I. 1 Conditions for Doppler-like frequency shifts.

Several authors searched “Doppler-like” frequency shifts produced by light-matter interactions to avoid an expansion of the Universe, but their solutions did not verify the following conditions:

I. 1. 1 Regular physics.

The introduction of new physical concepts must be justified by either a direct demonstration, or by a lot of explanations. It is better to use only old, reliable physics.

I. 1. 2 No blurring of the images: Coherent light-matter interactions:

| Same interaction between any involved (molecular,...) dipole and the local involved electromagnetic fields. | Consequence: From Huygens construction and Fresnel rules, if the number of involved molecules is large, the wave surfaces and images are clean. |
| Consequence: | Consequence: The theory of a Doppler-like effect must fail using a CW source. |
| Coherent Raman Effect on Incoherent Light (CREIL). |

I. 1. 3 No blurring of the spectra.

A monochromatic wave must be transformed into single, frequency-shifted monochromatic wave.

If the interactions are scatterings:

- i) the scattered wave must interfere with the exciting wave into a single frequency surface. (from the coherence, these waves have the same wave surfaces)
- ii) As the number of involved molecules is large, the individual exchanges of energy is infinitesimal, not quantified.

The molecules are perturbed by the waves to non-stationary states and return to the initial stationary state: it must be a parametric effect (i.e., matter is a catalyst allowing interactions of the waves).

Several waves exchange energy while the molecules are not (de)excited permanently.

The exchanges of energy must obey thermodynamics: from hot beams, redshifted (usually light, from Planck’s law) to cold beams (usually radiofrequencies).

I. 1. 4 (Nearly) constant relative frequency shifts.

A strict constant relative frequency shift Δω/ν as in a Doppler effect, is not required.

Observed variations of Δω/ν are interpreted in the “big bang” theory by a variation of the fine structure constant (Webb et al. 1999) or by a variation of the radiofrequencies).

The exchanges of energy must obey thermodynamics: from hot beams, the initial stationary state: it must be a parametric effect.

I. 2 Coherent Raman Effect on Incoherent Light (CREIL).

The refraction is a light-matter interaction which obeys the previous conditions, ... but does not change the frequencies! Is it possible to replace the coherent Rayleigh scattering which produces the refraction by a coherent Raman scattering?

I. 2. 1 Recall of refraction, that is of coherent Rayleigh scattering.

The thin sheet of matter lying between two close wave surfaces emits a coherent wave, having the same wave surfaces and same frequency than the exciting wave, delayed of π/2.

The amplitude remains E₀ because the infinitesimal scattered wave is in quadrature: the energy is preserved.

Definition of the index of refraction n: setting:

K = 2π/λ = Ωt/ε

Quantum point of view on refraction:

Set Ψ the (stationary) wave function of a refracting medium.

A perturbation by an electromagnetic wave Wᵢ transforms Ψ into a “dressed” (non stationary) state Ψᵢ = Ψ + φᵢ.

Ψᵢ emits the scattered wave delayed of π/2, having the same wave surfaces than the exciting wave.

I. 1. 5 Not Doppler frequency shifts.

A continuous wave emitted by S is received at a lower frequency by R. The number s–r of cycles (wavelengths) between S and R increases: it is a Doppler effect.

Consequence: The theory of a Doppler-like effect must fail using a CW source.


I. 2. 2 Replacing coherent Rayleigh scattering by coherent Raman.

At the start of a light pulse, the Raman scattered waves are in phase, so that, to conserve the energy, the amplitude of the exciting wave must be decreased.

FOR COHERENT ANTI-STOKES SCATTERING, (1) is replaced by:

E = E[|sin(Ωt)|] + K′|sin(Ωt)|] with K′ > 0

= E[|sin(Ωt)|] + K′|sin(Ωt)|] + K′|sin(Ωt)|] + K′|sin(Ωt)|] (3)

FOR STOKES SCATTERING, K′ is replaced by a negative K′. K′ + K′ is proportional to exp(iω/2πεθt−1), approximately to εωT. Thus, the frequency shift proportional to ΔΩ = (K′+K′), ε ε T.

As in refraction, the Ks are proportional to Ω if the dispersions of the polarisabilities are neglected. Thus ΔΩ is nearly constant.

