Cosmology and Quantum Mechanical Unstable States for Helium

Donald Gilbert Carpenter
Department of Electrical Engineering
Colorado Tech
Colorado Springs, CO 80907-3896, U.S.A.

Precise values are provided for the magnitude of the redshift associated with the helium atom for temporarily absorbed H_d*, Fe XIV,* Na_D *, and* H_a *photons, more details are given regarding the emission wavelengths of the two spin reversal photons that carry away the energy lost by the redshifted photon, and a crude time sequence of pertinent atomic events is suggested. When an Fe XIV photon is fleetingly absorbed with a wavelength of 5,302.30 Angstroms, one spin-reversal photon is emitted with a wavelength of 617,877 Angstroms and the other with 1,040,189. Angstroms. The redshifted photon is emitted with a wavelength of 5,375.84 Angstroms. The amount of the redshift for each single absorption and emission is 0.01387. The redshift per interaction is found to vary by wavelength. This is to be expected.*

Introduction

In earlier work (Carpenter 1987), I pointed out that the venerable quantum mechanics hypothesis, which explains why light travels less rapidly through matter than through a vacuum, suggests a quantum mechanical process that could produce a redshift in light. Subsequent investigation (Carpenter 1990) was encouraging. It yielded preliminary information regarding the magnitude of the redshift per interaction.

This paper gives more precise values for the magnitude of the redshift associated with the helium atom, more details regarding the emission wavelengths of the two spin-reversal photons that carry away the energy lost by the redshifted photon, and a crude time sequence of pertinent atomic events.

Another paper is planned to present similar information regarding the unexcited hydrogen molecule.

Theory

Quantum Mechanics is concerned with stable and semi-stable states. Its mathematics is not readily suited to treating unstable states. Therefore, an alternative approach is used here while adhering to Quantum Mechanics concepts and results. The Bohr model works well for low atomic weight atoms where the spin-orbit coupling is weak. For such atoms, spin is considered to be a conserved quantity. The following discussion and work are presented using the Bohr model as done by Beiser (1963) but modified and normalized to conform to results widely accepted (Peebles 1992).

This process does not violate the Pauli Exclusion Principle because that Principle does not address unstable states. Instead, it describes what was and is observed regarding stable and semi-stable states. No electron possessing a quantum state that is identical to the quantum state of another electron in the same atom can persist in that state. In this case, the He atom's undisturbed electron has a well-defined quantum state but its disturbed electron has an undefined orbital quantum number. The remainder of the disturbed electron's quantum state is identical to that of the undisturbed electron's because absorption of the photon with a spin of ±1 causes the disturbed electron to reverse spin and match the spin of the undisturbed electron.

I must point out here that this venerable quantum mechanics hypothesis has not yet been proven either correct or incorrect.

If it is correct, however, there are occasions when the disturbed electron (referred to here as electron A) is originally the more tightly bound of the two ground-state electrons. The more tightly bound electron A reverses spin during the absorption of the photon and rises to an unstable state. The electromagnetic field disturbance, that reveals the change in electron A's status, progresses from the location vacated by electron A to the location of electron B (the remaining electron). The signal's trip takes about 2×10^{-19} seconds at the speed of light in a vacuum.

The signal contains considerable information. It reveals that the lower energy ground-state is vacant, the other electron's shielding of the nucleus is decreasing, the negative electric field is weakening, and that another electron with an undefined orbital quantum number has exactly the same spin as electron B. Electron B thus "sees" a nucleus whose effective Z is increasing from 27/16 to some higher value less than but very close to 2, causing electron B to tighten its orbit and give up some energy. It "sees" the lower energy state vacated by electron A. It reverses spin and occupies that lower energy state, emitting a spin-reversal photon. In another 2×10^{-19} seconds the information regarding electron B's new status, including spin, is conveyed to electron A. Electron A continues to move further from the nucleus until it reaches the vicinity of its unstable state. The total trip outward takes approximately 2.970×10^{-18} seconds. That trip produces further tightening of electron B's orbit. The subsequent further tightening of the orbit causes electron B to transfer energy to electron A, moving electron A fully into its unstable state.

In another 2×10^{-19} seconds, the further change in electron B's status reaches electron A. Meanwhile, electron A must de-excite. Electron A "sees" electron B in the atom's lowest energy state with opposite spin to electron A. The only state left open to electron A is the state that was originally occupied by electron B but that state cannot be accessed directly by electron A because of the spin prohibition. Electron A cannot even drop into the orthohelium state because that state requires approximately 20 eV above ground-state. The photon that caused this situation had an energy less than that necessary to raise helium to its first excited state—and that first excited state's energy is only about half of what would be needed to achieve the orthohelium state.

An alternative path might be open, though. Electron A can reverse spin twice rapidly. The first reversal emits a spin-reversal photon, the second reversal gives up part of its energy to electron B, and emits a photon with the remaining energy. That photon emission provides another reversal of spin for electron A. In this manner, electron A is able to drop into the higher energy of the two ground states. Electron B uses part of the energy given up by electron A to move away from the nucleus back into the lower energy one of the unexcited atom's two ground-states.

