Electron-Spin-Reversal Noise in the Gigahertz and Terahertz Ranges as a Basis for Tired-Light Cosmology

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A well-known quantum mechanical hypothesis is found to anticipate ubiquitous electromagnetic noise in the gigahertz and terahertz ranges. It also appears to anticipate the so-called cosmic "thermal background" radiation and the astronomical redshift. It might form the long-sought underlying physical basis for the tired-light model of the universe.

Introduction

The submaximum speed of light through a non-vacuum medium is known to depend upon the frequency of the light and upon the density and nature of the medium. The view of quantum mechanics, however, is that light always travels at the same maximum speed regardless of the medium. That speed is the speed of light in a vacuum.

The time delay experienced by light while travelling through matter is hypothesized to be due to absorption and re-emission of the photons. Each photon that is absorbed by a unit (ion, atom, etc.) of the ambient matter excites the structure of that unit to a higher energy state. If that higher energy state does not match one of the unit's stable higher energy states, there is almost immediate emission of a photon and a return of the unit to its lower energy stable state. An exception is the very rare case where the excited unit undergoes a collision with other matter and the energy difference between the actual higher energy state and a lower energy stable state adds to the recoil energy of the collision.

The hypothesis holds that when the energy absorbed by the unit is not adequate to raise the unit to the next higher energy stable state, the emitted photon has the same energy and direction as the absorbed photon. There is a small time delay due to the processes of absorption and re-emission, and that small time delay is the reason light travels less rapidly through matter than through a vacuum.

The more dense the medium, the higher the probability of such absorption and re-emission. Thus, the greater the total time delay and the slower the speed of the light.

This foregoing quantum mechanical hypothesis has been accepted since at least the 1930s, but has yet to be proven correct. Furthermore, as pointed out in a recent publication (Carpenter 1987), this hypothesis is far from being as innocent as it seems.

As does this paper, that recent publication assumed the foregoing quantum mechanical hypothesis to be correct and investigated an unexplored possible consequence of that hypothesis.

This paper's purposes are to clarify that already identified possible consequence, to provide a better description of the anticipated spin-reversal gigahertz and terahertz electromagnetic noise, and to identify some further consequences.

Theory

The basic theory has been presented elsewhere (Carpenter 1987) and will only be treated briefly here.

Any unit that has two electrons in precisely the same quantum mechanical state except for spin, such as parahelium or parahydrogen, is considered to absorb a photon of energy inadequate to raise the unit's electron structure to the next higher stable state. If the higher energy electron (identified as electron #2) of the nearly-identical pair is the one raised to the unstable state, photon emission occurs as hypothesized and electron #2 drops back to its stable state.

Suppose, however, that the lower energy electron (#1) of the pair is raised to the unstable state. Electron #2 would not only “see” a vacant lower energy state into which it could drop but it would also “see” another electron (#1) of the same spin and of slightly higher energy albeit in an unstable state. Additionally, it would “see” an abrupt increase in ambient magnetic field magnitude, B. Electron #2 would have a non-zero probability of reversing spin, dropping into the vacant lower energy state, and causing a spin-reversal photon to be emitted.

Electron #1 would then reverse spin, drop into the ortho state, and cause a photon to be emitted with the same energy as the original (absorbed) photon minus the energy of two spin-reversal photons. Electron #1 would subsequently reverse spin again, dropping into the para state, and the second spin-reversal photon would be emitted. It is assumed for this paper that the foregoing process occurs at a significant rate.

The process thus consists of a single photon being absorbed and three photons being emitted. The three photons have the same direction and total energy as the original photon and are separated slightly in time. Two of the three photons are of spin-reversal energy (one of slightly higher energy than the other), and the third photon is of the same energy as the original photon less the energy of the two spin-reversal photons. For this process to occur, the original photon must be of energy greater than or equal to approximately three times the spin-reversal energy.

Although not stated by Carpenter (1987), this process can also occur for units that are molecular or crystal.

The remainder of this theory section addresses a more accurate technique for determining the frequencies of the spin-reversal photons emitted by atoms and ions. It applies this technique to a ground-state helium atom, a positive lithium ion, and a negative hydrogen ion. It also addresses the effect that scattering of the spin-reversal photons from the components of the ambient medium will have on each spin-reversal spectrum, and some loss mechanisms that prevent the spin-reversal photons from continuing to increase in population.

Ground-State Helium Atom: The usual method for determining theoretically the difference in energy between two adjacent energy levels, is to determine accurately the energy of each level and take the difference between them. For two energy levels that differ only by spin, however, that approach sometimes leads to an erroneous value. The reason for this is that the difference between the two energy levels sometimes lies within the error associated with the determination of each level. That is the case here.

There is an approximation method which provides a more accurate value for the spin-reversal photon energy in such cases as this. That method is presented in Appendix I. It yields a photon frequency ν of:

$$\nu = 1.368\,(4Z - 1)^3\,(2Z - 1)\,g\,n^{-5}\ \text{GHz} \tag{1}$$

where:

Z = atomic number,

g = Landé g factor,

and n = the orbital quantum number.