I. 2. 3 Preservation of space-coherence with ordinary light:

Low frequency Raman resonance.

The interactions starting at the beginning of a pulse, keeping Ω small along a light impulsion, requires a Raman period larger than the length of the impulsion, that is than the coherence time.

Low pressure gas.

To avoid a destruction of the space coherence, the collisional time must be longer than the coherence time.

We verify that “ultrashort” (i.e. “shorter than all relevant time constants”) light pulses allow to keep the coherence. (Lamb 1971, Yan et al. 5)

A problem:

It cannot be any permanent exchange of energy between the molecules and the light because the molecules must return to their stationary state after the interaction ...

It is necessary that the interaction involves several beams, so that the final balance of energy is zero for the molecules.

This coherent effect is “parametric”: The molecules act as a catalyst.

The “Coherent Raman Effect on Incoherent Light” (CREIL) is a SET of elementary coherent Raman effects (followed by interference with the exciting beams) in which all transfers of energy obey thermodynamics.
CREIL effect

I. 2.4 Application to astrophysics.
Lamb's conditions are fulfilled in any matter using femtosecond pulses; the coherence time of ordinary light is much longer (some nanoseconds).

Long enough a collisional time requires a gas pressure generally lower than 1000 pascals.

The frequency of the required Raman resonance must be lower than some MHz, but not too low (formula 4: shift proportional to $\omega^2$) to produce strong CREIL effects. Such low frequencies are not common, or they appear in states whose population is low.

Neutral atomic hydrogen has a too high Raman frequency (1420 MHz) in its ground state. It has convenient frequencies in the 2S1/2 states (178 MHz), in the 2P1/2 states (59 MHz) and in the 2P3/2 states (24 MHz).

Hydrogen in these states will be noted H*.

I. 2.5 Quest for “anomalous” frequency shifts.
It is a quest for excited atomic hydrogen H* or similar molecules.

As the CREIL effect increases the entropy of a set of simultaneously refracted beams, we must search the temperature of these beams by Planck's law. Usually, the high frequency beams are hot, therefore redshifted; the thermal, radio beams are cold, blueshifted.

H* is mainly obtained:

Thermally around 100 000 K if a sufficient pressure forbids an ionization.

Around 15 000 K, with a Lyman-$\alpha$ pumping.

By a cooling of a plasma.

II. PROPOSITION OF A FAR UV CONTINUOUS SPECTRUM BEAM IN ATOMIC HYDROGEN.

The light excites the Ly$\alpha$ line, populating the 2P level, so that a CREIL effect appears.

II. 1 Invisible new lines,

<table>
<thead>
<tr>
<th>Intensity $I$</th>
<th>Absorbing line $\Delta I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta v$</td>
<td>Initially continuous</td>
</tr>
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</table>

The linewidth of a sharp line becomes equal to the frequency shift which may be large. The resulting broad, weak lines are usually mixed, they cannot be observed.

... improved contrast of existing lines.

<table>
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<tr>
<th>Intensity $I$</th>
<th>Frequency $\nu$</th>
<th>$\Delta I$</th>
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<tr>
<td>$\Delta v$</td>
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The column density of H* which needed to produce the redshift $\Delta v$ depends on the initial state of the gas and the absorbed intensity $\Delta I$, but not on the initial intensity, so that the contrast of the lines is improved.

II. 2 Propagation of a far UV continuous spectrum in atomic Hydrogen.

II. 2.1 Multiplication of the lines (look at the following figure)

During the strong redshift phase, the intensity at the Lyman $\alpha$ frequency is larger than the intensity $\Delta I$ whose absorption is needed for a permanent redshift. Therefore each gas line absorbs (or emits) a constant intensity which is usually too low to be observed.

The strong absorption phase happens when an absorbed line gets the Lyman $\alpha$ frequency:

the redshift almost stops, so that all gas lines are strongly absorbed (or emitted).

“Almost” because higher states are excited, which produce weak redshifts, and from which the atoms may decay to the 2S or 2P states.

Thus, a redshift phase restarts, until, at least, the frequencies of the $\beta$ and $\gamma$ lines which were just written get the $\alpha$ frequency.

II. 3 Structuring the redshifting gas.

With a single, small source of UV light, the redshift and absorption phases correspond to spherical shells of gas. The pumpings of several sources add, so that the shells are more complicated.

