A History of Dark Matter?

Abstract

In developing their wave equations, both Huygens and Maxwell assumed space was filled with touching material particles. Since their equations correctly predict important properties of light, their concepts of a material ether were accepted as fact, until early in the twentieth century.
Several experimenters, including Sir J.J. Thompson, reported the appearance of surprisingly large quantities of hydrogen gas during electrical discharge in vacuum. Clarence Skinner reported that during electrical discharge in low- pressure helium, hydrogen was produced at the cathode and the initial rate of hydrogen production obeyed Faraday's laws of electrolysis. He obtained thousands of times more hydrogen from a silver cathode than it could have originally contained.
Recently scientists have produced Bose-Einstein Condensed rubidium, sodium and lithium and found that they transmit light at much lower speeds than vacuum.
Could dark matter be Bose-Einstein condensed hydrogen and the medium for light transmission?
According to Linus Pauling, atomic hydrogen is paramagnetic. If Bose-Einstein condensed hydrogen is a matrix of protons and unpaired electrons, it would be paramagnetic and have dielectric properties. The presence of such a matrix permits simple explanations of the forces between separated permanent magnets.

Seventeenth Century

Christiaan Huygens' book, "Treatise on Light", was published in 1678. An English translation was published by Encylopaeda Britannica, in 1952[1]. The translation includes the following:
Huygens referred to an experiment, in which Torrecelli (a contemporary of Galileo) filled a glass U-tube with mercury to a sealed end and evacuated the tube through the other end. Light passed through the space that developed at the sealed end. Huygens concluded that the medium for light transfer was present in vacuum and that the medium easily passes through the glass and/or the mercury. He proposed that the medium was made up of extremely fine, touching material particles, which transfer light by a mechanism similar to that by which sound travels through air. He suggested the energy is transferred much like the transfer of energy from sphere to sphere in a series of suspended balls. All the energy on one ball is transferred to an adjacent ball. The velocity of transfer depends on the properties of the balls. The following quote is from the English translation:

"And it must be known that, although the particles of the ether are not ranged thus in straight lines, as in our row of spheres, but confusedly, so that one of them touches several others. This does not hinder them from transmitting their movement and spreading it always forward."[2]

He assumed that each activated ether particle is the start of a new wave and, on this basis, developed equations that predict observed diffraction patterns. For many years, scientists considered this strong evidence of a material ether.

Nineteenth Century

James Clerk Maxwell's book, "A Treatise on Electricity and Magnetism Volume 2" was first published in 1891.[3] The following quotes are from that book:

"In several parts of this treatise an attempt has been made to explain electromagnetic phenomena by means of mechanical action transmitted from one body to another by means of a medium occupying the space between them. The undulatory theory of light also assumes the existence of a medium. We have now to shew that the properties of the electromagnetic medium are identical with those of the luminiferous medium.

To fill all space with a new medium whenever any new phenomenon is to be explained is by no means philosophical, but if the study of two different branches of science has independently suggested the idea of a medium, and if the properties which must be attributed to the medium in order to account for electromagnetic phenomena are of the same kind as those which we attribute to the luminiferous medium in order to account for the phenomena of light, the evidence for the physical existence of the medium will be considerably strengthened"[4]

"According to the theory of undulation, there is a material medium which fills the space between the two bodies and it is by the action of contiguous parts of this medium that the energy is passed on, from one portion to the next, til it reaches the illuminated body."[5]

"Let us determine the conditions of the propagation of an electromagnetic disturbance through a uniform medium, which we shall suppose to be at rest, that is, to have no motion except that which may be involved in electromagnetic disturbances.

