# Some fundamental problems in the Physics of the twentieth century.

Laboratoire de physique,
Université de Bourgogne,
BP 47870, F-21078 Dijon cedex, France.
email : Jacques.Moret-Bailly@u-bourgogne.fr

Einstein showed the quantification of the energy exchanged between an electromagnetic wave and a particle which jumps from a stationary state to an other. It was wrongly deduced that the field is always quantified, while it exchanges a non-quantified energy with a non-stationary system, for instance during the refraction of a "photon", that is of an electromagnetic energy $h\nu$.
Trying to associate classically a wave with a particle, that is to solve the "wave particle duality", de Broglie found that the wave cannot verify a linear equation, but he could not solve equations for the "double solution". The development of the study of the nonlinear systems introduces solitons which solve the problem. To avoid the UV divergence, and to get the creation of electron pairs from gamma rays, Maxwell's equations must fail at high energies; this failure may introduce the nonlinearity required to make solitons, so that matter could be purely electromagnetic.

Supposing the existence of the photons as particles, and forgetting that isolated systems do not exist in quantum mechanics, the scattering of the light is Compton, blurring the images, while coherent optics, in particular the refraction shows the contrary. The astrophysicists deduced from this wrong idea that the frequency shifts of the light without blur of the images are possible only using the Doppler, relativistic or expansion effects. Thus, they get the theory of the big bang which, in despite of a lot of hypothesis, explains poorly the observations. Interactions between the dynamical polarisations, introduced by the regular theory of the refraction, allow coherent frequency shifts which explain very simply a lot of astrophysical observations.

## Introduction

The use of physical laws requires some care because their precision is limited. The limits may be due to the limited precision of the observations which founded the laws, to the appearance of an effect which may be neglected in the usual domain of variation of the parameters, or, more fundamentally to approximations needed to get an easy to use mathematical formulation; these limits are generally known by the user, but it often happens that some of them, considered as too trivial, are missed in the description of the law. Trying to understand an effect for which a law appears bad, we may try to study the foundations of the law to detect some neglected limit, but physics is now so wide that we are unable to know it well, to discuss the foundations of many rules, so that the best, or at least the simplest way to get an apparently good law is to put a patch on the failing law. Unhappily the finesses of the old theories are too often forgotten, so that the excessive use of this last method leads to complications and errors. It appears that a lot of discussions in the development of the physics of the 20 th century results from this lack of understanding and using old and reliable theories.

The origin of this paper is answering questions of graduating students in electromagnetism, optics and spectroscopy; therefore, the starting points are elementary and well described in classical books, so that few references are given.

## A lost part of the classical electromagnetism.

At the end of the 19th century, many physicists discovered new electromagnetic waves, (X and gamma rays, radio) unified by Maxwell's equations and its approximations. The serious discoveries induced far-fetched attempts (N rays...) and serious questions: what happens to the energy of Hertz waves not absorbed by a receiver ? These lost waves inspired charlatans (dowsing) although the question is serious. The classical books explain the computation of the *retarded* electromagnetic fields emitted by a source for instance by an oscillating dipole (field improperly named "spherical"); then they compute THE emitted energy; this is very bad because it implies implicitly that it exists insulated electromagnetic systems; the use of such systems is useful for the mathematical theory, but not physical, so that it is good to distinguish *mathematical electromagnetism* (MEM) in which only the given fields are taken into account, from *physical electromagnetism* (PEM) in which the external fields are not neglected.

In the vacuum and with linear conditions at the limits, Maxwell's equations are linear for the fields, so that their solutions may be combined linearly, and represented by the elements of an infinite vector space **M**. The energies do not obey a linear equation, so that the energies of two solutions are generally not additive; if, in MEM, the sum of the energies of two (finite) solutions is the energy of the sum of the solutions, these solutions are defined as orthogonal. It is convenient to call "mode"a set of solutions which differ only by a multiplicative constant, the amplitude; the mode is represented by a ray in **M**. The orthogonality extends to the modes and the frames in **M**.

The students, working in MEM frequently ask the question: "We compute the energy emitted by a dipole , but what is the energy absorbed by a dipole placed in an electromagnetic field ?"

