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1966: Unidentified Flying Objects, May (folder B48-25)
Gerald R. Ford Congressional Papers

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LEGISLATIVE

INFO

(CHAMPE, G.)

RE: ANTI GRAVITY INFO

May 16, 1966

Mr. Clark N. Champe
619 - 18th Street
Manhattan Beach, California 90266

Dear Mr. Champe:

I wish to acknowledge and thank you for your letter of May 9th enclosing material on anti-gravity research. While I was interested to glance through this, my main concern has been to urge that a Congressional investigation be held to look into all the possibilities.

As you may know, a contract is to be let to a certain university this fall when teams will start to work on the study on a part-time basis, with a report that will be available to the public. Although this is not what I called for, it is a good first step. Thank you for your material.

Kindest personal regards.

Sincerely,

Gerald R. Ford, M.C.

GRF:jb

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May 9, 1966

Congressman Gerald R. Ford,

You have indicated an interest in UFO investigations. I am therefore sending you a copy of a report which I wrote entitled "Anti-Gravity Research!" It is an investigation into the state-of-the-art of gravity control.

I believe that anti-gravity is used as the means of propulsion by the UFOs, enabling them to make sharp turns at high speed and extremely rapid accelerations with no stress to the vehicle or possible crew members.

You may be interested in the last half of the introduction to my report which explores the vast changes in the transportation industry which would be brought about by the introduction of a gravity-control propulsion system.

Thank you for your time.

Sincerely,



Clark N. Champe, B.S.A.E.
619 18th Street
Manhattan Beach,
California 90266

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~~Price: \$1.00~~

ANTI-GRAVITY RESEARCH

Contains gravity theories, matter and energy concepts, nuclear and universe structure theories, etc., from hundreds of the latest anti-gravity research reports.

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ANTI-GRAVITY RESEARCH

INTRODUCTION

Gravity control is at the forefront of scientific research today. This document contains summaries compiled from hundreds of the latest reports by the world's leading gravity researchers. It contains gravity theories, matter and energy concepts, nuclear and universe structure theories, etc. It should provide an excellent mental exercise to jog your own brain into producing ideas which may lead to the actual gravity mechanism.

It is hoped that this book will be of some help in the dispersion of gravity knowledge so that this field can be furthered more quickly and lead to a breakthrough in the utilization of gravity as a space propulsion method.

During the author's 12 years of independent gravity research, he has never failed to find this to be a fascinating field. In the opinion of the writer, gravity control will be possible within the next 10 years. This prediction was derived from noting the rapid acceleration of present day scientific technology. Innovations are not increasing at a linear rate, but more on an exponential rise. Murtaugh proficies that a gravity control machine or some new means of propulsion (possibly using lasar technology) will be invented by the early 1970's. He arrived at this date from observing the fact that we will need a new type of propulsion, and the economic incentive will be of sufficient magnitude to support a rapid development of a new technology.

In this report, you will find no formulas pertaining to the measurement of the gravity field. Any physics book can give you that information. You will find no "pat answers" herein, because as of yet there are none. We are not trying to discover how to measure gravity, we are trying to discover what it is, what causes it, what is its mechanism, how can it be controlled?

Consequently, this report contains a vast number of theories as to the mechanism of the gravity effect or some related phenomena which may shed light on the gravity research. You will find many theories which are in direct conflict with each other in this report. This must be. Any one of these theories may lead a researcher onto the right path which will give as a result, gravity control. Somewhere a shred of evidence exists which will tie some loose ends together and we will grasp the final product.

The more we study gravitation, the more there grows upon us the feeling that there is something peculiarly fundamental about this phenomena to a degree that is unequaled among other natural phenomena. Its independence of the other factors that effect other phenomena and its dependence only upon mass and distance suggest that its roots avoid things superficial and go down deep into the unseen, to the very essence of matter and space.

You will note that theories pertaining to an ether are included herein. This is because the writer feels that ether theories are not yet a dead issue. Many effects can be readily understood and accepted if an ether concept is used for visualization.

As a noteworthy item, the assumption of an ether capable of absorbing a certain minute quantity of energy can be used to predict two effects derived initially from other considerations. These two effects are: (1) The extra shift of the elliptical orbit of the planet Mercury predicted from the relativity equations, and (2) The red shift of the spectral lines of distant galaxies usually attributed to an expanding universe.

Also, consider this; calculation shows that the centrifugal force of the earth in its orbit would require a steel cable 5000 miles in diameter to keep it from flying into space. And yet space, "empty space" holds the sun and the earth together.

Any universe model (be it based on relativity, ether, or something else) is used basically to set up a mathematical "game" which is manipulated to fit the external facts. We then attempt to play this "game" as far as it will go watching for new phenomena along the way.

Therefore, it makes no difference which universe model is used to derive the equations that will enable us to design a practical gravity control space drive. The end result is the same.

A vehicle powered by a gravity control method would actually have only one item different from present day space craft. This of course, is the propulsion system. All other technologies, life support, navigation, structural materials, etc. would be direct derivations from those in use today. But what a propulsion system! According to many physicists it would not only drive the vehicle it would also eliminate inertial effects on the vehicle and the crew! This would mean unlimited accelerations in any direction including small-radius turns. For a tight turn, a force field would exactly counterbalance the centrifugal force so that neither the vehicle nor the passengers would be subject to uncomfortable strains.

High accelerations could be used to attain relativistic speeds within a reasonably short time thereby making possible space travel not only to distant solar systems within our own Milky Way galaxy, but exploration of at least some of our nearby neighboring galaxies. Since the speeds would be near that of light, these giant steps could be easily made within the life-span of one generation of crew members. However, it must be realized that the earth would have gone through many generations by the time the excursion had returned, and some precautions will be necessary to provide for this time difference. As an example, a crew member may want to have his immediate family with him on a trip to insure reasonable adjustment to earth life on his return.

But what of the effect of gravity control machines here on earth? As a starter, all other forms of transportation would become obsolete. As efficient 3-dimensional travel becomes practical, automobiles, trucks, railroads, ships and even airplanes would be considered impractical. Highways, bridges, railroad tracks, harbors and airports as we know them would no longer be needed and therefore would vanish from our landscape.

Transformation of our cities would be phenomenal and can only be guessed at. Intra-city transportation would be by air thereby eliminating the need for streets. No limits on building height would be necessary as deliveries could be made at any floor with ease. Many factors affecting the location of cities (such as good highways, waterways, etc.) would no longer prevail as supplies would be readily available from any part of the country within minutes and with great efficiency. Indeed, cities might not remain at ground level at all. Power would be no problem, with anticipated energy from thermonuclear fusion.

True suburban living would become a reality with most families owning a high-speed gravity propulsion machine, able to land in any small cleared area with little noise and great safety. A typical commuter might live 200 miles or more from work in a secluded mountain setting of his choice. After morning breakfast, he would stroll to his back yard, hop into his anti-gravity car and be at work in a few minutes. In fact, his home itself may be highly mobile with the capability of quickly moving from area to area which today's trailer homes only hint at. Picture a home capable of being moved from a seashore to a favorite mountain lake and then to a spot along a quiet river or a secluded desert hideaway all within minutes after the thought occurred to you. This is well within the capability of a home built around a gravity control propulsion unit. Close contact with friends and relatives would still be maintained with the anticipated advancements in the art of communications. This is an exciting future to look forward to.

At the beginning of this report are noted a few experiments which have been performed and which apparently showed some form of gravity control. These might be kept in mind as we delve into the various theories on the chance that something will mesh together and help us find our goal of a practical anti-gravity vehicle.

* * *

In 1959, Dr. M. Pages proposed a theory (at the International Congress of Satellites and Missiles) wherein gravity is not caused by the attraction of the Earth, but is caused by the repulsion of the cosmos. Accordingly, the force which we call gravitation, he calls "sheer concentrated protonic energy". He supports his theory with a design of an anti-gravity machine which liberates itself from the force of gravity by an electric field rotating at the speed of light around the vehicle. This rotating field also suppresses mass inertia. This principle was tested successfully on small pieces of mica.

* * *

An experiment was performed by Majorana in which he surrounded a measured mass with a sphere containing ten tons of mercury. He noted an apparent loss in weight of the experimental mass and concluded that the loss was due to an absorption of gravity waves by the dense mercury.

* * *

Another experiment involving mercury entailed a test set-up wherein two weights were balanced on an extremely accurate scale balance. Underneath one of the weights, a quantity of mercury was caused to oscillate by a high-capacity pump. With the pump in operation, the balance indicated a minute loss in weight of the mass located above the mercury. The ratio of input energy (via the pump) to weight loss was impractically large.

* * *

The Foucault pendulum exhibits an effect such that the plane of the pendulum swing does not change. The apparent rotation of the plane is actually caused by the rotation of the Earth beneath the pendulum.

However, during a total solar eclipse, M. Allias found that the pendulum swing shifted approximately 15 centesimal degrees exactly at the start of the eclipse. Near the end of the eclipse, the plane again shifted and returned to the normal periodic cycle it had been following previous to the eclipse. This gives a very definite impression of a screen effect.

