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Chapter 5, Part A: Problems with the All Pervading Ether Hypothesis

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Abstract: Examines the logical inconsistencies in the All Pervading Ether Hypothesis. Specifically, the all pervading Ether hypothesis is created to uphold the notion that (1)wave implies medium, at the expense of dismissing (2) apparent experimental evidence to the contrary (electromagnetic waves travel through empty space). However, (1) arises from a macroscopic view of waves, whereas (2) is experimentally found down to the atomic level. In order to uphold the notion that macroscopic phenomenon is the result of microscopic phenomenon (and not vice versa), it is proposed that we uphold (2), at the expense of abandoning (1). This paper presumes that the reader has already read my paper on "A Brief Overview of SRT" and another paper "Light Isotropy-Theory and Experiment". A wholly contained argument on why The All Pervading Ether Hypothesis is untenable is provided in Appendix 1. The last sentence in the appendix outlines the argument. Appendix 2 draws a distinction between the type of ether discussed in this paper and the type of ether discussed in another one of my papers "Propagation Geometry and Propagation Character-Two issues or One Issue".

Contents:

1. Introduction

All waves we know of are found to travel through material mediums, with the exception of electromagnetic waves. Electromagnetic waves are found to be transmitted across regions of apparently empty space. On the one hand, we have the notion that all waves must travel through material mediums. On the other hand, we have experimental evidence that electromagnetic waves travel through regions of space that are empty (without a medium). The ether was hypothesized to reconcile this apparent discrepancy. The Ether is a hypothetical medium which has not yet been detected but which is presumed to permeate all empty space. According to ether theorists, it is the existence of this medium which permits the electromagnetic wave propagation from one charge to another. Without such a medium, ether theorists claim, wave transmission would not be permitted.

One might expect ether theorists to have strong reasons for asserting the existence of something that hasn't been detected or experimentally verified. Their reason, for this hypothesis, as mentioned, is to preserve the notion that wave implies medium. In turn, one might expect them to have pretty good evidence for maintaining such a notion. The evidence is simply that all waves, with the exception of electromagnetic waves, are found to always travel through material mediums.

One must ask the question: Which is a more fundamentally correct statement: 1) That all waves travel through material mediums or 2) that electromagnetic waves travel through empty space? In this paper, we hope to show that it is the latter statement which is more fundamental. We try to show this by demonstrating that the former statement stems from a limited, macroscopic view of waves, whereas the latter statement is experimentally verifies at microscopic levels. Ordinarily, phenomenon occurring at microscopic levels is used to explain phenomenon observed at macroscopic levels, and not vice-versa. In this way, phenomenon examined with a microscopic perspective is seen as more fundamental than the same phenomenon examined from more macroscopic views.

According to the ether theorists, postulating an ether is a relatively small price to pay to preserve the general rule that wave implies medium. One should have pretty strong reasons for postulating the existence of something that is presumed not to be detectible. I ask you-Is the preservation of the idea that wave implies medium a strong enough reason to predict the existence of an invisible, undetectable entity?

2. When to Abandon Theories

Often times, Macroscopic phenomenon is first explained from a macroscopic perspective. Then, as new technology becomes available and as new experiments are performed, the same macroscopic phenomenon can be explained from a more microscopic perspective.

As an example, let us consider the macroscopic phenomenon of a heated gas, exerting pressure on the walls of a container enclosing the gas. From a macroscopic perspective (say, available interpretations about the nature as based on observations performed with the naked eye) the gas appears to be empty space. The finding that, when the container is heated, it expands, may lead one to hypothesize about some invisible fluid-like ether that expands when heated. From a microscopic perspective, however, we find that a gas exists within the container. We learn that pressure on the inner walls of the container arises from the collisions suffered by the molecules with the walls of the container. When the temperature of the gas inside the container matches the temperature of the gas outside the container, the average velocity of a gas molecule is the same inside the container as it is outside the container. As such, and assuming the densities of the inner and outer gases are the same, the outward pressure on the walls of the container is the same as the inward pressure on the walls. The container neither expands nor contracts. However, when the gas inside is heated, the molecules inside the container move faster, consequently exerting an increased level of outward pressure on the inner walls of the container, and the container expands. We know that this theory is true because one can derive the ideal gas law (confirmed experimentally) from its assumptions.