Generating circles.

A low pressure of the gas reduces the absorptions by impurities, so that the periodicities do not appear.
III APPLICATIONS TO ASTROPHYSICS

III. 1 In the solar system

III. 1.1 Transfer of energy from solar light to radio frequencies.

Beyond 5 UA, the cooling of the solar wind produces atomic hydrogen in excited states; in particular, the 2S state is metastable at low pressure. In this hydrogen, energy is transferred from the solar wind to radio, thermal waves, producing blueshifts. In particular:

- Anomalous accelerations

After corrections of the frequency shifts produced via the Doppler effect by known accelerations (Sun, planets, Kuiper asteroids, ...), the cosmic microwave background remains blueshifted, that is heated (Anderson 2002, Markwardt 2002). As the corona which generates the wind has an anisotropy bound to the ecliptic, the fluctuations of the CMB are, in particular, bound to the ecliptic:

- Binding of the anisotropy of the CMB to the ecliptic.

The development of the CMB into spherical harmonics show not only the movement of the Sun to the apex, but, by the quadrupoles and octupoles, a binding to the ecliptic. (Land & Magueijo 2005), Naselsky et al.2005, Schwarz et al. 2004.

This frequency shift is possible for the CW radio wave because the sunlight is incoherent and the radio wave strongly mixed with noise. The standard explanation by a Doppler effect and an anomalous acceleration of the probes toward the Sun requires a change of the celestial mechanics.

Usually, the energy flows from hot to cold, so that the signs chosen by Peter & Judge for the redshifts do not seem convenient. With our signs, the right, decreasing part of the curve obeys more thermodynamics, supposing that the lines exchange energy during a propagation in excited atomic hydrogen, to the mean temperature corresponding to the emission of He I.

Supposing that hydrogen cannot ionize, it contains a high concentration of H* around 100 000 K (log(T)=5). On the following figure, curve D represents the concentration of D, the column density of H* crossed by light propagating from right to left. Curve A built by Peter & Judge represents a function product of functions C and D.

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<th>CREIL shift</th>
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<tbody>
<tr>
<td>F_0</td>
<td>laboratory or computed frequency</td>
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III. 1.2 Frequency shifts of the far UV lines of the Sun.

After corrections due to the movement of SOHO in particular, the shift of these lines is a function of the radius of the solar disc. Peter & Judge (1999) use the standard interpretation of the redshifts by spicules or siphon flows, so that the shifts are supposed zero at the limb, in contradiction with the lab or theoretical determinations.

Accepting old frequencies, the shifts whose directions are opposite are non-zero at the centre and large at the limb of the Sun:

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The VROs (Hall et al. 2001, Wold et al. 2003, Boller et al. 2003) are generally connected by a visible bridge of gas or dust. The redshift of the galaxy is usually much lower than the redshifts of the quasars, although it seems larger than the redshifts of similar galaxies.

However, it remains to do a big spectroscopic work, taking into account the shifts which follow the multiplication of the lines), and the value 72 km/s result from an averaging.

The modulaton due to atomic hydrogen is so stronger than this modulation that, in the case of the quasars, the 36 km/s is not visible.

III. 3.4 The cosmic microwave background

The energy lost by the redshifts blueshifts, that is heats the thermal background. This heating is particularly large close to the bright, redshifted sources. Within radio waves, the CREIL effect is resonant, particularly large, leading to a thermal equilibrium, including isotropy.

The observation of the quasars and the galaxies shows that the regions where a CREIL active effect exists by an UV pumping of atomic or molecular hydrogen are wide: therefore, except for an observation close to bright objects, the thermal equilibrium is reached, the CMB is almost isotropic; only the movement of the solar system, and the amplification of the CMB by the cooled solar wind trouble the equilibrium.

Conclusion:

“Anomalous” frequency shifts of light beams are produced by their propagation in gases obeying Lamb’s conditions.

In atmosphics, the main active gas are:

- Neutral atomic hydrogen in states 2S and (or) 2P mainly produced by a Lyman α pumping which requires a very hot source, an accreting neutron star named quasar.
- Cold molecular hydrogen pumped by the light of the galaxies.

Try to explain the 36 km/s periodicity in the spectrum of the galaxies: it is probably a simple problem!

Short bibliography: