray is tangent to Strömgren's sphere.

This difficult, random start of coherent light beams provides flares generated, for instance, by an electric power in a very low pressure gas, or by electrons in polar aurora. Studying lasers pumped by light (ruby, neodyme YAG, dye lasers) spectroscopists observed that superradiance of a ray produces strong coherent absorbtions of most other rays in a "competition of modes" of light in matter.

An usual, semi-classical explanation of I factor in second member of Einstein's equation is a synchronization of molecular dipoles on sheets, wave surfaces of incident light. An obtained set of synchronous dipoles works as a single dipole. Emitted amplitude is proportional to the momentum of synchronous dipoles, radiated energy is proportional to the square.

Rays close to exciting one may have some coherence with dipoles and can be slightly amplified. But far modes have an incoherent but strong interaction with syncronized sheets of dipoles, they have a super-absorption. For a better study of super-absorptions of light by matter, and references, see Higgin's paper [2].

Superabsorption plays an important role in light-pumped lasers (ruby, dye,..), active medium of which becomes dark if a superradiant (laser) ray is emitted.

Competition of modes and beams interactions with variously excited atoms is generally too complicated for a precise study, so that it remains only the two fundamental rules of thermodynamics: While energy flows, entropy increases. (Temperature of a polarized, monochromatic ray is deduced from its frequency and spectral radiance by Planck's law).

2.2 * Emission of a ring shows the limb of a Strömgren's sphere.

Stars may emit a "stellar wind" made mainly of protons and electrons. These particles are cooled by expansion and combine on a "Strömgren's sphere". Outside, a Strömgren's shell contains mainly excited H atoms.

Amplification of light in shell is superradiant for rays having a maximal path in this shell, that is tangentially to the sphere (figure 1). De-excited by super-radiance, then involved in super-absorption, atoms intensely absorb energy received from the star. This energy can not be stored notably in gas which works as medium of a "light pumped laser".

Picture 2 shows initial limbs of SNR 1987A in which absorption or scattering of light by equatorial planets or rings strangled Strömgren's sphere into a three limbs (to Earth) hourglass. Now, the star has eaten its planets.

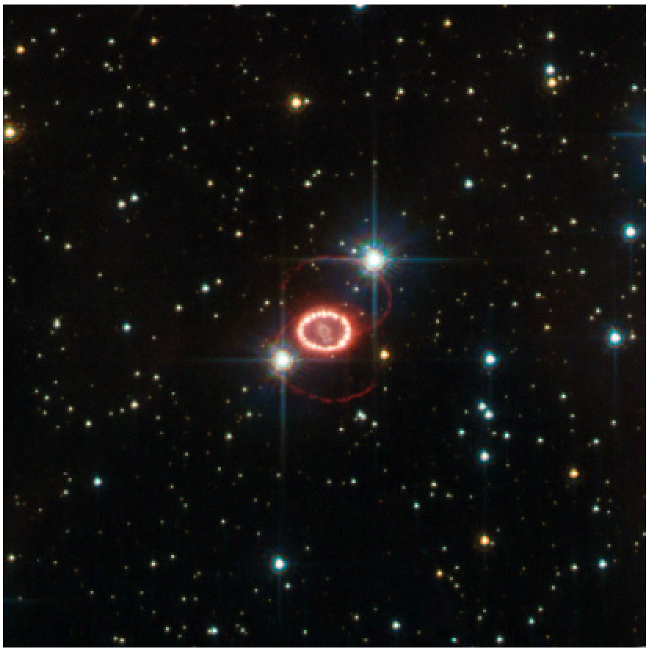

Figure 2: SNR 1987A in 2012 (Hubble picture). The three rings are limbs of an hourglass of excited H atoms.

This picture proves superradiance, with a high probability: **Two background stars are much brighter than a lot of other background stars, while they are seen through rings: Radiance of rays received from a star being large, their light is much more amplified than light initially generated in Strömgren's shell.**

Coherent dipolar interactions explain that SN1987A disappeared when its rings appeared. At scale of propagation time of light, these effects are simultaneous because energy stored by atoms excitation is negligible.

SNR1987A shell is an optical black hole:

Inside rings, it remains only radiation of hydrogen Lyman lines probably emitted by rare atoms in external region of Strömgren's sphere. Corresponding energy cannot be absorbed through shell because a transfer of energy to rings would decrease entropy.

Spectroscopy of light-pumped lasers or optical black holes is complex. Thermodynamics is the main rule, almost all stars radiation energy being transferred to rings.

In sky, astronomers observe many limbs, (circles or arcs), that competition of modes may punctuate.

May we say that light-pumped lasers are black holes ? Do gravitational black holes exist?