The derivation of the ideal gas law from the kinetic molecular theory is too compelling to refute. Experiment can tell us how many particles are in that container of gas (n). Given n, the ideal gas law yields a given product PV. Kinetic molecular theory predicted this precisely. If the expanding liquid ether was still presumed to be there (in the empty space between the particles of the gas), it would contribute to an additional pressure on the walls of the container. This would bump up the PV product, rendering it inconsistent with the ideal gas law. Therefore, one cannot maintain the previous hypothesis of the expandable liquid ether. The new kinetic molecular theory would therefore call for either a complete abandonment of the expanding ether hypothesis or else a revision to the hypothesis.

Let us say that, for some reason or another, someone had grown comfortable with this theory, and wanted to preserve it, in spite of new evidence against it. One could say that there still existed this liquid-like ether, filling the empty space between the gas molecules, only this ether does not expand. But what would be the point in this? There may have been justifiable reasons to postulate the existence of an ether in the first place, but what reasons are there now? Does this ether predict other experimentally verifiable conclusions that cannot be alternatively explained? To answer this question one must ask themselves why, exactly, they like it so much. Why not abandon it? What purpose does it serve?

These questions we framed about the ether, in our example, translate to other entities as well, as new evidence is found. As we transcend microscopically, we must be continually asking ourselves, is the impetus for the hypothesis of the entity still there, or can the previously hypothesized entity be abandoned altogether in this more microscopic perspective? New evidence which requires amendments to/modifications of the hypothesis should be a trigger to ask such a question, before going to great pains to rescue or preserve such a hypothesis.

3. Four Types of Waves

Waves are broken into two types: longitudinal (sound and heat) and transverse (electromagnetic, water ripples, plucked strings). Transverse and longitudinal waves can occur in a gas (e.g. electromagnetic, sound), or in a liquid/solid (e.g. water ripples, heat). So there are really four types of waves : 1) Transverse-gas (electromagnetic), 2) Longitudinal-gas (sound), 3) Transverse-liquid/solid (water ripples), 4) Longitudinal-liquid/solid (heat). We will take a look at each of these four types of waves, first with macroscopic (molecule and above) information only, and second with microscopic (charge and above) information. The description of propagation will stem from what is primarily occurring (i.e. occurring over larger regions of space).

3.1 Macroscopic Information Only

3.1.1 Transverse-Gas

In a gas there is a lot of empty space between the molecules. A molecule is disturbed. This disturbance transmits a signal through empty space to the next molecule, which becomes similarly disturbed. It receives the signal from the empty space before it and transmits the signal into the empty space after it. This continues from molecule to molecule. One could choose to describe this phenomenon in one of 2 ways: 1) successive disturbance of molecules, or 2) successive transmission of electromagnetic fields through the empty space between the molecules. Since the phenomenon of signal transmission between the molecules occurs over much larger regions of space than the small regions of space within which the molecules are disturbed, the second description is more appropriate.

3.1.2 Longitudinal-Gas

A molecule travels through the air and collides with the next molecule. This molecule travels in the same direction as the prior molecule while the first molecule bounces back. The second molecule collides with a third molecule, and so on. On could choose to describe this situation in one of two ways: 1) successive vibration of molecules, or 2) successive collisions of molecules. Since the vibrations of molecules occur over much larger regions of space than do the collisions which take place, it makes more sense to use the first description.

3.1.3 Transverse-Liquid/Solid

In a solid/liquid, the molecules touch (apparent). Just think of a long line of people holding hands and one person running forward and then backward. One can describe this phenomenon in only one way: Successive vibration of molecules.

3.1.4 Longitudinal-Liquid/Solid

Just think of dominoes. One can describe this phenomenon in only one way: Successive vibration of molecules.