* * *

The ether may behave like an elastic solid for vibrations so rapid as those of light, but yielding like a fluid to the much slower progressive motions of the planets.

Bjerknes showed that two spheres which are immersed in an incompressible fluid, and which pulsate (i. e., change in volume) regularly, exert on each other (by the mediation of the fluid) an attraction, determined by the inverse square law, if the pulsations are coincidental; and exert on each other a repulsion, determined likewise by the inverse square law, if the phases of the pulsations differ by half a period. If the phases differ by a quarter period, there is no action.

If the spheres instead of pulsating, oscillate to and fro in straight lines about their mean positions, the forces between them are proportional in magnitude and the same direction, but opposite in sign to those which act between two magnets oriented along the directions of oscillation.

The results obtained by Bjerknes were extended to the case of two spheres pulsating in an elastic medium. For this system, Bjerknes' results are reversed, the law being now that of attraction in the case of unlike phases, and of repulsion in the case of like phases; the intensity is as before proportional to the inverse square of the distance.

A theory of gravitation has been based by Korn on the assumption that gravitating particles resemble slightly compressible spheres immersed in an incompressible perfect fluid; the spheres execute pulsations whose intensity corresponds to the mass of the gravitating particles, and thus forces of the Newtonian kind are produced between them.

A bar magnet might be regarded as vibrating tangentially, the direction of vibration being parallel to the axis of the body. A cylindrical body carrying a current will have its surface also vibrating tangentially; but in this case the direction of vibration will be perpendicular to the axis of the cylinder. A statically electrified body, on the other hand, may be regarded as analogous to a body whose surface vibrates in the normal direction.

We must now proceed to consider those models in which the ether is represented as composed of more than one kind of constituent. Of these, Maxwell's model formed of vortices and rolling particles may be taken as the type. Another device by FitzGerald was constituted of a number of wheels, free to rotate on axes fixed perpendicularly in a plane board; the axes were fixed at the intersections of two systems of perpendicular lines; and each wheel was geared to each of its four neighbors by a rubber band. Thus all the wheels could rotate without any straining of the system, provided they all had the same angular velocity; but if some of the wheels were revolving faster than others, the rubber bands would become strained.

A strain on the bands represents dielectric polarization (i. e., an electric field), the line joining the tight and slack sides of any band being the direction of the field.

Such a model is capable of transmitting vibrations analogous to those of light. For if a group of wheels be suddenly set in rotation, those in the neighborhood will be prevented by their inertia from immediately sharing in the motion; but presently the rotation will be communicated to the adjacent wheels (by the flexible rubber bands), which will transmit it to their neighbors; and so a wave of motion will be propagated through the medium. The motion constituting the wave is readily seen to be directed in the plane of the wave, i. e., the vibration is transverse. The axes of rotation of the wheels are at right angles to the direction of propagation of the wave and the direction of polarization of the bands is at right angles to both these directions.

Models of types different from the foregoing have been proposed, which involve the idea of vortex motion. One of the greatest achievements of Helmholtz was his discovery that vortex rings in a perfect fluid are types of motion which possess permanent individuality throughout all changes, and cannot be destroyed, so that they may be regarded as combining and interacting with each other, although each of them consists of a motion pervading the whole of the fluid. The energy of the fluid can be expressed in terms of the positions and strengths of the vortices.

As Helmholtz showed, vortex filaments interact mechanically like linear electric circuits (but with attraction replaced by repulsion and vice versa), the strengths of the vortices corresponding to the current strengths, and the velocity of the fluid in the neighborhood of the filaments corresponding to the magnetic force; magnetic poles would be represented by sources and sinks in the fluid.

The individuality of vortices suggested a connection with the atomic theory of matter. The earliest attempts to build up a general physical theory on the basis of vortex motion were made by Thomson (Kelvin) and were suggested by a display of smoke rings which he happened to see in a lecture room. He used vortices in the first place to illustrate the properties of matter rather than of the ether, and pointed out that if the atoms of matter are constituted of vortex rings in a perfect fluid, the conservation of matter may be immediately explained. The mutual interactions of atoms may be illustrated by the behavior of smoke rings, which after approaching each other closely are observed to rebound; and the spectroscopic properties of matter may be referred to the possession by vortex rings of free periods of vibration.

A further recommendation of the vortex-atom hypothesis was that it seemed to throw some light on the mode of propagation of gravity, which since LaPlace's investigations on the subject had been believed to be instantaneous. For the actions between two vortex rings in a perfect liquid are not propagated from one to the other: they are due to the fact that each vortex ring is accompanied by motion throughout the liquid, so that each may be regarded as extending over the whole

of space, and involving all the others; and the effects are simultaneous everywhere.

At first an objection to the vortex theory was that the virtual inertia of a vortex ring increases as its energy increases; this fact, however, fits in with later discoveries regarding the connection of mass and energy, and would therefore now be regarded as highly favorable. It is doubtful however whether vortex atoms would be stable. Kelvin concluded that they would probably not be.

* * *

Ether has absolute continuity. Matter is discontinuous; it consists of portions with vast gaps between.

There is some connection between matter and ether, because a particle cannot vibrate or move without disturbing the medium in which it exists.

Sound travels four times faster in water than air due to higher incompressibility. In ether, waves travel 1,000,000 times as quickly; hence the ratio of elasticity to density in the ether must be very high. It is calculated that the specific gravity of ether is 10^{12} and the elasticity is 10^{33} .

The ether has two properties, an electric property and a magnetic property, the one corresponding to elasticity and the other to density. Elasticity gives it a recoil property, density gives it an inertia property.

Moving matter has extra mass associated with it, and that kind of temporary mass can be shattered off into radiation by an ordinary encounter with other matter or fields of force. Indeed, that is how all radiation is generated.

In a radio antenna, the electrons are rushing along and being reflected. They are thus put into a state of large scale oscillation, and the waves emitted are comparable to the dimensions of the antenna. Short waves such as we call "light", are generated by oscillations of molecular dimensions, and x-rays are generated by oscillations or collisions of atomic dimensions, or sometimes even of the still smaller dimensions of an electron. There is no other way of generating radiation: it is all generated by sudden changes in the speed of particles, and is an outcome of their close relation or interaction with the ether. The ether seemingly stands by always ready to pick up any loose energy and broadcast it with the speed of light.

That one body may act upon another at a distance, through a vacuum, without the mediation of anything else by and through which their action may be conveyed from one to another, is to me so great an absurdity that I believe no man, who has in philosophical matters, a competent faculty of thinking, can ever fall into it. - Newton!

The whole mass of any body is just the mass of ether surrounding the body which is carried along by the Faraday tubes associated with the atoms of the body. In fact, all mass is mass of the ether; all momentum, momentum of the ether; and all kinetic energy, kinetic energy of the ether. This view, it should be said, requires the density of the ether to be immensely greater than that of any known substance. - Sir J. J. Thomson.

Electric particles are of two kinds, the positive kind and the negative kind (so-called). No importance need be attached to the idea of positive and negative, except that they are opposite in sign, and can therefore neutralize each other. Whether they ever do really neutralize each other we do not know; discharge through vacuum is extremely difficult, perhaps impossible. It seems unlikely that things which differ in potential by a million volts can approach within ultra-microscopic distance and retain their charges without loss: yet as a rule they do. However, this may be under unusual circumstances, the oppositely charged particles we know attract each other, and when they come very close together they practically blot out each other's field at a distance, so as to form a manner of neutral combination. By orbiting, the negative particles around the positive, a neutral group is formed (orbiting force keeping them apart?). (What causes the electrons, free to begin with, want to orbit?).

Particles are probably composed of ether in a certain special condition. For instance, they are subject to gravity, whereas the rest of the ether is not. Matter could be likened to a knot in a string. The knot has properties but still is a string. The knot can be untied but only from one end of the string.

It is postulated that ether is just as dense as any modified (particalized) portion of it can be. The modification into matter does not increase the fundamental density. Density would cause inertia, not resistance to motion. Viscosity causes resistance to motion and ether has none. Possibly, ether pressure (a function of elasticity) holds an electron together against the mutual repulsion of its parts.

A charged body has additional mass by virtue of its extra energy. The whole mass of an electron is accounted for by its electric field. Not so with a proton. It seems extra full, while an electron seems empty.

There is a fundamental difference between electric and magnetic lines of force. The main difference is that an electric line of force has two ends, a positive end on a proton and a negative end on an electron; a magnetic line of force has no ends, it is always a closed loop. We can think of this loop being expanded out when a piece of iron is magnetized; from small molecular sized loops, to a large macroscopic loop.

A magnet can "create" magnetism in another magnet without loss, but an electrical charge cannot be transferred without a "loss" from the original source.

An electron at rest has no magnetic field; it has a field of electric force, lines of which radiate from it in all directions. When it moves, its line of motion is surrounded by magnetic rings. It does not generate those loops, it rearranges pre-existent loops in the ether. When the motion of an electron is stopped quickly, the magnetic rings do not shrink, they rather expand; the electric and the magnetic fields which had previously existed quietly together, now combine into an ether disturbance. They travel out, not as a series of waves, but a pulse, a shell of wave, rapidly expanding with the speed of light.