The PEM answers: *An electromagnetic field is absorbed if it is cancelled by an opposite field.* The opposite of the field required for a complete absorption of a field radiated by a source, called the *advanced field*, was introduced by Schwarzschild and Fokker and it is easily deduced from the radiation of the source: the source is split into point sources, themselves split into harmonic multipoles whose radiated fields $R$ are transformed into partial advanced fields $A$ by charge conjugations and space-time inversions. For an harmonic oscillating dipole, the transformation is simply a time inversion provided that the phases are convenient.

Summing the problems of an advanced field, and of the corresponding retarded field (and their dipoles), cancels the dipoles, so that a converging then diverging field $T = A + R$ is obtained, without dipole; $T$ is solution of Maxwell's equations in the vacuum; the diverging part $R$ of field $T$ may cancel a field $R' = -R$ generated by a dipole opposite to the initial one. Concluding, the advanced fields allow to replace dipoles by fields to get a solution of Maxwell's equations without charges, and to cancel the fields emitted by a dipole. But while computing an advanced field is easy, making it physically and rigorously is impossible so that the approximate absorption of the field emitted by a dipole requires the emission of fields emitted by lots of dipoles and a lot of time. Therefore,*it remains always and everywhere a field, stochastic far from the sources.*

The computation of the mean amplitude of this field at 0K (zero point field) done by Nernst [1] in 1916, requires Planck's constant. The zero point field is often named "quantum field" although its origin is trivial in classical electrodynamics; it is often split from the real field to obtain a remaining "usual field", physically meaningless because the field in a mode depends on the amplitude only, forbidding any distinction between component fields.

## Excitation of an absorber.

Using Schwartzshild and Fokker trick, Maxwell's equations are linear, relative to a space without charges. Therefore, the solutions of Maxwell's equations build a linear space $\mathbf{M}$ in which orthogonal frames are defined using the orthogonality of the modes. Therefore, supposing that the frame in $\mathbf{M}$ is chosen so that the field $F$ emitted by a dipole is represented by a vector

**F** on an axis of the chosen frame, an energy may be exchanged with the field $F$, that is with the dipole only by a field having in **M** a non-zero component on **F**.

The usual computation of the excitation of a dipole by the electric component of an electromagnetic field is generally wrong because it is not done in **M**. In particular, exciting a dipole by a plane wave, as usual in experiments, only the component of the plane wave on the spherical mode of the dipole may be cancelled, absorbed, leading, in the usual computation, to a loss of half of the energy; the other components produce a diffracted wave.

This result is observed experimentally: comparing the emission of a wave stimulated by the zero point field (that is the spontaneous emission) with the emission stimulated by a plane wave, the careless usual computation uses the zero point field of the spherical mode, and, wrongly, the field of the plane wave, so that, to get the experimental result, the energy of the zero point field must be multiplied by 2 [2, 3, 4]; more seriously, it is the energy of the plane wave which should be divided by 2.

This experimental result shows that the "reduction of the wave packet", a fundamental postulate of quantum electrodynamics is wrong[1].

## Planck's law.

Planck obtained the good law of the radiation of the blackbody assuming that the variations of the energy in a monochro-

[1] A lot of beautiful experiments using photon counting were done to show that quantum electrodynamics is better than classical electrodynamics; their positive result is due to an error in the used classical computation: it uses the "usual field", neglecting the zero point field.

matic electromagnetic mode are the product of the $h$ constant by an integer and the frequency. To get the result of thermodynamics that the energy in a degree of liberty tends to $kT$ for a large temperature $T$, the *mean* value of the energy in a mode must be set equal to $(n + 1/2)h\nu$ where n is an integer, the "number of photons" in the mode. A first problem is that monochromatic waves do not exist in the limited time of physical experiments; the simplest way to avoid their use is the wavelets which have a limited support, and for which a mean frequency value $\nu$ may be defined.

A worse problem results from the definition of the used set of orthogonal modes: it must not be particular to get a general physical law, but changing an initially chosen set of modes, a mode containing a photon may be mixed with modes containing none, so that the photon is split.

A third problem is the physical introduction of the temperature in Planck's law: How do the statistical properties of the particles which make the matter are transferred to the waves, in particular if, in the symbolic experiment used to found Planck's law, the used modes are strained by perfectly reflecting *unphysical* planes ?

The classical physicist does not quantify the energy in the modes, quantifying only the *exchanges* of energy with matter, provided that the initial and final state of matter are stationary. Thus, it is easy to extract transitorily from a single photon the energy required to polarise all atoms of the prism which refracts it. Remark that the zero point energy makes a thermodynamical bath, so that while the emission of a photon is in the average followed by the detection of a photon, it exists a probability of no detection or many detections.

In quantum electrodynamics, when the physicist changes his choice of a set of orthogonal modes, the photon jumps from a mode to one other among the set of modes not orthogonal to the initial one: this “reduction of the wave packet”, is the source of a lot of paradoxes (EPR...).

## The wave-particle duality.

The quantification of the energies of the stationary states of matter is a natural property of usual mechanics: If a system has several minimums of energy (a complicated potential function), the energy exchanged with outside is quantified by the jumps between the minimums. The quantification of the electromagnetic field is an useless source of problems.

The initial methods of computation of the eigenstates (Schrödinger equations) were founded on a wave equation, but the resolution of these equations is equivalent to the matrix quantum mechanics and to a study of a Lie algebra which is a much more powerful tool: Is it anymore useful to consider waves to compute the eigenenergies? The quantum mechanical computations of the stationary states uses assumed symmetries, but there are so many models, so many adjustments of parameters that these computations are phenomenological, they may be included in the classical theory.

The interpretation of de Broglie’s association of waves to the particles is impossible using linear waves because no singular point (able to represent, for instance, the centre of mass) may be bound to a linear wave. On the contrary, the solitons have properties of particles, and suggesting to bound its double solution waves by non-linearities, de Broglie introduced a sort of soliton that he was unhappily unable to study.

The study of nonlinear wave equations is very difficult, so that only few 1-dimension solitons wave equations lead to rigorous analytical solutions. Happily, the propagation of light in matter subject to Kerr or photorefractive nonlinearities is so interesting that the resolution of Maxwell's equations in which the permittivity increases with the electromagnetic field up to a saturation has been extensively studied both theoretically and experimentally. In particular, a powerful enough laser beam propagates as a filament stable if the absorption may be neglected.

The field of a filament may be split theoretically and somewhat arbitrarily into a core (de Broglie's $u$ field) in which the nonlinearity is large, and an evanescent part ($\Psi$ field), in which the behaviour of the matter is nearly linear. This evanescent field $\Psi$ mixes, interferes with external fields, allowing small exchanges of energy and interactions able to bend the filament, to induce an attraction between far filaments and various interactions at low distances. For a given neighbourhood, the flux of energy in a filament has a well defined value, that the filament is able to adjust by an exchange of energy with the surrounding fields. If the $u$ part of a filament crosses a Young's hole, the $\Psi$ wave crosses both holes, interferes, and the maximums of the obtained fringes attract the core. It seems possible to make "light bullets", stable solitons obtained by cutting small lengths of filaments. These bullets may be considered as particles because their positions and stable energies may be measured, and their property to interfere is preserved, extended to particles.

However, the light bullets propagate (as neutrinos) nearly at the speed of the light, while usual particles may be static.

Supposing that the permeability of the medium in which a filament propagates increases also until a saturation, the straight filament becomes unstable, gets a radius of curvature, closes into a torus [5, 6]. The energy is quantified, the properties of a true particle are got.

The vacuum appears perfectly linear in the radio and optical domain, so that it seems impossible to build solitons, that is particles; but the vacuum is surely not linear in the gamma domain, because purely electromagnetic interactions are able to generate electron-positron pairs. This does not demonstrate that the physical particles are the solitons we described, but it is a possibility, and other, similar buildings of solitons may be thought. The non-linear properties of the filaments may be able to replace extra spaces of the theory of strings.

This particular suggestion of a solution of the wave-particle duality may not be the good one. But it is sure that the solitons provide an elementary, although mathematically complex, solution of this problem transformed by the principles of quantum mechanics into an absurd “philosophical”problem.

# The Big Bang.

## A damage of quantum mechanics.

When Townes was planning the building of the first maser, he asked the advices of the most prominent specialists of quantum mechanics [7, 8]. Some were careful and did not answer, the other said “it cannot work”. It worked, and this showed that applying the fundamental postulates of quantum mechanics is not reliable.