For ground-state helium with a Landé g factor of 2,

$$n = 2.8 \text{ THz} \tag{2}$$

This is in the long wavelength infrared regime.

Because this method is only approximate, and because the two electrons reverse spin in the presence of magnetic fields that differ from each other by as much as five percent or so, it is not appropriate to specify more than two place accuracy for either the energy or the frequency of the photons.

Kinetic motion (thermal, etc.) of the helium atoms in interplanetary and interstellar space should blur the spin-reversal characteristic emission line.

Positive Lithium Ion: For positively-ionized lithium, equation (1) specifies a spin-reversal photon frequency of approximately:

$$n = 18 \text{ THz.} \tag{3}$$

This frequency is near the geometric middle of the long wavelength infrared regime.

Negative Hydrogen Ion: For negatively-ionized hydrogen, equation (1) specifies a spin-reversal photon frequency of approximately:

$$n = 74 \text{ GHz.} \tag{4}$$

That particular spin-reversal line should be observable from the surface of Earth because it lies 14 GHZ above the 60 GHz electromagnetic noise produced by its nearest competition, atmospheric oxygen (Martin 1978). The 74 GHz spin-reversal emission might also be observable in the laboratory, and a search for it is urged.

The main source of opacity of the solar atmosphere is the negative hydrogen ion (Bethe and Salpeter 1957). There is a dense layer of negative hydrogen ions surrounding Sol. Solar photons remove ions from the layer through de-ionization but new ions form at the same rate. Our sun (and every star) should be a strong source of 74 GHz spin-reversal photons.

Ambient Medium Scattering: The interstellar ambient medium temperature in this part of the Milky Way is approximately 50° K. The medium is sparse, consisting primarily of hydrogen in the form of negative ions, atoms, and positive ions. There is a sizable minority of helium atoms, and an electron gas. Low energy photons (100 THz and less) should scatter readily, the lower the frequency the greater the cross-section for scattering. The scattering not only randomizes the directions of the low energy photons but also tends to make the photons and the ambient medium approach a common temperature.

The 2.8 THz helium spin-reversal photons are at a slightly higher "temperature" than the interstellar ambient temperature, so they should be gradually reduced in energy toward the ambient background. The weak 2.8 THz flux, the blurred emission line and the thermalization of spin-reversal flux into the ambient background would thus combine to make the 2.8 THz helium spin-reversal photons difficult, if not impossible, to detect.

The 74 GHz negative hydrogen ion spin-reversal photons are at a considerably lower "temperature" than the ambient medium temperature in local interstellar space. An average spin-reversal photon should scatter upward in energy until reaching a photon energy of three or more times the spin-reversal energy.

The probability of this, more energetic, photon undergoing spin-reversal division into three photons should be quite high. Two of the resultant photons would be of spin-reversal energy and the third would be of slightly greater energy. The 74 GHz spectrum would thus be quasi-thermal in frequency distribution and essentially isotropic (random in direction due to a high probability of scattering). That spectrum would grow from small magnitude at frequencies less than 74 GHz to a maximum in the vicinity of 220 GHz and drop off rapidly at higher frequencies. The spectrum should be easily observable from the surface of Earth.

Loss Mechanisms: If it were not for loss mechanisms, the negative hydrogen ion spin-reversal flux would increase continuously in intensity. The same spin-reversal process, however, can occur for molecules and crystals. That removes energy from the negative hydrogen ion spin-reversal flux and causes it to be re-emitted in lower frequency ranges. Solid matter can absorb the photons and re-emit the energy as heat photons. Other loss mechanisms are thought to exist (e.g. black holes).

Conclusions

GHZ and THZ Noise: As has been seen from the foregoing material, one unexpected consequence of the venerable quantum mechanics hypothesis is an ubiquitous flux of electromagnetic noise in ranges such as 74 to 220 GHz, and including 2.8 THz and the frequencies immediately below. The 74 to 220 GHz noise bears a striking resemblance to the so-called background radiation from the "big bang" (Penzias and Wilson 1965, Dicke et al 1965).

Astronomical Red Shift: As infrared, visible and ultraviolet photons travel through intergalactic, interstellar and inter-planetary space, they encounter negative hydrogen ions and ground-state helium atoms. Not only should many spin-reversal photons be produced and randomized in direction (through scattering) but also the infrared, visible and ultraviolet photons should be gradually shifted downward in energy. The further these latter photons travel the less energy each of them will have. This offers an alternative explanation for the astronomical redshift which hitherto has been explained by the expanding universe concept.

Tired-Light: The quantum mechanical hypothesis appears to lead to a physical basis for the tired-light model. Originally the tired-light model competed with the expanding universe model as an explanation of the astronomical redshift. Various factors caused most researchers to set aside the tired-light model. These factors were summarized by Geller and Peebles (1972) as:

1. lack of an identified physical basis,
2. no natural provision for the microwave background,
3. disagreement between the universe curvature derived from the observed angular size of galaxies and that derived (through tired-light theory) from the apparent bolometric magnitude as a function of redshift, and
4. disagreement between observation and tired-light theory regarding the location of the antipode.