The magnetic ring around a moving electron may be made of circulating ether, and the energy is represented by this circulation. This might be detected by light traveling through the circulating ether. In one direction, it should be retarded. This has been tried but with no results. However, if ether is as dense as is calculated, the circulation would be very small and still carry a lot of energy. Hidden away in the constitution of ether is a fundamental and absolute speed, a speed not of linear velocity but of internal circulation.

* * *

Dirac conceived the idea that "empty space" is actually tightly packed with electrons of negative mass that are inaccessible to any physical observation. We can observe an electron only when it is raised into the region of positive energy. The removal of an electron from the continuous distribution forms a "hole" which represents a "positive" electron, or a positron.

It is easy to see that when the motion of such as "hole" is studied under the action of any external physical force, a positive mass will be ascribed to it. For Dirac's ocean of "extraordinary" negative electrons possessing a negative mass, we conclude that a "hole" in this distribution must possess a mass opposite to that of the particles forming it, i. e., a positive mass. Thus, through double negation, we find that the "holes" in Dirac's ocean must behave as ordinary particles carrying a positive electric charge and a positive mass.

From what has been said, we can conclude that in order to form a positron we have to remove a negative electron from its place in Dirac's "ocean". But when this electron is removed from the uniform distribution of the negative electric charges, it becomes observable as an ordinary negatively charged particle. Thus, the positive and negative electrons always must be formed in pairs. This process is called the "creation" of an electron pair. The opposite of the "creation" of an electron pair is the "annihilation" of a positive electron is a collision with an ordinary negative electron. Accordingly, the annihilation process occurs when an ordinary negative electron finds a "hole" and falls into it. In this process, the two

individual particles disappear, giving rise to gamma radiation with a total energy equivalent to the vanished mass radiating from the place of encounter. All predictions of this theory stand in perfect agreement with experimental evidence.

* * *

Einstein reasoned that: If the forces of gravity can be replaced by the effect of the acceleration of a moving system, then they cannot be "real" forces such as the pull of a winch. They must rather represent some geometrical property of a space-time continuum in which the motion of material bodies is taking place.

In order to explain the gravitational field which may be present in one place (near the sun) and practically absent in another (between the stars), it was necessary to introduce some geometric property which can vary from place to place. This brought Einstein to the idea of curved space varying in curvature.

Einstein argued that the motion of material bodies conventionally interpreted as being caused by the forces of gravity might simply be due to the curvature of the four-dimensional space-time continuum in the vicinity of massive bodies such as our sun.

We can illustrate how a varying curvature can take the place of a real physical force. Picture a rubber membrane stretched over the top of the water in a swimming pool. Assume a lead ball is thrown onto the pool cover, creating a depression in one area. If we were to roll a marble across the membrane, the depression will tend to deflect the marble's path from a straight line. Indeed, it may "capture" the marble, causing it to go into some manner of orbit around the lead ball. If we were to look at the pool from above, we would not notice the depression and would assume that the motion of the marble were due to an "attraction" between the marble and the lead ball.

In this illustration, the marble would create its own slight depression which would correspond to a simulated mass. In both cases, the slope of the surface of the depressions at any point is representative of the local force. The depth of the depressions should be relative to the amount of material that is in each of the bodies.

Of course, a theory is worthless unless it can be used to predict new effects which can be proved experimentally. Einstein not only was able to predict new effects, he showed how his theory could account for an observed abnormality in the orbit of Mercury (i. e., the excessive precession of the orbit not accounted for by Newtonian mechanics). Some effects predicted by the Einsteinian equations include: (1) The bending of light rays in a gravity field. This was later observed during a solar eclipse. Light is a form of energy and therefore must possess mass. Consequently, when light enters a gravitational field, it will, like any mass, travel in a curve. (2) The rate of time decreases as the gravity field increases. This effect was at first too small to detect on our sun, but was observable on high density bodies known as dwarf stars. Measurements were made

by noting the frequency shifts of atomic radiations. (3) The increase in mass of a body as it nears the velocity of light. The evidence for this is well documented from experiments on particle accelerators. Electrons accelerated to a small fraction from the speed of light have been noted to increase in mass several thousand times. (4) The decrease in time rate on a body as it nears the speed of light. This again has been noted from experiments with particle accelerators. Nuclear radiations were the source of the measurements.

Einstein sought, in his final years, to derive the complexities of the entire universe in one unified theory, wherein the macrocosm and the microcosm - the giant wheeling galaxies of cosmic space and the micro-structure of the atom and all their various manifestations, would emerge. Mass and energy, particles and waves, matter and radiation, electromagnetism and gravitation - all would be accounted for simply by changes in the structure and density of the primordial field.

* * *

In Einstein's concept of gravity, masses warp the space-time continuum in the immediate vicinity such that masses "fall" towards one another.

If masses can warp space, it seems likely that an electromagnetic field can be set up which could also warp space, straighten it out if originally warped, or warp it in the opposite direction to any degree. The last two ideas result in gravity nullification and anti-gravity. This "space-warping" by an electromagnetic field is indicated from a transformation of the equation $E = mc^2$ into $m = E/c^2$. This later equation is significant from the standpoint that it says that mass can be simulated by some form of energy and since mass causes gravity, some form of energy could likewise create the same effect. But since energy is a more flexible utensil, we should be able to "create" gravity in any direction and utilize it as a propulsion system.

* * *

Einstein's theory of relativity states that the effects of gravitation and acceleration are exactly the same. From this, one can realize a gravitational theory in which "gravity" is said to be produced by masses expanding in an accelerated manner. Thusly, the Earth, sun, solar system, galaxy and universe would all be expanding at some particular rate. Since everything observable would be in this state, no size changes could be detected. When it is considered that a charged nuclear particle (an electron, proton, etc.) should be tearing itself apart since like charges repel, an expanding mass can be readily visualized.

* * *

Hubble found that the light coming to us from distant galaxies shows a shift of spectral lines towards the red end of the spectrum. He also found that this shift increases in direct proportion to the distance of the galaxies from us. He theorized that this observed red shift was due to the recession velocities of the light sources, and concluded that our universe is in a state of uniform expansion, with the mutual recession velocities between any two galaxies in space being proportional to the distance between them.

Friedmann theorized two types of time behavior of the universe: a periodic type and an aperiodic one. In the case of the periodic, or pulsating universe, the distances between neighboring galaxies reach certain maximum values, after which they will begin to decrease. The universe will contract until a certain maximum density is reached. This high-density state is followed again by an expansion to a maximum distance and then again by a contraction.

The aperiodic or hyperbolic theory shows the universe contracting from an infinitely thin state, which existed eons ago, until it reaches a maximum density then bounces again into a state of unlimited expansion.

Comparing the kinetic energies of galactic recessions with the forces of gravity acting between them, we find that the velocities with which galaxies fly away from each other are seven times larger than the velocity necessary for mutual escape. Thus, we conclude that our universe corresponds to a hyperbolic solution and that its present expansion will never stop. There is one possibility which can change this conclusion. If there are materials scattered through space with a mass exceeding that of all galaxies by a factor larger than seven, the conclusion will have to be reversed, and our universe will have to be considered pulsating. Such a large amount of extra material cannot exist in intergalactic space in the form of minute particles, since this would produce reddening of distant galaxies, and would also result in strong absorption lines in the galaxy spectrums.

* * *

It is well known from the theory of electricity that oscillating or revolving electric charges always emit electromagnetic waves. The emission of electromagnetic waves must result in the loss of energy by the emitting particle, so that the electrons in the atom model should spiral towards the central nucleus and fall into it when all of their kinetic energy is spent on radiation.

Bohr calculated that the emission of electromagnetic waves (which in the case of the atom corresponds to light waves of different lengths) would cause the electrons forming an atomic system to lose all their energy and fall into the nucleus within one hundred-millionth of a second. We know that this is not the case.

Bohr therefore stated that in the case of the motion of electrons within an atom the following postulates must hold. (1) From all the mechanically possible circular and elliptical orbits of electrons moving around the atomic nucleus, only a few highly restricted orbits are "permitted". (2) Circling along these orbits around the nucleus, the electrons are "prohibited" from emitting any electromagnetic waves, even though conventional electrodynamics says they should. (3) Electrons may "jump" from one orbit to another, in which case the energy difference between the two states of motion is emitted in the form of a single light quantum. These postulates permitted Bohr to construct a consistent theory of internal atomic structure.

* * *

Anti-gravity devices can be readily throrized from Einstein's theory of gravity. However, major breakthroughs are needed in theories and materials and energy sources before a practical anti-gravity device can be constructed.

Gravitational forces exerted by a body depends on both the mass of the body and its motion according to Einstein. Because of the gravitational effects associated with rotating or accelerated masses, in theory it is possible to build a machine that will set up a gravitational field in any direction. This field could then be utilized to counteract the Earth's gravitational field. As a propulsion unit, gravitational drive is very attractive from the standpoint of extremely high accelerations without any stresses on the vehicle or its occupants.