In the middle of the twentieth century the big gang was not considered as a serious theory, and many people tried finding an alternative to the systematic interpretations of the redshifts by a Doppler effect. The big bang won, using two arguments:

i) If a photocell receives a number of cycles of light lower than the number of emitted cycles, the number of wavelengths between the source and the receiver decreases. As the wavelength is, in the vacuum, an unit of length, the distance between source and receiver decreases, it is a Doppler effect. The error in the demonstration is the implicit hypothesis that the source is coherent. However, this critic is very useful because showing that, with a time-coherent light, there is no alternative to the Doppler effect, it shows that the incoherence of the light is a fundamental parameter of an alternative to the Doppler effect.

ii) If a photon hits a molecule, it is diffused as shown by the Compton effect, so that any interaction between light and molecules blurs the images.

This argument was used against Townes' ideas too, although the existence of the refraction shows it is wrong. The lack of reliability of quantum mechanics was patched simply: the prominent specialists of quantum mechanics did not take into account that quantum mechanics is not separable, so that in the refraction by a prism, the physical system includes all molecules of the prism, and the result is just the classical result.

Unhappily, in despite of the development of the lasers, in despite of the demonstration of space-coherent redshifts using lasers, the astrophysicists were not as tenacious than Townes !

## The Coherent Raman Effect on Incoherent Light (CREIL).

It is generally assumed that the exchanges of energy between the electromagnetic waves and matter are always quantified, while this is true only if the initial and final states of matter are eigenstates.

The polarisation of the matter done by a pulse of light which crosses it requires an energy which is returned to the exciting pulse when its intensity decreases. Without a quantification by a change of the state of the matter, there is no permanent exchange of energy between light and matter. How can the energy of a light beam be changed ?

The solution is that several beams of light polarize the matter, so that the balance of energy is zero for the matter, but not for the individual beams: the matter appears as a catalyst which allows an exchange of energy between the beams. Thermodynamics says that energy must flow from hot to cold. Following Planck's definition of the temperature of a mode, the high frequency beams are generally hot, therefore their frequencies are decreased, the contrary for the low frequency beams which are generally beams of the thermal background.

In a quantum point of view, supposing that all molecules of the polarising medium are equivalent and in the same non-degenerate state, their set is in an extremely degenerated state whose degeneracy is destroyed by the light beams, each mode defining a state. The CREIL is an exchange of energy between these particular, polarised states.

To get a strong effect, the coherence of the excitations of the molecules during a light pulse must be kept, the molecules must be stable during the pulse, that is the length of the pulse must be shorter than the time constants which may occur for the molecule [9]. These time constants are the collisional time constant and the time constant in the interaction between the levels of polarisation. As it is an interaction between levels of same parity, it must exist a quadrupolar (Raman type) interaction whose time constant, that is the period must be longer than the length of the pulses. The frequency shifts are easily observed using femtosecond lasers [10] whose high peak power needed to have enough mean power for the detection, induces a nonlinearity.

The length of the light pulses of ordinary light is of the order of some nanoseconds, so that the molecules must have a quadrupolar resonance frequency lower than $\sim$ 1 GHz. The pressure of the gas must be relatively low. An elementary computation shows that, for hot enough beams, neglecting the dispersion of the optical constants, the relative frequency shifts $\Delta\nu/\nu$ are constant, as in a Doppler effect [11].

## Spectroscopy of the redshifts in astrophysics.

The most common gas is hydrogen; the well known quadrupolar transition in atomic hydrogen has too high a frequency (1420 MHz), while in the states of principal quantum number $n$ = 2 (178 MHz in the $2S_{1/2}$ spin state, 59 MHz in $2P_{1/2}$ , and 24 MHz in $2P_{3/2}$ ) or $n = 3$, the frequencies are low enough to allow the CREIL, and high enough to provide a high CREIL.

The ratio of the ionisation energy of the atom of hydrogen to the Boltzman constant $k$ is 158 000 K, so that over a temperature of 300 000 K it remains nearly only protons and electrons, no CREIL. Thus sharp emission lines of very ionised atoms are emitted close to the surface at 1 000 000 K of a neutron star embedded in a cloud of dirty hydrogen (accreting neutron star, or *accretor*).

The energy of the $Ly_\alpha$ is the three fourth of the ionisation energy, so that, down to about 30 000K the atoms are notably excited, the hydrogen produces CREIL, the hot beams are "redshifted", the cold ones are "blueshifted", that is amplified if they are simply thermal. During the reshift, no emission or absorption is visible because the lines are weak, having the width of the shift. Thus, there is a gap of redshifts between the emission of sharp lines and other lines of the star.

