White light through low pressure H atoms.

Jacques Moret-Bailly

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Abstract

Propagation of white light in very low pressure, relatively cold H atoms of space, is spatially coherent. Lyman alpha absorption pumps atoms to 2P states. Stimulated Raman losses (SRL) using fine levels quanta of excited H, redshift light at all frequencies until an alpha superradiant flare de-excites H and super-absorbs a black line of a Lyman forest. Pumping stops when an absorbed line is shifted to alpha frequency, so that beta and gamma lines are visibly absorbed. If there is energy enough at Lyman beta frequency, a similar, slow redshift restarts the process. A quasar H spectrum is generated. Hubble redshift evaluates a column density of H in 2P state.

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1 Introduction

In 1917, Einstein wrote that interactions of light with a low pressure gas are spatially coherent. Thus [1,2]:

i) In a ray, gas-light interactions do not depend on "selection rules", but may be positive or negative amplifications of modes of incoming ray.

ii) Different rays may interact through a change of properties of matter. In a laser, super-radiance binds dipoles on wave surfaces, so that laser coherently radiated energy which depends on squares of momenta is increased while most other rays are super-absorbed by incoherent super-interactions.

Stars emit winds mainly made of protons and electrons which cool down enough to combine on Strömgren's spheres, generating superradiant shells of excited gas which draw bright limbs of Strömgren's spheres and super-absorb stars light.

Out of these shells, light-gas interactions are spatially coherent.

2 Signature of atomic hydrogen in 2P states.

2.1 Observation of quasar redshifts.

Burbidge [3] and Karlsson [4] studied redshifts (relative frequency shifts) of light emitted by stars. Karlsson's formula shows that redshifts are often quantized, with values given by formula Z(n)= nK, where n is an integer of serie 3, 4, 6,

... , and Karlsson's constant 0.062. This result for n=3 or 4 is verified using Rydberg's formula:

$Z_{(\beta,\alpha)} = (\nu_\beta - \nu_\alpha)/\nu_\alpha = [(1 - 1/3^2 - (1 - 1/2^2)]/(1 - 1/2^2)] \approx 5/27 \approx 0.1852 \approx 3 * 0.0617$;

$Z_{(\gamma,\alpha)} = (\nu_\gamma - \nu_\alpha)/\nu_\alpha = [(1 - 1/4^2 - (1 - 1/2^2)]/(1 - 1/2^2)] = 1/4 = 0,25 = 4 * 0.0625$;

But Karlsson's formula works well only for n = 3 or 4 !

2.2 Improvement of Karlsson's rule: Main redshifted lines.

Redshifted Lyman beta and gamma lines are not observed because they are exactly shifted on alpha line. Many such coincidences show that absence of alpha absorption stops redshifts: Main redshifts require a Lyman alpha absorption generating H atoms in 2P state .

Karlsson's formula does not work well for $n > 4$ because successive redshifts do not add integers to n in Karlsson's formula.

2.3 Quasar main lines.

A sketchn (croquis) of an absorbed Lyman spectrum of H atom assumes that a white spectrum (temporally perfectly incoherent continuous frequencies light) is absorbed at lines frequencies:

- either partially, (not well visibly), during a redshift,
- or strongly if light is not redshifted during a stop of redshifts.

In a first step, we assume that redshifts add as successive Doppler redshifts :

i) We apply a Doppler-like redshift to sketch, such that a first gas absorbed line reaches Lyman alpha frequency.

ii) This stops redshift so that all gas lines are strongly absorbed (sketched).

iii) Assuming a slow remaining redshift, return to i). The remaining slow redshift is produced by a Lyman beta absorption if light redshifted to beta frequency was initially emitted by star. Else, there are no more alpha absorption, no more redshifts.

The chromatic dispersion of redshift may be introduced by a multiplication of computed frequencies by a function of these frequencies close to 1 except at low frequencies.