Let C be the specific conductivity of the medium, K its specific capacity and u its magnetic 'permeability'."[6]

Both Huygens and Maxwell based their wave equations on the presence of touching material particles in vacuum. If, in Huygens' mechanism, an activated ether particle often passed its energy to more than one adjacent particle, the frequency of the energy transmitted would be quickly reduced. Since this is not the case, the great majority of activated particles must pass all of their energy to one adjacent particle.
Maxwell's mechanism requires that the medium have magnetic and dielectric properties. Magnetic properties are generally attributed to the presence of unpaired electrons. Dielectric properties require the presence of negative and positive particles. This suggests that his medium might be a matrix of unpaired electrons and positive particles.

Early Twentieth Century

The following is the introduction to a 1905 article by Clarence Skinner of the University of Nebraska:

"In several parts of this treatise an attempt has been made to explain electromagnetic phenomena by means of mechanical action transmitted from one body to another by means of a medium occupying the space between them. The undulatory theory of light also assumes the existence of a medium. We have now to shew that the properties of the electromagnetic medium are identical with those of the luminiferous medium.

To fill all space with a new medium whenever any new phenomenon is to be explained is by no means philosophical, but if the study of two different branches of science has independently suggested the idea of a medium, and if the properties which must be attributed to the medium in order to account for electromagnetic phenomena are of the same kind as those which we attribute to the luminiferous medium in order to account for the phenomena of light, the evidence for the physical existence of the medium will be considerably strengthened"[4]

"According to the theory of undulation, there is a material medium which fills the space between the two bodies and it is by the action of contiguous parts of this medium that the energy is passed on, from one portion to the next, til it reaches the illuminated body."[5]

"Let us determine the conditions of the propagation of an electromagnetic disturbance through a uniform medium, which we shall suppose to be at rest, that is, to have no motion except that which may be involved in electromagnetic disturbances.

Let C be the specific conductivity of the medium, K its specific capacity and u its magnetic 'permeability'."[6]

Skinner employed various metals as cathode and found that most tarnished during discharge in helium and each produced hydrogen. Metals tarnish in the presence of atomic hydrogen, but not in helium. The following quote is from his article:

"Altogether about two cubic centimeters of gas have been given off by this silver disk, which is 15 mm. in diameter and about 1 mm. thick. It shows no sign of having its supply of hydrogen reduced in the least."[8]

Many respected experimenters have reported the surprising appearance of hydrogen gas in their experiments. The following quote is from a 1914 article by Sir J.J. Thomson:

"I would like to direct attention to the analogy between the effect just described and an everyday experience with discharge tubes. I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of positive rays. Though you may heat the glass tube to the melting point, may dry the gases by liquid air or cooled charcoal and free gases you let into the tube as carefully as you will from hydrogen, you will get hydrogen lines by the positive ray method, even when the bulb has been running several hours a day for nearly a year." [9]

Since the gases tested by Thomson were subjected to electrical discharge prior to test, he may have produced hydrogen by the same mechanism as Skinner. If the medium proposed by Maxwell is a matrix of protons and unpaired electrons, atomic hydrogen might be produced from the medium by electrolysis. If so, the hydrogen would be produced at a fresh cathode at the rate predicted by Faraday's laws. Atomic hydrogen is extremely reactive and would be expected to tarnish metal cathodes and form diatomic hydrogen gas, as noted by Skinner.

In a 1914 article[10], George Winchester of Washington and Jefferson College gave results of electrical discharge experiments using cp aluminum electrodes approximately one millimeter apart and pressures as low as one millionth of a millimeter. He obtained hydrogen and traces of helium and neon early in the experiments. He proposed that helium and neon had been occluded in the electrodes.
"The case of hydrogen is different; I have sparked tubes until the electrodes were entirely wasted away and this gas can be obtained as long as any metal remains." [11]

A 1928 article[12] by Stearcie and Johnson of McGill University reports on an exhaustive study of the solubility of hydrogen gas in silver. They reported that, at 25 ^{o} C., silver absorbed 0.007 volumes of hydrogen per volume of silver. As pointed out above, Skinner's silver cathode, which had volume of about 0.08 cc. produced 2 cc. of hydrogen gas or 25 times its volume of hydrogen and,

"It shows no sign of having its supply of hydrogen reduced in the least."[8]

The cathode could have contained only 0.08 X 0.007 = 0.00056 cc. of hydrogen. The hydrogen Skinner produced could not have been initially present in his silver cathode.