Some effects calculated from the Einstein theory are (1) Two pipes with a high-density liquid flowing at a high velocity through them in the same direction will repel each other from the gravitational equivalent of the magnetic "pinch effect", and two large, high-density rotating gyroscopes will repel each other if they are oriented properly.

An example of an anti-gravity device would be a unit of accelerated liquid mass whose flow can be equated to the electric current flow in a wire-wound torus. In this system, the mass flow through a pipe wound arround the torus causes a field in the torus. If the flowing mass is accelerated then this field increases with time and this time-varying field then creates a bipolar gravitational field.

Unfortunately, in order to generate a force large enough to counteract the Earth's gravitational field, we need a mass of nuclear density accelerated at approximately 10^{12} ft/sec² through a pipe hundreds of feet in diameter wound around a torus miles in diameter. This would still only last a small fraction of a second as the mass would rapidly reach the speed of light.

So, obviously, a system based on this configuration is many decades in the future if possible at all.

* * *

Though gravitation is weak, it may play a crucial role in the structure of an atomic particle. If an elementary particle is a complex structure of very small size consisting of a core particle surrounded by a swarm of attendant virtual particles, the gravitational interaction may be one of the dominant forces acting on very high momentum particles found at the core.

* * *

A section of Mach's principle states: Inertial forces originate in the acceleration of a particle relative to distant matter. Mach apparently had in mind a type of instantaneous action at a distance as the means by which very distant matter would produce this force. It would be more in keeping with modern notions of the nature of forces if the inertial force could some day be traced to a purely local interaction with the particles of a quantized field. This field would be assumed to have its source in all the matter of the universe. A particle at rest at the origin of a coordinate system in which distant galaxies are moving uniformly away from the origin would feel no force by reason of symmetry. However, an acceleration destroys this symmetry, and it would be expected that this distant accelerated matter would be a source of a gravitational field.

* * *

The Earth may be affected by the distribution of matter in the universe. Inertial forces might be considered as interactions with this distant matter.

The only relativistic means available to us for producing interactions between widely separated bodies are the long-range fields. The prototype of such fields is electromagnetism. The electrostatic interactions between widely separated charged bodies is well known; so is the fact that electromagnetic waves exist, propagating with the velocity of light.

The principles of relativity and quantum mechanics provide us with a rigid classification for long-range fields. All such fields may be divided into two classes, boson and fermion. The necessity for interchanging pairs of fermions makes it unlikely that long-range interactions will occur through a fermion field.

When we are limited to boson fields there is a further classification provided by relativity. All such fields may be classified as scalar, vector, tensor, and higher-rank tensor. We shall assume that higher-rank tensors will not occur on the grounds that the mathematics are extraordinarily complex. The tensor field already provides enough mathematical difficulties. There is a long-range vector field that is associated with electromagnetism. Similarly, a long-range symmetric tensor field is believed to exist in the form of the gravitational field.

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It is in connection with the tensor field that a direct relationship between inertial forces and the distribution of distant matter appears. It is found that the interaction of a tensor field with a particle leads to two different types of forces. One is a force proportional to the acceleration (inertial force). The other type of force is quadratic and is recognized as a gravitational force. Both types of forces may be called gravitational. Through the use of coordinate transformation, inertial forces may be converted into gravitational forces of opposite sign.

If it is only the position of matter relative to other matter that is significant, an absolute coordinate system in space should be without significance. If all coordinate systems (including time as a fourth coordinate) are of equal value, the mathematical tool appropriate for treating physical problems, including geometry, is the tensor calculus, since it is designed to treat geometry analytically but without reference to a specific coordinate system.

* * *

Hoyle is an originator of a theory of continuous creation, which holds that the universe is still being formed by particles that appear out of nothing in empty space. His new theory stems from the Mach principle (the mass of every object in the universe is affected by its interaction with every other object).

The new theory explains why gravity is always a force of attraction, never of repulsion. Einstein arbitrarily assigned a minus sign to a key quantity in his equations. Hoyle shows why the sign must be minus. Hoyle's theory also explains why galaxies in distant parts of the universe can, theoretically, move away from the Earth faster than the speed of light - a limit that Einstein said could not be exceeded. Hoyle argues that it is wrong to compare the speed of light in one locality with the speed of an object in another locality.

As Hoyle sees it, a universe with nothing in it is impossible. There must be at least two particles, each to give mass to the other. The masses, and therefore the gravity of the sun and the Earth are partly due to each other, partly to more distant objects such as the stars and galaxies.

* * *

Half of the galaxies in the universe may be anti-matter, the other half ordinary matter. But the radiation that comes from them will reveal nothing unusual about them. Only when galaxies of hostile types happen to collide will their matter interact violently. This

may be the source of energy of quasars (cosmic sources of extremely high energy outputs). The principle of equivalence (shown so far to be accurate to a high degree of accuracy) may be affected if there were more anti-matter around.

* * *

Zwicky has discovered that Newton's universal law of gravitation is not universal, but that it breaks down if the interacting bodies are separated by distances greater than about five million light years.

Until recently, no real evidence was ever presented that Newton's law holds for separations of masses which are greater than about a light year, or for bodies located outside a radius of 700 light years from Earth.

From counts of galaxies in many galaxy clusters, it was possible to determine the following:

1. Many of the galaxy clusters are spherically symmetrical, with axial fluctuations lying well within the limits expected.
2. The 500 brightest galaxies of a cluster show a radial distribution which is adequately represented by equations for an isothermal gas sphere.
3. There appears to be a marked separation of bright and faint member galaxies in a cluster, an effect which is expected to exist in stationary swarms.
4. The structural features are the same for spherically symmetrical clusters at all observable distances.

These four observations prove that Newton's law, with a fixed value for the universal gravitational constant, adequately describes the interactions between large masses such as galaxies, if these masses are not separated by distances greater than the radii of large clusters of galaxies, about three million light years.

Some strong evidence has come to light which indicates that the law breaks down when the interactions between clusters of galaxies, rather than galaxies, are examined.

If the law is universal, we should expect the clustering of galaxies to be unlimited. Actually, however, the largest spherically symmetrical clusters found among the 10,000 clusters searched are very similar, and all are of about the same size and population. Thus, there seems to be a limit to the size and population of stationary and geometrically well-organized clusters.

If the law is universal, we should also expect to find clustering of clusters of galaxies. Investigations have shown, however, that this is not the case.

It has been observed that the 100 nearest clusters are distributed in space with remarkable uniformity. There is no close pair or multiples among them. In sharp contrast to this is the fact that there is hardly a single galaxy among the 100 nearest or brightest which is not bunched with other galaxies in groups of two or more.

It has been demonstrated that the 10,000 observable galaxy clusters are distributed uniformly and randomly, both in breadth over the sky, as well as in actual depth of space, as if they were completely noninteracting objects. As a result of these observations, we must conclude that Newton's law of gravitation seriously breaks down when the interacting masses are separated by distances greater than about five million light years.

Assuming this lack of interaction at great distances to be true, we are faced with several serious consequences. First, the general theory of relativity will require some revision since the theory is based on field equations which are adjusted, at their limits, to Newton's law. Secondly, all conclusions about the evolution of the universe and its supposed expansion will need reanalysis.

* * *

Dicke is performing a new version of the Eotvos experiment which has substantially higher accuracy. As the original Eotvos experiment, this test is to check once again the principle of equivalence (gravitation and acceleration effects are the same). Basically, it compares the acceleration of two materials towards the sun. An accuracy of one part in 10^{11} has been obtained so far.

At least four important conclusions could be drawn from an experiment showing that objects accelerate equally regardless of composition; First, that single neutrons and hydrogen atoms (or electron-proton pairs) would be expected to fall with the same acceleration; Second, that the strong nuclear forces that bind the nucleus of the atom together, although quantitatively different in light elements and in heavy elements, have no effect on acceleration; Third, that the greater electrostatic energy associated with

the nuclei of heavy elements has no effect; Fourth, that the velocity of electrons occupying the inner shells of heavy elements, although higher than those in light elements, have no effect.

* * *

Assume a 3-dimensional rod passing through a fluid 2-dimensional plane; the rod slightly sloping from a perpendicular direction to the plane. As the rod passes through the plane, on the perpendicular, an observer within the 2-dimensional plan sees only a circular mass moving along in his 2-dimensional world.

Therefore, projecting this idea into our world of 3-dimensions, making the rod 4-dimensional extending into the "time" dimension, we see that possibly all that has ever come into being or will come, co-exists, which passing slowly on, leaves in our consciousness, limited to a narrow space and a single moment of "time" a record of change.