The quantum mechanical hypothesis addresses the first two of the foregoing objections and therefore re-opens the possibility that the tired-light model might be the more correct representation of the universe.

Appendix

Calculation of approximate spin-reversal photon frequency

A calculation similar to that below, is found in Beiser (1963) for the ground-state hydrogen atom.

Given any atom (such as He) with two ground-state electrons (that differ in quantum state only by spin) in its outer shell: the magnitude of the centrifugal "force" (F_c) must exactly equal the magnitude of the electric force (F_e) for each of the electrons:

$$F_c = F_e \tag{1-1}$$

It is known that:

$$F_c = mu^2/r \tag{1-2}$$

and

$$F_e = [Ze^2/(4\pi\varepsilon_0 r^2)] - [e^2/(16\pi\varepsilon_0 r^2)] \tag{1-3}$$

where the electron mass is

$m_e = 9.108 \times 10^{-31}$ kilograms, (1-4)
u = electron "orbital" speed,
r = radius of electron's "orbit"
(assumed circular),
Z = atomic number,
e = electron charge,
$= 1.602 \times 10^{-19}$ coulombs, (1-5)

and

e = permittivity of free space,
$= 8.854 \times 10^{-12}$ coulomb^2/(newton-meter^2) (1-6)

So equations (1-1), (1-2) and (1-3) yield:

$$u^2 = e^2 (4Z - 1)/(2^4 pe_0\, m\, r) \tag{1-7}$$

There are still two unknowns (u and r) in equation (1-7). A second equation is needed to resolve the situation. That second equation is based on the concept that an integer number of matter waves must fit into each complete electron "orbit":

$$n\,l = 2pr \tag{1-8}$$

where

n = a positive integer,

l = the de Broglie wavelength of the electron,

$= h/(m\mathbf{u})$ (1-9)

and

h = Planck's constant,

$= 6.625 \times 10^{-34}$ joule-second. (1-10)

So, from equations (1-8) and (1-9),

$$\mathbf{u} = n\,h/(2\pi m r) \quad (1\text{-}11)$$

Combining equations (1-7) and (1-11) yields:

$$r = 4\mathbf{e}_0\,h^2\,n^2/[pme^2\,(4Z-1)] \quad (1\text{-}12)$$

and

$$\mathbf{u} = e^2\,(4Z-1)/(8\mathbf{e}_0 hn) \quad (1\text{-}13)$$

The number of times (W) the electron circles the nucleus each second is:

$$W = \mathbf{u}/(2\pi r). \quad (1\text{-}14)$$

Equations (1-12) and (1-13) are substituted into equation (1-14):

$$W = me^4\,(4Z-1)^2/(2^6\mathbf{e}_0{}^2 h^3 n^3) \quad (1\text{-}15)$$

The strength of the magnetic field (B) is found through the electromagnetic loop relation:

$$B = [m_0\,i_z/(2r)] - [m_0\,i_e/(4r)] \quad (1\text{-}16)$$

where

m_0 = permeability of free space,

$= 1.257 \times 10^{-6}$ weber/ampere-meter (1-17)

$$i_z = W\,Z\,e \quad (1\text{-}18)$$

and

$$i_e = We \quad (1\text{-}19)$$

Combining equations (1-15), (1-18) and (1-19) yields:

$$B = pm_0\, m^2 e^7\, (4Z-1)^3\, (2Z-1)/(2^{10}\, e_0^3 h^5\, n^5) \qquad (1\text{-}20)$$

This provides an estimate of the magnitude of the magnetic field "seen" by each electron. It is only an estimate because it assumes that each electron is in the same circular "orbit" (with the nucleus at the center of the circle) and the electrons are at opposite ends of a diameter through the nucleus. Actually, the absorption of a photon disturbs that assumed structure and causes the calculated value of B to be too small for one of the electrons. The exact amount of the error in B is a function of the original absorbed photon's energy.

The energy (E) of the emitted spin-reversal photon is the product of two times B, the Bohr magneton ($eh/4\pi m$), and one-half the Landé g factor:

$$E = 2B\,(eh/4pm)\,(g/2) \qquad (1\text{-}21)$$

Substitution of equation (1-20) into equation (1-21) yields:

$$E = m_0 m\, e^8\, (4Z-1)^3\, (2Z-1)\, g/(2^{12}\, e_0^3\, h^4\, n^5) \qquad (1\text{-}22)$$

The frequency (n) of the emitted spin-reversal photon is theoretically:

$$n = E/h \qquad (1\text{-}23)$$

Substituting equation (1-22) into equation (1-23) yields:

$$n = m_0 m\, e^8\, (4Z-1)^3\, (2Z-1)\, g/(2^{12}\, e_0^3\, h^5\, n^5) \qquad (1\text{-}24)$$

Substituting the known values into equation (1-24) yields:

$$n = 1.368\, (4Z-1)^3\, (2Z-1)\, g\, n^{-5}\ \text{GHz} \qquad (1)$$

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