Mid Twentieth Century

The following quotes are from Linus Pauling's, "Nature of the Chemical Bond"[13] :

" The most stable orbit in every atom is the 1s orbit of the K shell. In the normal hydrogen atom this is occupied by one electron, the spin magnetic moment of which makes monatomic hydrogen gas paramagnetic. In the normal helium atom the 1s orbit is occupied by two electrons, which are required by the exclusion principal to have opposed spins; in sequence of this helium is diamagnetic, the spin magnetic moment of the two electrons neutralizing one another." [14]

"It is customary to refer to electrons with opposed spins as paired, whether they occupy the same orbit in one atom or are involved in the formation of a bond."[15]

If space is filled with a matrix of protons and electrons, the structure may be similar to that of molten salt. Just as no chloride ion touches another chloride ion; no electron touches another electron and the electrons are not paired. Such a matrix would be paramagnetic and respond appropriately to an approaching magnet. The presence of such a matrix permits a simple explanation for the forces between separated permanent magnets.

Later in the Twentieth Century

The January issue of Scientific American includes an article by Silvera and Walraven of

Harvard University. It discusses Bose-Einstein condensation (BEC). The following quotes are from that article:[16]

"The statistical theory that describes atoms was first studied by the Indian physicist S. N. Bose and is called Bose statistics. The phenomenon predicted by Einstein is a mathematical consequence of Bose statistics, but it was so contrary to the intuition of physicists in the 1920's that it was regarded as a mathematical oddity that would never be found in a real system. It is now thought, however, that the phenomenon is observable in the laboratory. It is called Bose-Einstein condensation."[17]

"In a Bose-Einstein-condensed gas, however, a large fraction of the atoms would occupy the ground state at an experimentally accessible temperature, and nearly 100 percent of the atoms would become condensate at a temperature above absolute zero."[18]

"The most sought after quantum phenomenon is a sudden condensation of a large proportion of the atoms in the gas into a state of minimum energy. The condensation is expected to take place at a low temperature that depends only on the temperature of the gas. For example, at a density of 10^{24} atoms per cubic centimeter the critical temperature is .016 degrees K, whereas at the density of interstellar hydrogen the critical temperature is 10^{-18} degree K. The critical temperature for the condensate is proportional to the density raised to the 2/3 power."[19]

"It is the coherent motion of the condensate atoms of a Bose-Einstein-condensed gas that is expected to give rise to extraordinary macroscopic properties at a temperature well above absolute zero."[20]

"It is highly possible but not definitely established by experiment that superfluid helium 4 is Bose-Einstein condensed."[21]

"Liquid helium 4 at or below 2.18 degrees is therefore called a superfluid. If it is set flowing in a tube closed on itself, the liquid continues to flow without friction, never coming to a stop as a normal fluid would. It flows into the smallest passages of its containing vessel and has the remarkable ability to flow through a densely packed powder as if the barrier were not present. A vessel with microscopic holes that would be impenetrable to a normal fluid can be a leaky sieve to a superfluid. Such a vessel is said to have a superleak."[22]

If the medium assumed by Huygens and Maxwell is actually Bose-Einstein condensed hydrogen, in which each electron is surrounded by protons and each proton is surrounded by electrons (similar to sodium and chloride ions in molted salt) and all the particles are touching, the condensate would be stable to extremely high temperatures. The space between atomic nuclei of materials would be extremely wide gaps to the condensate, which might be expected to flow through materials, with no resistance.
The following quote is from a 1969 textbook by Weidner and Sells.