* * *

Assume the universe to be composed of an extended gaseous medium. Then assume a disturbance like a sound wave passing through the gas as condensations and rarefactions. A condensation, because of the concentration of mass within it exerts a greater gravitational attraction on neighboring particles than a similarly sized volume of undisturbed medium. When this phenomenon happens on a universe-sized scale, the gravitational forces may become very important. The attraction within each condensation becomes so strong that there is no subsequent rarefaction. When this happens, the extended medium is said to be gravitationally unstable. According to Jeans, it will then collect into many big chunks.

The size of a condensation is proportional to the wavelength of the disturbance, since the latter is the distance covered by a condensation and a rarefaction. Jeans found a formula for the shortest wavelength of density fluctuation, λ_0 , that will cause instability in an extended medium. Any disturbance that has a wavelength equal to or greater than λ_0 will produce a collapse of the extended medium.

The first fragmentation of the gaseous medium that was to become our Milky Way system could not have resulted in stars; but in much more massive condensations. The large masses suggest conglomerations that later evolved into star clusters. Perhaps the clumps that were to become globular clusters first separated out this way when the material of our galaxy was still in a spherical shape. They would contract under their own gravity and become denser. Then a second fragmentation might occur in accord with Jean's criterion. Because of the higher densities of the contracting clouds, their breakup would result in smaller masses, perhaps comparable with a star's mass.

While fragmentation is going on, the atoms in the galactic gas suffer numerous collisions. If the primeval galaxies did have net angular momentum, the collisions would gradually tend to change its shape from a sphere to a disk as seen in spiral galaxies.

* * *

A comparison between the observed and predicted position of the planet Jupiter shows they do not quite agree. It is possible that the fundamental theory of Newton may not be exactly right. Jupiter sometimes appears to be ahead of where it should be, sometimes behind. The difference changes regularly with time and goes through a complete cycle once every 12.4 years. The magnitude is small: about 600 miles. No clear indication of a similar effect has been found in the other outer planets, Saturn, Uranus, Neptune and Pluto.

* * *

Einstein's principle of equivalence is true for electromagnetic waves such as radio and light. The **equivalence** principle states that there is no difference between the force of gravity and the force produced by acceleration. Early experiments proved the equivalence principle for material bodies, but only recently has the effect of gravity on light, radio waves and gamma rays been detected in the laboratory. If gravity and acceleration are equivalent, Einstein concluded that a gravitational field should lower the frequency of light rays escaping from a gravitational field. This effect, called the gravitational red shift, had not been conclusively measured before.

Experimenters found that gamma rays were raised in frequency when falling in a gravity field, and lowered in frequency when rising against the force of gravity.

Also, the red shift predicted by Einstein's general theory of relativity has been confirmed directly on the sun. Previous measurements had not been sufficiently precise to separate this shift from other effects, such as those caused by changes in temperature or pressure. Measurements on stars such as the companion to Sirius had a large margin for error.

* * *

The gravitational waves sent out by such large bodies as the sun and other stars are much too small to be detected in the near future. However, a double star has been found which has the shortest period of rotation known - 81 minutes. One is a dense white dwarf, the other is not observable optically. The stars are believed rotating around a common center so fast - 1,500,000 mph - that energy is radiated as gravitational waves. This presents a possibility for detection of the waves.

* * *

Schiff accounts for gravitation by assuming that it comes from the exchange of neutrinos between any kinds of matter. Neutrinos are nature's "ghost" particles, having no electric charge and virtually zero mass.

Scientists have suggested that gravitational force might resemble electromagnetic or nuclear forces in that the last two arise from the exchange of some kind of particle between the interacting objects. Electromagnetic forces arise from the interchange of light quanta, or photons, between electrons or protons, and nuclear forces arise from the interchange of pi mesons between neutrons or protons. Previously, the idea that gravitational forces could arise from the interchange of neutrinos could not be made consistent with Eotvos experiment (weight/mass = 1). Schiff modified the theory to account for this.

* * *

Shaw tested for a temperature effect on gravity to an accuracy of two parts in one million per degree centigrade. He found no connection. Comets heat up considerably when passing close to the sun so they should deviate from their predicted course if there were ~~some~~ connection between temperature and gravity. This test is of an even higher degree of accuracy than Shaw's.

Many crystals exhibit different physical properties in different directions. Experiments have been made to see whether or not crystals show any change in weight when they are differently oriented with respect to the Earth. This has produced negative results to one part in one billion. Weighing pieces of steel in a magnetized and in an unmagnetized condition has also given negative results.

* * *

The irregularity in the orbit of the planet Mercury can be explained by the assumption of a belt of diffuse attracting matter surrounding the sun equatorially. But such matter, in quantity sufficient to produce this effect, would undoubtedly be visible.

* * *

The stars are steadily converting their mass into radiant energy and the sun actually radiates four million tons of its substance into space every second. The Earth and the planets intercept a minute fraction of this radiation, the bulk of which travels on into space. Similarly, the radiation from billions upon billions of other suns has been pouring into space, so that "space" is never really empty. What effect, if any, does this large amount of ejected matter play in the mechanism of gravity? Also, does this ejected mass reform again to create new galaxies and suns and planets?

* * *

Radiant energy travels through space in discontinuous units called "quanta." This "step-function" quanta is produced by electrons falling from one given orbit to another given orbit. Since the orbits are fixed in relation to the atom, only a discrete level of energy can be given off when the electron changes orbits. Only one sixteenth of the radiation frequency range takes the form of visible light. Any attempt to explore the universe in terms of what our eyes can see would be futile. The entire frequency range must be studied in order that we may have available all necessary information.

* * *

From the observation that light is attracted by a gravitational field, it is not difficult to understand that the total of all the matter in the universe will produce a combined distortion on space so that we have the conception of a universe which is closed in upon itself; a ray of light will travel in a great curve and should, theoretically, return to its point of origin.

* * *

Antiparticles, that is particles that are related to normal particles by the "charge conjugation" operator of quantum theory, have positive mass and, hence, would be useless for employment in gravity shields. But this does not exclude the possibility of elementary particles of negative mass (whose antiparticles would possess negative mass as well), although such particles have not yet been discovered.

According to Newton's second law ($F = ma$), force and acceleration point in opposite directions for a particle of negative mass. Particles having masses of the same sign will attract each other gravitationally, whereas particles of opposite masses will repel each other. Hence, all "accelerations" of particles of whatever mass will point toward particles of positive mass and away from particles of negative masses. If two particles having masses of opposite sign and equal magnitude act on each other purely gravitationally, then the particle of negative mass will chase the particle of positive mass, both their accelerations pointing in the same direction.

* * *

Gravitational waves can possibly be divided into discrete energy packets, or quanta as electromagnetic waves are.

Dirac obtained a solution whereby he quantized the gravitational-field equation and showed that the energy of gravity quanta, or "gravitons," is equal to Planck's constant, h , times their frequency- the same equation that gives the energy of light quanta or photons. However, the spin of the graviton is twice the spin of the photon.

The interactions of matter fall into distinct classes: (1) Nuclear forces; (2) strong interactions, which include electromagnetic forces; (3) weak interactions such as the "beta decay" of a radioactive nucleus, in which an electron and a neutrino are emitted; (4) gravitational interactions, which are much weaker than the ones called "weak."

The strength of an interaction is a function of the rate of the emission or absorption of its quantum. As an example, a nucleus takes about 10^{-12} second to emit a photon. In comparison the beta decay of a neutron takes about 10^3 seconds. It can be calculated that the time necessary for the emission of a graviton by a nucleus is 10^{60} seconds, or 10^{57} times slower than the weak interaction.

Neutrinos are particles with an extremely low probability of interaction since they have no charge and no mass. In the weak interactions, neutrinos are emitted together with other particles. A process involving only neutrinos has not been detected but they may occur, possibly on the same time scale as the gravitational interaction. A pair of neutrinos would furnish a spin of two (the same as the graviton). It is therefore speculated that there is a connection between neutrinos and gravity.

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The true relation between gravitational and electromagnetic forces will probably be found through an understanding of the elementary particles. We must understand why there exist particles with only certain inertial masses and not others. Also the relation between the masses and the electric and magnetic properties of the particles must be determined.

* * *

The calculation of the relative strength of the electrostatic and gravitational forces between a pair of particles (assume pi mesons) shows that the ratio equals the square of the charge on an electron divided by the square of the mass of the particles times the gravitational constant (e^2/m^2G). For two pi mesons the value is 10^{40} . Any theory relating electromagnetism and gravity must explain this ratio.

Dirac has proposed that the large ratio of electric to gravitational forces is characteristic of the present age of the universe. He assumes as a unit time the time required for light to traverse the radii of the average particle. The radii is assumed to be 3×10^{-13} centimeter and since the velocity of light is 3×10^{10} centimeter per second, the elementary time unit is 3×10^{-13} divided by 3×10^{10} or 10^{-23} second. The age of the universe expressed in terms of this elementary time unit is about 10^{40} ! Dirac then claims that gravity is decreasing as the universe expands and the matter is rarefied.

* * *

Gravitational polarization, which could make possible a gravity "shield" requires that there be two types of matter, some with positive gravitational mass and some with negative gravitational mass. As of yet particles with negative mass are unknown. The mass of antimatter or antiparticles has proved to be of a positive sign thereby providing no help for a gravity "shield."

* * *

The Foucault pendulum exhibits an effect such that the plane of the pendulum swing does not change. The apparent rotation of the plane is actually caused by the rotation of the Earth beneath the pendulum. Therefore the pendulum arc should show an apparent rotation of one cycle every 24 hours.

Maurice Allias conducted some remarkable experiments with some pendulums during which a cycle was found which was between 24 and 25 hours long. Allias's experiments were performed with a high degree of accuracy with continuous readings of about a month and in two widely separated locations.

Also, during a total solar eclipse, the plane of the pendulum swing was noted to shift approximately 15 centesimal degrees exactly at the start of the eclipse. Near the end of the eclipse, the plane again shifted and returned to the normal periodic cycle it had been following previous to the eclipse. This gives a very definite impression of a "screen" effect.

The abnormalities noted in the pendulum experiment are possibly closely related with the abnormalities encountered in a number of observed dynamic phenomena, which have yet to be explained:

- (1) Abnormalities in the tide theory.
- (2) Size of the deviations to the south noted on falling bodies.
- (3) Variations in the amplitude of the deviations to the east noted on falling bodies.
- (4) Abnormalities noted in the action of terrestrial rotation on the flow of liquids.
- (5) Abnormalities noted in the motion of the horizontal gyroscope.
- (6) Various abnormalities noted in the geophysical measurements, ascribed until now to experimental errors.

(7) Abnormalities is the oscillation of a pendulum noted by Pasteur.

To these abnormalities, which are dynamic, add the static types:

(1) An apparent excess of gravity over the ocean and a deficiency above the continents.

(2) The abnormalities in the experiments of Newtonian attraction. There is some absorption of gravity (experiments by Majorana), but also - and mainly - a variation of the Newtonian force according to the medium where it is acting (Cremieu claimed that gravity forces act as though gravitation measured in water were greater than that computed by Newton's equation).

The accuracy of verification of the laws of gravitation are presently:

(a) Astronomical - three parts in 10^6

(b) Mechanics on Earth's surface (pendulum) - one part in 10^5 .

These figures are of the order of magnitude of the abnormalities noted in these pendulum experiments. From this, it will be seen that the abnormalities that have been found do not run contrary to the earlier experimental data, either on the surface of the Earth or even in the field of astronomy.

In the present status of known data, the abnormalities observed can be accounted for only by considering the existence of a new field.

* * *

Stanyukovich has theorized that lowering the temperature of matter to absolute zero would lead to a considerable decrease in gravitational forces and possibly their disappearance, thereby creating "weightless matter."

He has also constructed a theory in which the gravitational field of ponderable masses is caused by superhigh-frequency (multi-billion-cps) vibrations of matter and by the ejection - from the vibrating body - of energy in the form of gravitational quanta or "gravitons." He states that this gravitational radiation would be more intense at high temperatures and, conversely, reduced virtually to zero at low temperatures, near absolute zero.

Other scientists believe there are energy-carrying gravitational waves which can be quantized into energy quanta, hypothetically named "gravitons." However, they consider the amount of energy transported to be so small as to be a negligible aspect of gravitation. Thus, even a total elimination of gravitational-wave quanta or "graviton transmutation" could not effect an annihilation of gravitation.

Recent subatomic-physics research has disclosed the existence of an anti-particle for every particle of ordinary matter; there is then reason to believe that half the celestial objects in our universe are made of antimatter.

Spectrual lines emitted from antimatter stars or galaxies would be of the same wave length as radiation from their material counterparts, making them useless for identifying distant antimatter.

Such astral entities as quasars appear to emit enormous quantities of energy that probably could not be produced by any known nuclear reactions. In some cases, "total annihilation of matter and antimatter may be the only possible energy source." Also, the sudden release of great amounts of energy from a supernova, has never been satisfactorily explained. It might well be caused by the collision of antimatter and matter stars.

* * *

Traveling at close to the speed of light, human impressions of time and distance would shrink drastically, according to Einsteinian concepts of relativity. The crew would consequently regard the distance from the earth to the sun as a mere fraction of a mile. Round trips to distant galaxies would thus be easily accomplished within a single generation of the crew. A trip around the entire universe would take, according to the clocks aboard the high-speed ship, only tens of years. In the meantime, however, the earth would have had billions of years of existence.

* * *

Most research to date is trying to find some relationship between gravity and other forces of nature. Electricity became useful when experimenters were able to relate it to magnetism, which had seemed until then like an unrelated force. There may be some sort of gravity-magnetic wave or gravity-electric wave.

* * *

The velocity of light is known to be reduced when propagating through a transparent mass such as air, water, or glass. D. Akers has made the suggestion that the same effect might be noted on gravitational waves.

* * *

In a superfluid (a fluid near a temperature of absolute zero), friction of motion becomes almost negligible. Theoretically, at absolute zero, friction of motion becomes zero. The total fluid acts as one molecule. If an emitter of atoms (ions) is placed in the fluid, the atoms driven off form vortices which travel theoretically at undiminished velocity at a temperature of absolute zero. In the experiment, 0.28 degrees Kelvin was reached and exhibited very low friction.

As energy is supplied to the vortex (force times distance), the vortex grows in diameter and decreases in velocity along its axis. Stored energy in a vortex is directly proportional to the axis length, explaining the growth in diameter. As the vortex increases in diameter, opposite sides of the vortex can effect each other less, and therefore decrease its velocity along its axis.

The vortex in the superfluid also exhibited quantum effects, and this was on a macroscopic scale (vortex diameter approximately 10,000 times larger than the distance between two atoms in the fluid). The energy level of the vortex was of a discrete level. The experimental set-up was not powerful enough to produce vortex energy levels of a factor of two.

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The Theory of Relativity indicates that the universe is closed on itself. That is, a beam of light directed off into space will traverse the universe and return to the point of origin, from the opposite direction. But there is nothing to limit the journey to only one cycle. Theoretically, the light could make an infinite number of round-trips.

Perhaps this explains the super-high energy sources known as quasi-stellar sources or quasars. Quasars, have energy levels far exceeding even thermonuclear processes. Also, a disturbance in a quasar travels much faster than the speed of light through the quasar region.

Possibly we are seeing the original "big-bang" initiation of the universe, not only once, but over and over again. This would explain the extremely high energy levels of the quasars. Also, this would change the size scale factor so that the speed of light would not be violated.

* * *

A fundamental characteristic of all forces is that they exist in pairs. One apparent exception is gravitation.

Each piece of matter contains the so-called "energy of constitution" of the value mc^2 . This collection of energy/matter can be interpreted as being of a potential nature. Since the energy release of mass is in the form of radiation, we then call this particle of energy/matter potential radiation.

Possibly the above knowledge could be linked so that the outwardly directed potential radiation force of energy/matter is shown to be the counterforce of the inwardly directed force of gravitation. The author calculates the gravitational constant G from the potential radiation of a mass and finds that it agrees extremely well with the experimentally determined value.

* * *

All matter is composed of elementary particles, most of which are charged. Electric forces between charges and gravitational forces between masses are both long range, i.e., they fall off with the square of the distance, rather than exponentially like the short range nuclear forces. Between two charged elementary particles the electric force is tremendously stronger than the gravitational force--by a factor of the order of 10^{40} . Why then do not electric forces predominate on the astronomical and cosmological scale? The answer is, of course, that electric charges of both signs appear in nature, that they "shield" one another, so that matter in the large is electrically neutral.

Gravitation charge or mass, however, is always positive. This is why gravitation is important on the large scale.

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Since in a real gravitational field, space-time is curved, the principle of equivalence cannot apply to large regions of space-time, and the loose formulation of the principle must be abandoned and replaced by a restricted and sharpened formulation: the principle of equivalence applies to the history of a small region of space, which is a thin tube in space-time; any physical experiment within a thin space-time tube in a gravitational field gives identical results, to the first order in the small lateral dimensions of the tube, as the corresponding experiment in a suitable thin tube in flat space-time free of gravitational fields.

The concept of a gravitational force disappears in a curved space-time theory of gravitation, and the gravitational field becomes the geometry of space-time. How is the gravitational field, the geometry of curved space-time, determined by its sources, the masses and concentrations of energy which produce the field? The curvature of space-time gives rise, in a natural manner, to interesting new possibilities in cosmology. The space of our universe can be finite in volume without having any boundaries, in much the same way in which the curved two dimensional surface of a sphere in ordinary Euclidean space has a finite area.

* * *

The principal characteristic of electromagnetic radiation is that when radiation is produced, the radiator loses an amount of energy which is independent of the location of the absorbers. With gravitational radiation, on the other hand, it is still not known whether a gravitational radiator transmits energy whether there is a receiver near or not.

The power radiated by the solar system in the form of gravitational waves is approximately 10^{24} times less than that radiated electromagnetically, and is about one kilowatt. Therefore, it is possible to neglect the action of gravitational radiation waves in all but purely theoretical calculations. This result shows that the problem of the motions of systems of gravitating masses may be considered as a problem in mechanics, disregarding radiation.

* * *

It is theorized that a light ray would be polarized when passing through a gravitational field (in addition to the well-known "bending"); also, it is suggested that an electromagnetic field (light) would excite gravitational waves of the same frequency.

* * *

The phenomenon of galaxy systems connected by curved ties or arms is attributed by some physicists to magnetically produced non-gravitational repulsive pressure fields, whereas others view it as a result of a decreasing gravitational constant.

* * *

The postulated existence of antigravitation leads to a nonconservation of gravitational energy, that is, a gain "out of nowhere" in each photon cycle. The assumption that the gravitational charge (that is, equivalent gravitational mass) of a photon is zero, leads to a similar violation of the law of conservation of gravitational energy.

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Is the structure of "ball lightning" equivalent to the structure of nuclear particles?

* * *

As we examine nuclear, electromagnetic, weak and gravitational interactions, we find them to decrease in intensity and increase in universality in that order.

* * *

If we assume that a nucleon (or any other elementary particle) radiates gravitational energy, a relativistic examination shows that the radiation pressure of such quanta is proportional to r^{-4} , but that between two nucleons which radiate gravitational energy an attraction force proportional to r^{-2} must prevail since the distribution of waves becomes unsymmetrical in that instance and more energy is carried off by the waves that are radiated away from the two bodies than by those exchanged between the two bodies.

* * *

The local curvature of space, which is dependent on the mass of the matter in the immediate vicinity, can ultimately close around itself and isolate its contents from the rest of the universe, provided that the density of the matter is high enough. The ultimate radius at which this envelopment occurs is given by the expression $2GM/c^2$, where G is the gravitational constant, M is the total mass and c is the speed of light. This radius is

the Schwarzschild singularity, and when it is reached, matter disappears entirely from view. When matter collapses to this radius, the energy released is equal to $1/2 MC^2$. This process is estimated to be about 100 times more efficient than any known thermonuclear reaction.

* * *

The magnetic properties of a superconducting metal may be described in the following manner: At no time can a magnetic field penetrate into the depth of a superconductor. That property takes place regardless of the conditions in which the transition to the superconducting state has actually occurred. Thus, if the cooling of a specimen is performed within a magnetic field, then at the time of transition the magnetic lines of force are expelled from the body. The electrical properties (the absence of an electrical resistance) are merely inescapable consequences of the magnetic properties.

This consideration might suggest the possibility of a similar expulsion of the gravitational field from a body but only provided that a fundamental similarity between the magnetic and the gravitational field were proved to exist.

* * *

Mach's Principle - He regarded inertia as a dynamic gravitational effect due to the interaction of all the masses constituting the universe. Hence if a pail containing rotating water (and, with it, the earth and the apparently stationary ensemble of stars) is assumed to carry with it the reference system of coordinates, then the centrifugal force acting on the spinning body of water is attributed to outside forces. Mach concluded that the outside forces might be called either inertial or dynamically gravitational, the latter presumed to be due to an action of the masses of the universe with respect to which the body of water is spinning. On the other hand, if the reference system of coordinates is assumed to be fixed onto the water, then the body of water would have to be viewed as standing still, but the mass of the pail, the earth and the stars of the universe would spin about the now relatively stationary body of water and their dynamically gravitational pull would result in the formation of the same hollow surface which, under the previous assumption, resulted from the presumedly inertial centrifugal action.

* * *

There is the possibility of a force field of different origin counteracting the gravitational forces acting on a given body. A metal sphere can be levitated by an electromagnetic field produced by wire loop with little expenditure of power if the coil is kept below critical superconductive temperature. Also the radiation pressure of photons ejected by an intense thermonuclear process can overcome the gravitational force acting on particles and drive them away from the center of radiation. As an example, comet's tail is "blown" away from the sun while heavier particles are sometimes attracted out of comet core into the sun.

* * *

According to the Stanyukovich hydrodynamic hypothesis, bodies emit gravitons into their surroundings; when two bodies are in the vicinity of one another, the graviton density accumulating between them slows down the emission of gravitons in the interadjacent space, whereupon the thrust of the graviton radiation over the outer portions of the two bodies prevails and exerts a resulting force of attraction between the two bodies.

* * *

Gravitation can be attributed to the impact of numerous small particles. All bodies are continuously exposed to impacts by these particles. All impacts received by a single body in space would balance out, but, when there are two bodies, there is no longer an equilibrium between the impacts, since either body shields the other from the impacts of the particles traveling along the line that connects the centers of the two bodies. Thereupon the two bodies will be pushed together. And, since bodies of greater mass intercept more particles they experience greater gravitational forces.

* * *

The red shift of distant galaxies usually attributed to a Doppler-type phenomenon resulting from an actual geometrical expansion of the universe, may in reality be due to various changes in the electromagnetic waves which are not immediately apparent at short range, but which gain in importance as the transit distance increases.

* * *

When the equations of the gravitational field were in the first approximation linearized, the equations assumed the aspect of wave equations and yielded wave solutions for the case of weak gravitational fields. It has since been reasoned that if these wave solutions correspond to actual energy carrying waves, the resulting energy density would create a stationary, Newtonian, gravitational field which would deform the metric of space-time and in addition there would be gravitational waves propagating with the velocity of light. It is possible that gravitational waves could be quantized and the resulting quanta of gravitons would probably have a zero rest mass of a spin of 2.

The gravitational field in the main is as unmodifiable and irreducible feature of curved space-time and stipulates an extremely small energy transfer between bodies in motion by means of ripples in space-time, an energy transfer so negligible that it could in no way be used to annihilate the weight of a body.

Contrast between a space-time continuum and a quantum concept could possibly be resolved by (1) a hypothesis on the existence of a minimal discrete time interval; (2) a hypothesis of the existence of a gravitational mass of which all elementary particles are integer multiples.

It is quite possible that gravity plays a role in the elementary-particle problem, an assumption which provides one possible reason for quantizing gravitation.

Connected electron pairs--hence, the phenomenon of superconductivity at extremely low temperatures--are contingent on the presence of an attraction, no matter how small, to overcome the repulsive Coulomb interaction between the electrons. In this particular instance, the question of gravitational action at intra-pair distances may have a decisive effect on the delicate force balance obtained there.

It was at first felt that gravitational forces were "too small" to serve as the stabilizing force in the atomic nucleus, but further developments in elementary particle physics may change our concepts regarding space and time at extremely short distances.

In connection with the description of gravitation and electromagnetism in terms of space-time geometry exclusively, attempts are continuing in the development of a geometry that will satisfy the requirements of gravitational and unitary theory in the large and that will become quasi-Euclidean in the ordinary scale of human life and activity.

* * *

Molecules of ammonia have been used to determine whether a suppositional ether drift affects their natural vibration frequency when the apparatus is rotated through an angle of 180° . The accuracy of the test exceeds that of the classical Michelson-Morley experiment by about two orders of magnitude.

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Alzofon's postulation superficially parallels Stanyukovich's idea of graviton-emitting pulsation of electrons and other elementary particles. It follows from the basic premises of the theory that any reduction of the intensity of the creation and annihilation of charged particles (possibly at extreme low temperatures) would weaken the gravitational field produced by the resultant field fluctuation.

* * *

It is suggested that the inertial mass of a body depends not only on its rest mass but also on its velocity and on the character of its interaction with other bodies (e.g., on the magnitudes of the interacting electric charges, whereas it follows from Einstein's gravitational equations that, except for the dimensional units, the ponderable mass of a body always equals its rest mass.

* * *

How essential is gravitation in the physics of elementary particles? If gravitational waves exist, then transmutations of gravitons into electrons, positrons, and photons must also take place. The exceedingly small value of the universal quantum gravitational length (about 10^{-33}) cm indicates, that gravitational forces can hardly be consequential in the structure of elementary particles.

* * *

Are gravitational waves merely a "ripple" on the geometrical structure of space or do they carry energy and transform into ordinary matter?

On the transformation of two neutrinos into gravitons. Any such transmutation is fully contingent on the presence of a real energy-carrying radiation produced by some portion of the gravitational field.

* * *

A planet in a gravitational field can be regarded as absorbing gravitational quanta that are emitted by the central star. These gravitational quanta carry gravitational momentum and energy, just as electromagnetic quanta carry electromagnetic momentum and energy. We can visualize the sun as continually throwing out and reabsorbing gravitational quanta, producing a steady state of the mean number of quanta present in space. If we imagine that a planet can absorb quanta only when they are returning to the sun, we see that an inward force is produced by an enormous number of tiny impulses. The planet also emits quanta which are absorbed by the sun. Thus the two bodies attract each other, and energy is conserved. The force is constant due to a large number of impulses in a short time.

* * *

In an experiment conducted to detect any motion of the earth with respect to the surrounding "ether" the experimenters observed a change in the natural vibration frequency of molecules of ammonia when their apparatus was rotated through an angle of 180° . The actual change observed in the vibration frequency was of the order of 1 cps (for a natural vibration frequency of 23,870 mcps) regardless of time of day. From this it is concluded that the supposed ether drift velocity equals no more than one one-thousandth of the orbital velocity of the earth.