3.2 Microscopic Information Added

3.2.1 Transverse-Gas

We can now further explore the disturbance of each molecule. Since the electrons exist on the outside of the atoms in a molecule, they will receive transmission of the signal. The signal will continue to be retransmitted across the internal charges which make up the molecule,, until it comes out the other side and ventures back into empty space. The description of propagation remains the same as in the macroscopic case.

3.2.2 Longitudinal-Gas

We can now further explore the apparent collisions. During a 'collision', the molecules actually never 'touch'. Far away from one another, the molecules will appear electrically neutral to one another. But as they approach on another there comes a point where it becomes known to each molecule that the electrons are a little closer than the protons (electrons are one the outside). After this 'impact parameter' is passed, they begin to repel one another. To be sure, in order for the one molecule to communicate to its colliding partner where it is at each point in time, it must be continually transmitting signals to the other molecule. Hence, a collision involves a continual transmission and receipt (exchange) of electromagnetic waves through the empty space that separates the molecules. The description of wave propagation remains the same as in the macroscopic case.

3.2.3 Transverse-Liquid/Solid

We can now further explore the apparent 'touching' of one molecule to another. The molecules can connect either covalently or ionically. In either case, the molecules remain connected because the constituent parts of the molecule are happy with the stability provided to them in that state. The overall effect is a basic push/pull behavior between one atom and the next one it's connected to. We can think of the push pull effect as akin to the attractive/repulsive effect experienced between two charges. If the first charge experiences a side-to-side vibratory motion, the second charge will likewise experience a side-to-side vibratory motion. If the first charge experiences an up-down vibration, the second charge will likewise experience an up-down vibration. To be sure, this first charge must communicate to this second charge where it is at each point in time. This is accomplished via electromagnetic signal transmission/receipt from the first charge to the second charge. The overall propagation of the wave can be described in one of two ways: 1) successive vibration of molecules, or 2) successive transmission of the electromagnetic waves between the constituent parts of each molecule.

3.2.4 Longitudinal-Liquid/Solid

Same description as above.

3.3 Overall Description of wave Propagation

The most proper description of any one of the four waves is the following: An interplay between the successive vibration of bits of matter and the successive transmission of electromagnetic waves between the bits of matter.

For electromagnetic waves in a gas, the transmission of electromagnetic waves through the empty space between the molecules overshadows the vibration of the molecules. For sound waves in a gas, the vibration of the molecules overshadows the transmission of electromagnetic waves through the empty space between the molecules during the 'collision' process. But for waves in a liquid or solid, neither really overshadows the other.

All waves can be described as an interplay between the successive vibration of bits of matter with the successive transmission of electromagnetic field waves through the empty space between the bits of matter. Most fundamentally, if a charge is jiggled, it will send out a signal. When this signal comes into contact with another charge, the second charge will jiggle and resend the signal. All waves are ultimately propelled from this fundamental principle.

We know that this fundamental principle, responsible for all wave propagation, remains true down to the level of the atom. Above this level, the type of wave carried depends on: 1) the medium through which the wave travels, and two, the type of vibration suffered by the initially disturbed molecule. Below this level, it remains possible that there exist more smaller particles, with new and different forces. A sea of such particles might establish reason for referring to it as a new fourth medium (fifth medium if one considers plasma to be the fourth medium). Again, the type of wave observed to travel through such a medium would depend on: 1) The properties of the new medium, and 2) the type of vibration of the initially disturbed charge that generated the wave.

4. Macroscopic/Microscopic Considerations

As technology advances, we can probe deeper and deeper in nature, identifying the motion of objects in smaller and smaller regions of space. It is expected that phenomenon observed at the more microscopic levels will lend more insight into the reasons behind phenomenon observed at the more macroscopic levels. We have, to this point, scoped down as far as the atom, and even down there we find that electromagnetic waves travel through empty space between charges. Nevertheless, ether theorists remain unwilling to accept the notion that a wave can travel through empty space. Hence it is speculated that an ether exists between such charges.