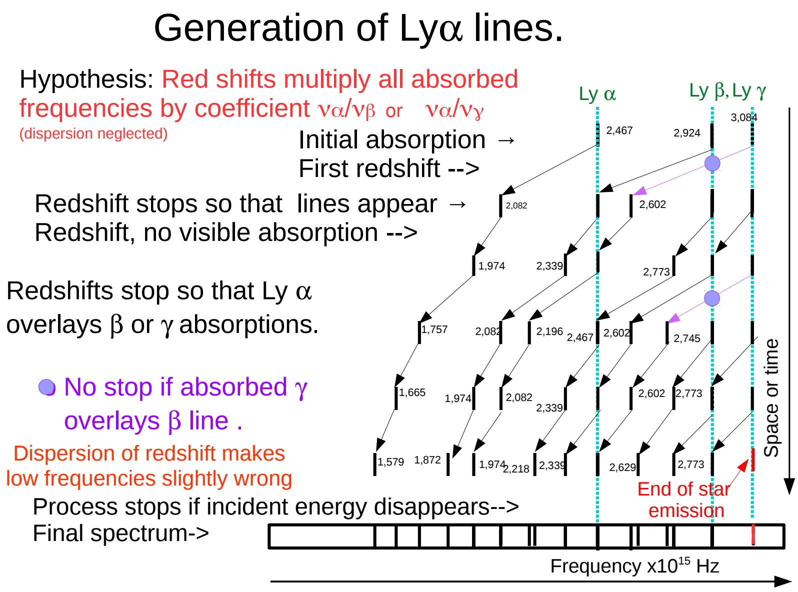

Figure 3: Construction of "H atoms Lyman alpha" lines of a quasar spectrum.

3 Quadrupolar (Raman), spatially-coherent gas-light interactions.

3.1 Quadrupolar interactions of light with excited hydrogen atoms: redshifts.

3.1.1 * Redshifts of "Lyman alpha lines" (Ly_α lines) of quasars.

In a quasar spectrum, Patrick Petitjean [3] found several absorption lines attributed to redshifted Ly_α line of H atom, but no shifted Ly_β or Ly_γ lines.

We searched for them by applying Rydberg and Doppler formulas to redshifted alpha lines and found that redshifted beta or gamma are mixed with differently redshifted alpha ones. This superposition explains Petitjean's observation and shows a quantization of redshifts according to Karlsson's formula because we notice that 3K (or 4K) (where K is empirical Karlsson's constant) is redshift that brings an absorbed beta (or gamma) line to alpha frequency. **Why does an absorbed line at alpha frequency stop redshift, allowing strong, sharp absorption of gas lines ? The simplest explanation is that redshift requires alpha absorption, thus creation of atoms in an excited 2P state.**

A weak, slow redshift resulting from a beta absorption may restart the process. This is possible as long as shifted emission spectrum of star has energy at beta frequency.

Picture 3 shows a construction of "Lyman alpha" lines of a quasar spectrum. It is mistakenly assumed that a redshift multiplies all frequencies of light by a constant, as in a Doppler shift. As redshift results from an interaction with H

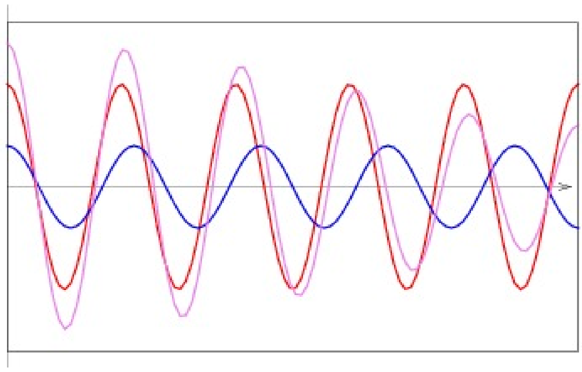

Figure 4: Amplitudes of blue and red sine waves are added in purple.

atoms, it has a dispersion, so that the scale of frequencies in picture 3 must be slightly modified, mostly at low frequencies.

3.2 Quadrupolar spatially coherent interactions: Impulsive Stimulated Raman Scattering (ISRS).

How do excited hydrogen atoms redshift light ?

3.3 Need of pulsed light.

Spectrum of monochromatic, incoherent light scattered by a gas shows generally new, Raman lines. Assume that, on figure 4, the red line represents time variation of amplitude of an exciting coherent light, the blue one amplitude of a Raman scattered line, and purple one their sum.

As long as beats are far (here around 3 periods), purple seems to be a monochromatic wave of intermediate period. Impulsive Stimulated Raman Scattering uses this result by use of short light pulses.

3.3.1 Quadrupolar (Raman) gas-light interactions shift frequencies of light.

Except in bi-refringent crystals, two light frequencies propagating along a same ray have different speeds. Thus, coherent Raman scattered at different points have generally different phases at an observation point, they cancel for opposite phases, resulting Raman intensity remains low. G. L. Lamb [4] shows that powerful interactions are obtained using light pulses “shorter than all involved time constants”. Thus, ”Impulsive Stimulated Raman Scatterings” (ISRS) used to study fast evolutions of chemical reactions require femtosecond light pulses [5].