"We shall see that, apart from the tremendous difference in their relative sizes, 10^{-10} m for atoms but less than 10^{-14} m for nuclei, nuclear structure is different from atomic structure in several significant respects." [23]

Every nucleus contains, at least one proton. This suggests that protons, like electrons, are extremely small compared to the spaces between the nuclei of materials. Could the spaces between nuclei be filled with the proposed medium?

As pointed out earlier, the critical temperature for Bose-Einstein condensation is proportional to the density raised to the 2/3 power. Using the known weights of protons and electrons and assuming radii of 10^{-15} meters, for each, one may calculate that a matrix of touching protons and electrons would be stable to extremely high temperatures.

Early Twenty First Century

An article in the December 2000 issue of Scientific American describes the work of Daniel Kleppner and Thomas Greytak of MIT.[24]

"When his former students were making their spectacular condensates of rubidium, sodium and lithium (alkali atoms), Kleppner was battling his career-long atom of choice; hydrogen. He has been studying hydrogen since he was a graduate student and postdoc at Harvard University in the late 1950s."

Their experiments toward producing Bose-Einstein condensed hydrogen appeared to be unsuccessful until they employed spin-polarized hydrogen. Perhaps, they had produced Bose-Einstein condensed hydrogen earlier, but couldn't detect it. It is difficult to detect water you have produced in a lake, in summer. Ice is much easier to detect.

"Daniel Kleppner began pursuing Bose-Einstein condensation in hydrogen back in 1976, racing against a Dutch group: 'It took a little longer than any of us expected.'"

The July 2001 issue of Scientific American includes an article by Lene Vestegaard Hau titled, "Frozen Light".[25] The article describes experiments her group performed at the Rowland Institute. They passed laser beams into Bose-Einstein condensed sodium and found that it transferred light at a much lower speed than vacuum. They were able to stop light transmission and then restart it, at will, using appropriate laser beams.

If Bose-Einstein condensed sodium transfers light, one might expect Bose-Einstein condensed hydrogen to transfer light at a much faster rate.

If the knowable is filled with touching materials the concepts of "action at a distance" should be reconsidered.

References

1. Huygens C. *Treatise on Light,* Great Books of the Western World **34**, Encyclopedia Britannica Inc., 13th printing pp. 556-560 (1988).
2. ibid p. 560.

3. Maxwell, J.C., *A Treatise on Electricity and Magnetism*. **2**, unabridged. 3rd ed., republished Dover Publications, New York, (1984). First published (1891).
4. ibid p.431.
5. ibid p.432
6. ibid p.433
7. Skinner, C.A. The Evolution of Hydrogen from the Cathode and its Adsorption by the Anode in Gases., Phys. Rev. **21**, 1-15 (1914)
8. ibid. p.6.
9. Thomson, J.J., Nature, **90**, pp. 645-647, (1914)

10. Winchester, G., On the continued Appearance of Gases in Vacuum Tubes, Phys. Rev. **3**, pp. 287-94, (1914)
11. ibid. p. 290.
12. Stearcie, E and Johnson, F., The Solubility of Hydrogen in Silver, Proc. Roy. Soc., London, **A**, **101**, pp. 290-299, (1928)
13. Pauling, L., *Nature of the Chemical Bond*, Cornell University Press, Ithaca, NY, 1945
14. ibid. pp. 21-22
15. ibid. p. 22
16. Silvera, I. And Walraven, J., The Stabilization of Atomic Hydrogen, Scientific American, pp. 66- 74, Jan. 1982
17. ibid. pp. 66-67
18. ibid. p. 67
19 ibid p. 66
20. ibid p. 67
21 ibid p. 68
22 ibid
23. Weidner, R. and Sells, R. *Elementary Modern Physics*, 2nd ed. Allyn and Bacon, Inc., Boston, p. 372, 1969
24. Collins, P., Hydrogen Man, the Godfather of BEC, Scientific American, Dec. 2000, p. 98
25. Hau, L.V., Frozen Light, Scientific American, pp. 66-73, July, 2001

Paul E. Rowe 2/18/07 02649rowepaul@netscape.com