5. Vibrating Fields, Not Matter

Ether theorists seem to have a difficult time with accepting the notion that an electromagnetic wave can travel through empty space. It's almost as if they have a fundamental problem with accepting the notion of a vibrating field in empty space (e.g. a lonely vibrating field). This author supposes that this is because their familiarity with waves such as water waves has impressed upon them the idea that no empty space exists between the adjacent bits of matter that seem to 'touch' one another and pass along a vibratory effect. But this impression is only apparent. Invisible fields are very real entities that have been proven to travel through empty space.

6. Conclusion

Pressure was a macroscopic concept. The kinetic molecular theory of gases was a microscopic concept. Mechanical waves were a macroscopic concept. Electromagnetic waves between charges is a microscopic concept. Electromagnetic waves through empty space is a better description of mechanical waves. And we know it. However, failure to abandon the wave/medium implication represents failure to accept the above.

7. Notes to Various Section

7. 1. Introduction-notes

Note 1: As mentioned, On the one hand, we have the notion that all waves must travel through material mediums. On the other hand, we have experimental evidence that electromagnetic waves travel through regions of space that are empty (without a medium). At this point the scientist is faced with a dilemma. She can say that our notion of a wave (requirement that all waves must travel through mediums) is incorrect and that experiment is correct, or she can say that our notion of a wave is correct and that our experiments are wrong. Ether theorists choose the latter option. To be sure, they don't exactly say that experiment is wrong, but rather that the results of experiments are misleading. They claim that it may appear as though electromagnetic waves go through empty space, but there is really something down there at some submicroscopic level that evades our detection. Notice, though, the strength of the ether assertion. Ether theorists are proposing that there is a physical medium present in a space that we can't detect anything at all.

Note 2: There are really two types of ether. One is motivated by the reasoning shown in note one of this section. Another merely arrives to provide us with a reference for light isotropy. There is subtle difference between the two but it's important to note. Consider if the ether is nothing other than a sea of photons. This type of ether would emerge for the latter reason and not for the former reason. Appendix two goes into more details about this subject.

This paper considers the ether of the type that is motivated by the reasoning outlined in note one. The other ether-the one that merely emerges as an answer to the question 'What is it that light travels isotropic to?- will be dealt with in a separate paper titled "Propagation Geometry and Propagation Character-Two Issues or one Issue?.

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7. 2. When to Abandon Theories-notes

Note 1: Note here that we are discussing the abandonment pf an ether theory. The situation can be directly likened to rescue attempts to same the ether theory. However, the situation can also be likened to the notion that wave implies medium itself. At all times, we must be asking ourselves, “What is the impetus for continuing to believe in this ‘wave implies medium’ notion?”

Note 2: or more information related to the kinetic molecular model of gases, see Young and Freedman, pgs 507-520 or Fowler, first lecture, “Kinetic Theory of Gases: A Brief review”.
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7. 3. Four Types of Waves-notes

Note 1: Note that these descriptions of the waves, on a microscopic level, are necessarily somewhat rough. The author only hopes that he has spoken correctly about wave phenomenon. For more information related to the ‘impact parameter’, and unbounded versus bounded motion of charges, see Goldstein, Chapter 3. For more information related to the transmittal of a wave between the constituent bits of matter, see Hecht, sections 3.4 and 3.5.

Note 2: For comprehensive work associated with the physics of waves, and the mathematics behind them, see Elmore and Heald.

Note 3: For comprehensive work related to light transmission in matter, see Dichtburn.
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7. 4. Macroscopic/Microscopic Considerations-notes

Note 1: If electromagnetic waves were limited to the macroscopic domain (if electromagnetic waves served only as macroscopic explanation of a wave), I don’t think I’d have a problem with the ether theorists’ taking exception to the experimental fact that electromagnetic waves travel through empty space. However, electromagnetic waves pops its head in the microscopic realm, and they do in fact contribute to the effects of all wave propagation. For this reason I don’t think we can just pawn it off as an overall exception to overall wave propagation. Rather, I’d prefer we abandon the notion that all waves must travel through material mediums.
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7. 5. Vibrating Fields, Not Matter-notes