3.3.2 Use of temporally incoherent light.

ISRS is generally performed in laboratories using 10 femtoseconds laser pulses [5]. Usual light, of thermal origin, temporally-incoherent, is formed of roughly 1 nanosecond pulses, 10^5 times longer.

Compare roughly orders of magnitude of ISRS frequency shift using 1 ns rather than 10 fs light pulses. Taking into account *only* variations of time constants due to Lamb's conditions:

- Increase of collisional time by 10^5 divides the acceptable gas pressure, thus the shift by this factor.

- Reduction of Raman resonance period divides ISRS twice: directly by reduction of Raman quantum, and by Boltzman factor for difference of hyperfine levels populations at equilibrium.

Thus, an equal frequency shift requires a path whose order of magnitude is 10^{15} times larger than in laboratory, an astronomical path. This explains the failure of experiments done to show a redshift of usual light by atomic hydrogen.

Hyperfine resonance at 1420 MHz of non-excited H atoms corresponds to a period less than 1 nanosecond, Lamb's conditions are not fulfilled. On the contrary, in excited states, hyperfine frequencies below 1 GHz produce an ISRS.

Hyperfine levels may be de-excited by another ISRS heating a thermal frequency without perturbation of isotropy. Such sets of ISRS are named "spatially Coherent Raman Effects on temporally Incoherent Lights" (CREIL).

4 * Applications

4.1 * Lyman forests of quasars.

Presence or absence of Ly_α absorption structures space into shells in which H atoms are excited or not. Previously described process provides a spectrum of so-called Ly_α lines. But quasar spectrum shows many other absorbed, sharper, saturated lines which make "Lyman forests": Ly_α absorption excites H atoms to 2P state, density of which increases in gas, that becomes able to amplify Ly_α H line. Start of coherent "emission" which is an amplification requires an initial ray possibly provided by zero point field, or rays refracted from observed ray by fluctuations of gas density. Thus, a superradiant ray bursts as an observable flare which also produces a superabsorption of observed ray, so that a "Lyman forest" line is absorbed in observed spectrum. Gas is excited, and so on ... It seems difficult to compute frequencies of this relaxation process.

4.2 * Correction of Hubble's law.

Hubble did not appreciate the common interpretation of his law. Thus we propose the following corrected interpretation: *Redshifts of stars provide column densities (from stars to Earth) of atomic hydrogen in state 2P.*

This sentence is not very precise because most excited states of H atoms, other atoms, may shift weakly frequencies of light, but it seems a good enough approximation for most uses.

4.3 * Redshifts of spiral galaxies.

Celestial mechanics provides a formula for stability of orbits of stars making spiral galaxies. With evaluation of distances by Hubble's law, that is the present evaluation of sizes of spiral galaxies, their masses must be increased by "dark matter". But it appears that search of "dark matter" inside laboratories buried under big mountains is negative. Thus it seems good to take into account an over-estimation of distances of these galaxies by an abundance of excited hydrogen emitted by hot stars, so that dark matter and energy are not needed.

4.4 * Dispersion of multiplets in spectra of far stars

As CREIL results from an interaction with matter as refraction, it depends on frequency. There is no need to modify fine structure constant.

4.5 * Very simplified descriptions of other applications.

** Model of quasar: Previous description of lines formation leads to a model of quasars:

- A kernel of neutrons is surrounded by a decreasing temperature pseudo crystal (stabilized by pressure) made mainly of H atoms able to transfer energy between X rays by CREIL. Entropy is increased by exchange of energy between observed X rays emitted at increasing distances from center, thus have decreasing thermal emission frequencies. (Such spectra are observed in X emissions of Sun.)

- An atmosphere of hydrogen has similar properties than Earth atmosphere, stratosphere, Heaviside noisy regions ....

** Anomalous accelerations of space probes: Radius of Strömgren's sphere of Sun is around 10 AU. Just outside, microwaves frequencies needed to compute distances and accelerations of probes may be increased by a CREIL transfer of energy from sunlight to colder microwaves, excited H atoms playing a role of catalyst.

** Maps of galaxies: Distances are exaggerated close to hot stars. Thus bubbles are inflated on maps, universe seems spongy.

** Isotropy of microwave background. Frequencies of these radiations are close to hyperfine frequencies: A strong CREIL inside background radiations increases entropy.

5 Conclusion

Interactions of light with interstellar gas are coherent.:

** Spatially coherent spectroscopy must be used in study of low pressure interstellar gas.

** Stars are surrounded by a shell of excited hydrogen atoms illuminating the limb of a Strömgren's sphere.

** Hubble's law does not evaluate distances, but column densities of excited atomic hydrogen.

** Dark matter and energy, big bang, are tales.

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