Again, conservation of energy, momentum, and spin require that the momentum and spin of the photonic energy emitted be identical to that absorbed. The net result is that one photon is absorbed and three are emitted. All three have the same direction as the original photon but are delayed in time because of the absorption/emission process. Two of the photons are of spin reversal, and therefore low, energy. The third photon has the original photon's energy less the energy contained in the two spin-reversal photons. Spin is conserved because two of the photons have the original photon's spin, the third photon is emitted with opposite spin. The total time required for the foregoing process is about 6×10^{-18} seconds.

Results

The total time for the process has not yet been determined accurately. The reason is that the absorbed photon energy causes the initial outward movement of the electron, but additional energy is then provided by the other electron shifting closer to the Helium nucleus. Yet the calculation done here assumes that all of the energy is provided at the same instant. This means that the actual time for the process is probably greater than indicated here, and might be as much as a factor of two different. (Detailed calculations are available from the author upon request.)

Table 1 shows the wavelengths of absorbed and

Table 1. The Redshift Process in Helium*

Light (Color)	Absorbed Photon l (Angstroms)	Re-emitted Photon l (Angstroms)	Redshift	Electron B Spin-reversal Photon l (Angstroms)	Electron A Spin-reversal Photon l (Angstroms)	Δt (10^{-18} sec)
Blue	4,101.74	4,144.57	0.0104408	617,877.1	1,110,223.	7.1309
Green	5,302.30	5,375.84	0.0138686	617,877.1	1,040,189.	5.9401
Yellow	5,893.00	5,984.72	0.0155636	617,877.1	1,018,217.	5.5347
Red	6,562.72	6,677.52	0.0174920	617,877.1	998,903.	5.1612

* If the probability of interaction were directly dependent upon frequency, the average redshifts occurring at these frequencies would be within 5 percent of each other for each interaction.

emitted photons, along with the redshift that results from each interaction of a photon with a ground-state He atom. The redshift and associated spin-reversal photon energies would necessarily be less if ground-state helium were replaced by ground-state hydrogen molecules.

There are some points of interest in Table 1. In each case, spin-reversal of electron B yields a photon of 617,877, Angstroms, so there should be a line emission at or close to that wavelength that might be detectable as generalized space background noise. The reason it would not be concentrated in starlight is that its relatively long wavelength would cause it to be very susceptible to scattering.

Absorbed (original) photons lying in a wavelength range from 6562.72 to 4101.74 Angstroms yield a spin-reversal wavelength range (of photons from electron A) from 998,903. to 1,110,223. Angstroms. The wavelength relationship is inverse. These band emitted photons are even more susceptible to scattering than are the line emission photons, and would thus be ubiquitous. I doubt these band-emitted photons can be detected with present astronomical equipment because of the width of the wavelength range, relatively high probability of scattering, and short photon lifetime in that wavelength range due to Compton scattering.

The redshift found here might appear to some, at first glance, to be incompatible with the cosmological redshift. The cosmological redshift, though, would be a product of the redshift (wavelength dependent) per interaction, the probability of interaction (wavelength dependent) per encounter, and the number of encounters along the path. Assuming that the probability of interaction is inversely related to the wavelength yields cosmological redshifts at all visible wavelengths that are within 5 percent of each other. That is within the error associated with these calculations.

The probability of interaction is normally directly related to the wavelength in a sawtooth fashion. That is, a photon of wavelength short enough to remove the most tightly bound electron from the atom, and provide it with considerable kinetic energy, has an extremely small cross section. As the wavelength increases to where the energy is just adequate to free that most tightly bound electron, the tiny cross section increases. As the wavelength increases slightly more, the energy is no longer adequate to free the most tightly bound electron, and the cross section drops abruptly to a lower, non-zero, value. Upon further increase in wavelength of the incoming photon, the cross section increases until the peak is reached for the next open state for the most tightly bound electron. This continues until all open states are used up for that most tightly bound electron. Then the next most tightly bound electron's states are addressed. That continues until all electrons' states are treated. Between those peaks, the longer the wavelength the greater the probability of interaction. That relationship, though, is for photons of energy adequate to raise an electron to a stable or free state.

These photons, however, are of energy inadequate to raise the electron to the next higher open state and might well show an inverse relationship between the cross section and the wavelength of the incoming photon.

The time required for this absorption/re-emission process for visible light lies between 5.16×10^{-18} and 7.13×10^{-18} seconds, within a factor of two.

As suggested previously (Carpenter 1990), a laboratory laser experiment with either helium atoms or hydrogen molecules under pressure in a long tube might enable detection of the anticipated spin-reversal photons. Should they be detected, the spin-reversal process will become a possible mechanism of the observed astonomical redshift. It might even prove to be the primary cause for the observed redshift.

The spin-reversal photons from neutral hydrogen molecules and from other molecules might, in fact, prove to be the chief source of the observed "background" radiation.

References

Beiser, A., 1963. *Concepts of Modern Physics*, McGraw-Hill.

Carpenter, D.G., 1987. A possible quantum mechanical source of gigahertz noise, *Speculations in Science and Technology*, 10 (1):31-36.

Carpenter, D.G., 1990. Electron spin-reversal noise in the gigahertz and terahertz ranges as a basis for tired-light cosmology, *Apeiron* 6:7-11.

Peebles, P.J.E., 1992. *Quantum Mechanics*, Princeton University Press, Princeton, N.J.