Note 1: If Ether theorists have a problem with accepting the notion of a vibrating field in empty space, to be consistent, why not also have a problem with accepting the notion of a stationary field in empty space (no one seems to have a problem with this)? My point is that, if we don’t have a problem with accepting the notion of stationary fields in empty space, then we shouldn’t have a problem with accepting the notion of vibrating fields in empty space. And that’s all an electromagnetic wave is (a string of vibrating electromagnetic fields). So if we don’t have a problem with vibrating fields in empty space, we don’t have a problem with electromagnetic waves in empty space.

In other words, claiming that 1) wave implies medium is analogous to claiming that 2) vibrating field implies oscillating matter which is, in turn, analogous to claiming that 3) stationary field implies moving matter. But such implications are true only when there is a medium/matter. Sometimes there is no medium/matter but the wave/field is still there. In such a case, we don’t have a difficult time abandoning (3), so why have a difficult time abandoning (1) or (2)?
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7. 6. Conclusion-notes

No notes.

8. Appendix 1: An Ingenious Argument against the All-Pervading Ether Hypothesis

As technology advances, and experiments get more precise, we can probe deeper and deeper into the nature of the universe. At every stage, we notice that nature is made up of little bits of matter and empty space between them. We can take a region of space with a bunch of these bits of matter and, depending on the way these bits of matter are arranged in the region of space, designate the aggregate of bits of matter as having a certain state (i.e. solid, liquid, gas, plasma). The state of the matter is merely circumstantial.-it only depends on the way in which the bits of matter are arranged. What is fundamental is that, at every point in our exploration, we find bits of matter and empty space between them. Further exploration reveals whether there are more bits of matter in the apparently empty space, of if the smallest bits of matter are made of more bits of matter themselves.

At present, our ‘microscope’ can see down to the atomic level, It looks like the atom is made up of protons, neutrons and electrons and empty space between them. Perhaps it will later be found that there are more particles in this empty space or even within the electron.

Ether theorists cannot accept the notion that light (a wave) travels through empty space. As such, they postulate the existence of a medium which is too ‘thin’ to have been detected yet (i.e. contains smaller particles than our current ‘microscope can see) but which permeates all empty space. That is, they postulate that there is no empty space. It is only apparent.

As our ‘microscope’ gets better and better, we will continue to find smaller and smaller particles, and smaller and smaller regions of empty space between such particles, in the formerly apparent so-called empty space. Let us refer to this as the empty space problem.

The empty space problem will remain as long as we keep finding bits of matter and empty space between them. The empty space problem will only be resolved the day that our ‘microscope’ becomes good enough to see one huge bit of matter permeating all empty space! Is this possible? No, it is not, because if the bit of matter is that big, it would have been detected by our naked eye. So, of course. as long as our microscope is imperfect, it will never detect an all pervading slap of matter, no matter how thin it is presumed to be.

The only recourse for ether theorists is to say that it would take a perfect ‘microscope’ to see it. That is, not only is it undetectable yet, but it is presumed to be inherently forever undetectable. However, if it took a perfect microscope to see it, that would imply that it is infinitely thin. This means that the only possible all-pervading ether is one which is infinitely thin. But if it was infinitely thin, it would have zero mass and zero density. This is an ‘intangible’ ether theory.

Some physicists will discuss this intangible ether as though it has similar characteristics to matter-such as being very thin. But it cannot just be ‘very’ thin-it has to be infinitely thin. In fact, with no density and no mass, it doesn’t even resemble matter anymore, and one cannot discuss it as having any of the same characteristics of matter. Here, the intangible ether theory is shown as untenable, and the intangible ether theory is dismissed as nonsense.