At a lower temperature, atomic hydrogen may be excited by Lyman absorptions, and a remarkable nonlinear behaviour appears: if hydrogen is excited, the spectrum is shifted, i. e. the frequencies of the light are lowered, so that the energy at the $Ly_\alpha$ frequency is renewed; the frequency shifting is maintained until it happens that an absorption line written in the spectrum reaches the $Ly_\alpha$ frequency; then the redshifting stops, the gas may absorb strongly a lot of lines, until a residual frequency shift restarts the permanent frequency shift.

This works for excitations at the $Ly_\beta$ frequency too, and, as previously absorbed lines, the $Ly_\beta$ and $Ly_\gamma$. Thus the strong Lyman lines of atomic hydrogen are chained by a coincidence of a line of a shifted spectrum with a line of the gas. If we suppose that all observed lines are considered as $Ly_\alpha$, and characterised by a redshift $z$, an elementary computation shows that $z$ is a linear function of an integer, with a multiplicative constant $z_b = 0.062$ [12].

Remark that the absorption of the Lyman lines over a permanently renewed frequency, that is in a wide band, absorbs a lot of energy, so that the temperature of the gas is self-regulated as long as the UV intensity is large.

In conclusion, a strong CREIL effect requires low pressure hydrogen and the radiation produced by a very hot object. If the gas is not very hot, a nonlinearity produces a "Lyman forest" with the periodicity 0.062 of the redshifts. The accretors are reputed being never observed, being called quasars.

Other gases, for instance some neutral or ionised compounds or allotropes of hydrogen and deuterium may produce a CREIL, but their abundance, therefore their contribution is probably low, negligible.

## The reasons why, in the Universe, the large redshifts are provided by the CREIL.

The previous simplified description[2] of the building of the very complex spectrum of the quasars, using CREIL, but without any new hypothesis or parameter is an astonishingly simple spectroscopic performance; in comparison, the standard theory cannot explain many characteristics (anti-correlation of the radio-loudness and the existence of broad lines, constance of the chemical composition of very far clouds, periodicities in the Lyman forests, ...) although it introduces a lot of hypothesis (for the stability and the high temperature of the clouds, to generate iron in young objects ...).

Two types of redshifts are easily explained by the CREIL while they do not have a standard explanation without introducting of a new concept:

Radio frequencies sent to some Pioneer probes were returned to the Earth after a multiplication by a fractional (therefore

[2] For a more precise description, see [12].

surely constant) factor. Taking the Doppler and relativistic effects into account, the returned signal has too large a frequency. The experiment is so reliable that it was concluded that the laws of mechanics are wrong [13, 14]. The problem seems particularily complicated because the Galileo and Voyager probes do not show frequency shifts. An explanation by the CREIL is elementary: close to the Earth, the solar wind is mainly made of free protons and electrons which cannot produce a CREIL effect; farther from the Sun, between the Pioneers and us, atomic hydrogen appears. There, except very close to the probes, the radio frequencies are very weak, mixed with the thermal noise which provides a modulation. The CREIL transfers energy from the high frequencies radiated by the Sun to the thermal frequencies, in particular into the modes of the radio frequencies which are detected. A change of the intensity, or a modulation of the radio emission could allow a spectroscopy of the gas which produces the CREIL, to verify that it is atomic hydrogen.

Studying the vibrations and the variations of luminosity of the stars, V. A. Kotov [15] observed a period of 160 minutes which does not depend on the redshift of the star. Although the origin of this period is not known, this effect appears common enough to be reliable. If the Universe expands, this period should be lowered for far objects. Using the CREIL, the frequencies of the pulses of light which allow the observation of the objects are redshifted, but the distance of the pulses is unchanged. This observation shows that, if it exists, the expansion of the Universe is very low, and that, in the absence of global movements, the Doppler contributions to the shifts do not reach high values.

## General applications of the CREIL in astrophysics.

We do not know now the origin of the CREIL which, in the intergalactic space produces the uniform redshifts leading to the Hubble law. On the contrary, the observations show that high redshifts appear where the conditions favour the appearance of excited atomic hydrogen. The first condition, the existence of hydrogen is easily fulfilled, but the second, its excitation requires the proximity of a hot source close to the path of the light between the observed object and us. It is the "proximity effect".