3 Redshift mechanism.

3.1 Recall of coherent interactions of light and matter.

Usual selection rules do not work for coherent interactions [1,2]: lasers use often forbidden lines. Incoherent, spontaneous emissions are replaced by more powerful interactions: exciting rays become often superradiant, while most other rays are strongly absorbed: For instance, in light pumped lasers (pink ruby, neodyme YAG, dye,...) exciting light is strongly absorbed when laser beam switches on.

3.2 A mechanism of redshifts: "Stimulated Raman Loss" (SRL) [1] also named "spatially Coherent Raman Effect on temporally Incoherent Light" (CREIL) [5]

Atoms in 2P states produce redshifts of spectra. How ?

Set F any frequency in ray spectrum. A quantum at frequency F excites by a Raman interaction a resonance which returns a quantum at frequency F-f. As interaction is spatially coherent, that is it involves in the same way atoms on wave surfaces orthogonal to observed ray, this return must be spatially coherent, corresponding to an amplification of a frequency F-f of ray. As white light emitted by a star is *perfectly temporally incoherent*, its spectrum contains frequency F-f which is amplified by addition of intensities.

Then, any quantum of energy hf transferred from observed ray to atom may be absorbed by a coherent or incoherent interaction with cold background light. Entropy increases.

Assuming that spectrum frequencies are larger enough than Raman frequency, the redshift depends on F by a close to 1 dispersion function.

A lot of convenient low energy interactions is available in 2P states of H atom:

* Fine structure: Energy in state $2P_{3/2}$ is larger than in $2P_{1/2}$ by 45 μeV (corresponding to frequency f=10,9 GHz, wavelength λ = 2,8 cm).

* Lamb shift : Energy in state $2S_{3/2}$ is larger than in $2P_{1/2}$ by 4,372 Strömgren'sμeV (f= 1.0576 GHz, λ = 28,37 cm).

* Hyperfine energy by coupling of nuclear and electronic spins: 5,9 μeV (f= 1,42 GHz, λ = 21cm).

SRL theory is usually verified in laser labs.

4 Applications of spatially coherent spectroscopy in astrophysics.

Subsection 2.3 gives the key of low pressure spectroscopy of H atoms around quasars.

4.1 New Hubble law.

Redshift by H atoms may be added to cosmological one, or replace it. It shows that Hubble law exaggerates distances where density of excited H atoms is large, in particular close to hot stars. Thus:

- Spiral galaxies are closer to us, smaller, so that their stability does not require dark matter.
- Bubbles inflate maps of galaxies.
- Being interactions with matter, redshifts by H atoms have a chromatic dispersion: there is no need to modify fine structure constant to explain the multiplet spectra of far stars.

4.2 Observation of Strömgren's spheres.

Protons and electrons making stellar winds cool down by expansion, combine on Strömgren's spheres, generating outside Strömgren's shells of ionized, excited gas (mainly hydrogen). This laser medium generates superradiant light rays in directions for which amplification is maximal (as in a laser), that is tangentially to sphere, showing its limb.

Depending on intensity, the limb of sphere may show: only an amplification of light of far stars seen through, or a bright ring possibly punctuated. For SNR1987A, the sphere was initially strangled into an hourglass probably by light absorption of planets turning in an equatorial plane: Three circular limbs appeared by superradiance, just when direct star light was super-absorbed.

What a beautiful "black hole" !

4.3 Anomalous accelerations.

Outside Strömgren sphere of the Sun, protons and electrons of solar wind are cool enough to combine into excited hydrogen atoms. These atoms are able to transfer, by Raman coherent interactions, energy from sunlight to microwaves used to evaluate distance and speed of Pioneer probes. Thus probes seem have an anomalous acceleration.

5 Conclusion.

Low pressure of interstellar gas makes light-matter interactions mainly coherent, thus similar to interactions used in laser technology. Depending on abundance of excited H atoms, distances evaluated from Hubble's law must be modified. Astrophysicists should apply spatially coherent (laser) spectroscopy to simplify theories of universe.

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