In summary, as we scope in on nature, we find apparent bits of matter and apparent bits of empty space between these bits of matter. We should stop there, without speculating about what lies beyond what we can detect. However, we consider the plausibility associated with speculating that t here are more bits of matter below. Although it remains possible that there are bits of matter in the portions of space that are too small to explore, one cannot further speculate that the smaller bits of matter make up a medium which covers all space, for the following reasons: we note that we have the empty space problem, and that it will continue forever unless one day our ‘microscope picks up one big chunk of matter that covers all space in the universe. But of course the day will never come because if that were the case we would have seen the big all-permeating chunk of matter with our naked eye. The only recourse is to interpret that the ether is infinitely thin, forever undetectable, and essentially intangible. But is it is something that is infinitely this, it has zero mass and zero density, and we have no right to maintain that such an ether would have any of the same characteristics as matter itself. Hence it is found that the ether, if it is presumed to be there, cannot be presumed to be all pervading. But if the ether is not all pervading, that means that there are some regions of space which are really empty. This implies that electromagnetic waves do indeed cross regions of empty space that are really empty, not just apparently so. And if such is the case, then what is the impetus for assuming that there are smaller particles down there that we cannot see? There remains no impetus.

9. Appendix 2: A Different Ether

The ether described in this paper is the ether which is presumed to exist to reconcile the notion, wave implies medium, with the experimental verification of electromagnetic waves traveling through apparently empty space. This ether hypothesis presumes the wave nature of light. This ether hypothesis must also presume that the ether permeates all empty space (if it is presumed to occupy only partial space, then there would remain portions of empty space for light to travel through). To distinguish this ether hypothesis from the following one, let us refer to this one as the All Pervading Ether Hypothesis.

The other ether hypothesis merely arises to serve as a reference for light isotropy. This ether hypothesis makes no claims about whether light travels through empty space in the form of a wave or a particle. Nor does this ether hypothesis necessarily presume that the ether permeates all empty space. All it presumes is that there is something down there in the empty space patches that dictates light isotropy. To distinguish this ether from the one discussed in this paper, let us refer to it as the Isotropic Ether. For more information about this aether, and why it is that one needn't simultaneously subscribe to the wave hypothesis of light, see my paper ("Propagation Geometry and Propagation Character-Two Issues or One Issue).

10. References

Alford, J. "Propagation Geometry and Propagation Character-Two Issues or One Issue?" http://www.wbabin.net/pprrel.htm Currently, the scientific community automatically links ether theory with wave character of light, and ballistic theory with corpuscular character of light. The reasonableness of making these associations is considered.

Alford, J. "Light Isotropy-Theory and Experiment". http://www.wbabin.net/pprrel.htm. It is examined how the six theoretical models for light isotropy (three ballistic, two ether, and SRT) stand up to the Original Michelson Morley Experiment and to Original Bradley (Airy not considered) Stellar Aberration.

Alford, J. "An Overview of SRT". http://www.wbabin.net/pprrel.htm Introductory Paper on the presentation of The Special Theory of Relativity.

Alford, J. "Future Considerations-After SRT is Ruled Out". http://www.wbabin.net/pprrel.htm, Alternative explanations to Einstein's are explored.

Dichtburn, Light, Dover, New York

Elmore W. and Heald M., Physics of Waves, Dover, New York, (1969)

Fowler, M., "Kinetic Theory of Gases: A Brief Review", www.phys.virginia.edu/classes/252. Well written series of lectures devoted to the development of Quantum Mechanics. Relevant passages include Kinetic Theory of Gases.

Goldstein, H., Classical Mechanics, 2nd Edition. Addison Wesley, New York, (1980) Hecht, E., Optics, 3rd Edition., Prentice Hall, Upper Saddle River, New Jersey, (1999)

Young H. and Freedman R., University Physics, 10th Edition., Addison Wesley, New York, (2000)

For information related to the ether, and the historical development of it, see:

Cushing, J., Philosophical Concepts in Physics, Cambridge University Press, United Kingdom, (1998) Chapter 13.

Whittaker, E. A History of the Theories of the Ether and Electricity. Thomas Nelson and Sons Ltd., New York, (1953). A good reference to consult to get a first-hand account of what really happened and what people really believed. Comprehensive. Thorough. Well organized (chronological in time).