The bright and much redshifted objects appear dusty, their neighbour radiating the thermal light of a black source whose temperature may reach several hundreds of kelvins. A problem is that the radiation of the main source should both corrode the dust and reject it by its pressure. The properties of these objects shows that the CREIL transfers a lot of energy to the thermal radiation: it is very probably sufficient to explain the observed thermal temperature.

The explosion of a very heavy old star into a supernova should generate at least a neutron star, but it is uncommon to observe a heavy residual object; when they are observed, they are pulsars, not visible stars. The usual explanation is that debris of the explosion mask the hot objects; the CREIL may contribute to this masking, redshifting the light so much that it does not remain any light in the optical range.

Halton Arp observed enough alignements of dense (neutron) objects and a galaxy to deduce that these alignements are not artifacts, and exist in the space [16]. As these objects have various redshifts, he must introduce "intrinsic redshifts", which are clearly CREIL redshifts: Supposing that the whole system is embedded in hydrogen, the atoms are much more excited close to the hot, neutron objects than close to the galaxy, so that, as observed, the hot objects are much more redshifted than the galaxy.

To try an explanation of the alignments of similar objects and a galaxy, we may imagine that during the explosion of a supernova, the kernel avoids some loss of angular momentum by ejection of matter, keeping, as a drop of liquid, the shape of an ellipsoid (in a first approximation). The short axis is along the angular momentum, the long one may be longer than the middle one. The cohesion forces being very different for a drop and a star, the first approximation would probably remain acceptable with a long axis much longer than the middle one. The cigar could vibrate along its long axis, up to a break into similar parts, and debris in the middle. The heaviest parts become the hottest, the brightest in the UV, therefore produce a higher CREIL, are more redshifted.

## Conclusions

The key of the understanding of many problems of physics and astrophysics should be searched first in old, reliable theories which, often do not need difficult computations. Why do people prefer setting new, complicated theories, so strange that they are nearly magic?

The development of physics was so large since the ninetieth century that *learning* physics replaced *understanding* it. Sure, it is impossible to understand all, but the scientific thought requires trying to find the origin of our main concepts, to ask permanently oneself “why do I think this ?”. It requires too the recognition of the weakness of our thought made mainly of an involuntary adoption of debatable thoughts of our teachers.

# References

[1] W. Nernst *Verh. Deutsch. Phys. Ges,*, **18**, 83-116, 1916.

[2] L.I. Schiff "Quantum mechanics", *McGraw-Hill, New York*, 1958.

[3] V. L. Ginzburg *Sov. Phys. Usp.*, **26**, 713, 1983.

[4] P. W. Milonni, *Am. J. Phys.*, **52**, 1340, 1984.

[5] J. Moret-Bailly, *Journal of theoretics*, **5-5**, 11, 2003.

[6] J. Moret-Bailly, *Quantum theory: reconsideration of foundations-2, Växjö Univ. Press, ISSN 1651-0267*, 425-434, 2004.

[7] C. H. Townes, *Opto & Laser Europe*, **69**, 20, dec. 1999

[8] W. E. Lamb Jr., W. P. Schleich, M. O. Scully, C. H. Townes, *Rev. Mod. Phys.* , **71**, S263-273, 1999.

[9] G. L. Lamb Jr., *Rev. Mod. Phys.*, **43**, 99-124, 1971

[10] Y.-X. Yan, E. B. Gamble Jr. & K. A. Nelson, *J. Chem Phys.* **83**, 5391, 1985.

[11] J. Moret-Bailly, *Quant. & semiclass. Opt.*, **10**, L35-39, 1998

[12] J. Moret-Bailly, arXiv, astro-ph/0406631, 2004.

[13] J. D. Anderson, P. A. Laing, E. L. Lau, A. S. Liu, M. M. Nieto & S. G. Turyshev, arXiv:gr-qc/0104064, 2002.

[14] S. G. Turyshev, J. Anderson & M. M. Nieto , Physics World, 21-22, Sept 1994.

[15] V.A. Kotov *ApJ*, **488**, 195, 1997.

[16] H. Arp, *ApJ*, **525**, 594-602, 1999.