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The Eotvos experiment was intended to investigate the equivalence of inertial and gravitational phenomena. A barbell with two balls of equal weight but made of different materials was supported in a horizontal position by a point support at its center. The barbell was lined up tangentially to a mid-latitude parallel. It was reasoned that if different materials had a different ratio of inertial mass to gravitational mass, a consequent difference in centrifugal force would have changed the alignment of the barbell relative to its original East-West alignment. No such effect was observed. The accuracy of the test was one part in 10^8 .

* * *

Einstein's equations have been solved by successive approximations. The third approximation then gives a small correction to the rest mass, which is found to be increased by the presence of other bodies. There is also a second order correction to the acceleration (not explicitly evaluated) which causes the perihelion advance in the two body problem.

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It is Einstein's view that matter should not be considered as something foreign to the metric field itself.

* * *

Mass cannot be divided from gravity. It is believed that direct energy conversion holds out hopes for overcoming of gravitational forces through the release of immense sources of energy.

* * *

Proposed methods for the detection of gravitational waves. These are based on the fact that the space derivatives of the fields of the waves give rise to a motion of a system of masses relative to each other. Mechanical resonance or excitation of acoustic vibrations then enables detection to be accomplished. It is also possible to make direct use of the strains set up by the space derivatives of the wave field. These strains may result in electric polarization due to the piezoelectric effect.

* * *

Physicists have considered the case of a quantized scalar field acting as a gravitational field source and derived therefrom a hypothesis of the mutual annihilation of a scalar particle and antiparticle with the emission of two gravitons, as well as the reverse process of creation of ordinary particles and antiparticles by graviton annihilation. The section of the annihilation process is found to be of the order of magnitude of the square of the gravitational radius of the scalar particle. Rosen contended that to all appearances a system of masses subject to their own gravitational field only cannot radiate gravitational waves.

* * *

It is possible that gravitational mass causes the formation of a gravitational field and that the gravitational field causes the space-time to curve. The "general theory of relativity" is more correctly named the "theory of the curvature of space-time under the influence of gravitation."

* * *

Each charged particle has its own proper time. Each of the many time variables constitutes the local time in a point of three dimensional space. Thus, instead of a three dimensional surface in the point of a three dimensional space we obtain a space-like variable surface in the four dimensional world. This surface consists of points which cannot communicate by light signals, since the time distance between two points, multiplied by c , is less than their distance in the space.

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There is a need for a maximal distance and a maximal time interval. Extrapolation of properties of space-time beyond these boundaries would be invalid.

The theory of relativity applies only to the macro world and does not apply to marginally small distances and time intervals. The theory of relativity is based on the continuum and hence can be expected to apply only to those scales in which the continuum concept applies.

* * *

Inertial mass changes with the velocity of a body. Since gravitational mass is equal to inertial mass, it should also change with the velocity of the body.

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There is no reason why phenomena observed in the visible part of the universe should be attributed to the whole of the boundless cosmos. The whole universe may not be expanding even though our part is.

* * *

There is a hypothesis that all bodies emit "portions" of gravitation and the intensity of the emission of gravitons per unit of mass depends upon the tension of the external field of gravitation. Evidently, gravitation field intensity between two bodies will be greater than outside of them. The same may be said about the pressure of the gravitation field. Therefore, the energy of gravitons radiation will depend upon the direction in which they move. When gravitons move into a medium with a great field counterpressure (that is, between bodies) the energy of radiation will be lower than when the radiation is emitted into vacuum. Thus, under unsymmetric radiation (in the sense of distribution of energy) a resultant force will arise leading to the approximation of attraction of bodies towards each other.

Besides the reactive force which arises in cases of uneven radiation of gravitational energy, the difference of pressure forces of the field exerts its action upon bodies. Since the pressure of the gravitational field between two given bodies is greater than the pressure of the field outside of them, these bodies are not only attracted to but also repulsed from each other. Under ordinary astronomical and physical conditions the forces of repulsion are insignificant in comparison with the forces of attraction. However, it may be supposed that in cases of very compact matter (of the order of 10^{14} grams per cubic centimeter) the tension and pressure of the gravitation field or gravitation medium may also be very great so that the magnitude of the forces of repulsion becomes comparable with the forces of attraction.

* * *

It is absolutely indisputable that bodies lose mass and energy when they emit gravitons or gravitation waves. At the same time, two gravitons may collide and form another pair of "fundamental" particles, for instance, an electron and a positron. If we accept this view, correction will have to be made to the equations of all theories of gravitation as a result of which it appears that the force of gravitation will diminish more rapidly in proportion to distance. This additional diminishing of forces of gravitation in proportion to distance is quite sufficient to explain Seliger's paradox (External gravity forces on a star is an infinite amount, so total force is indeterminant).

* * *

Attempts have been made to give a purely geometrical explanation of the electromagnetic field and to link it to the properties of space-time.

Inasmuch as gravitation appeared to be explained by a transition from the plane Euclidean space to the curved Riemann space, a possible geometrization of electromagnetism was proposed through a transition to a twisted space or through the introduction of a complementary, fifth dimension, or through a generalization of parallel translation, or through an adoption of a nonsymmetrical space metric.

* * *

All forms of matter move in space and contribute to the curvature of space-time according to the laws of relativistic quantum theory and the law of the general theory of relativity.

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While a fairly satisfactory classification of particles has been achieved, a single table of matter still does not exist.

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As we know today, all the elementary particles (electrons, atomic nuclei, etc.) exist in a continuously excited state, and pulsate, i.e., oscillate. And since their oscillations or pulsations take place in a gravitational and electromagnetic field, obviously each such pulsation is accomplished by the emission of a certain amount of energy. Now, this "certain amount" of energy that is emitted possesses a certain mass. And it is this elementary "certain amount" of "energy-mass" that we call a graviton.

Let us imagine two spheres some distance apart. Let us think of these spheres as bodies consisting of pulsating elementary particles--particles which continuously radiate gravitons in all directions. The flying departure of each graviton imparts to the body from which the graviton departs, a reactive "thrust" in the directional sense opposite to the departing graviton's own sense. But since, as we have noted, gravitons are departing from or flying out of the body in all directions at once, the body itself

does not feel or show the effect of any such reactive thrust or, to state the matter more precisely, the many reactive thrusts thus imparted to the body which impel it in so many different directions at the same time, simply cancel one another out. Now, if we assume that the number or quantity of gravitons emitted into a space already relatively saturated with gravitons will be necessarily smaller than the number or quantity emitted into an empty space, then, presumably, by moving two bodies closer together we shall destroy their relative equilibrium, since obviously the space between the two bodies will become relatively saturated with gravitons, and, consequently, the number or quantity of gravitons emitted into that space will grow smaller. Thereupon, the relative equilibrium of the two bodies will be destroyed, and they will start to move closer together, to be drawn toward each other, impelled by the combined reactive impulses or "thrusts" imparted to them by the "outwardly" departing gravitons.

Physical conceptions of gravitation as a force that is caused by nuclear radiation should not be considered as seeking to supercede the general theory of relativity. The general theory of relativity is concerned only with interactions between huge volumes of matter. Therefore, the conceptions mentioned above tend rather to supplement or complete the general theory of relativity.

* * *

Why should it be, for instance, that bodies are attracted to one another with a force that is proportional to their masses and not to the square of their masses? Why is it that when the distance between two bodies is increased by a factor of 2 the force of their gravitational attraction for each other decreases by a factor of 4 and not by a factor of 9 or 16?

* * *

It has become clear that all material bodies and substances of whatever nature (the sun, earth, all elementary particles, electrons, photons, etc.) produce in some peculiar way a curvature in space and that it is this curvature which manifests itself in the form of gravitational force. It is as though space were "warped" by the presence, let us say, of the sun. And thus the earth, and the other planets too, are forced to move through just such curved space not through an ordinary Euclidean flat space.

* * *

Alzofon seeks to explain the gravitational field as an averaged fluctuating electromagnetic field generated by the creation and annihilation of charged particles on a subatomic scale. This can be considered since a given mass may be electrically neutral on a macroscopic scale, it will not be so on a subatomic scale. Creation and annihilation processes are incorporated into physical theory in a fundamental manner by altering the concept of a light signal to include these processes as fluctuations. Because the space-time metric is quadratic, a root mean square effect is generated which allows description of matter and radiation by a single field. The

force field generated by creation-annihilation processes is shown to be attractive, proportional to the mass of the source, and inversely proportional to the square of the separation of source and test body. The law of force changes when the particles approach one another to within a distance of the order of magnitude of the Compton wavelength. The red shift observed in the light received from distant galaxies can be explained in terms of the proposed model in terms of particle creation, rather than as a Doppler shift.

The following items were considered in this theory:

- (1) The gravitational field exists wherever masses exist; no permanent electric charge need be present, whence it follows that the gravitational field is different in origin from the electromagnetic field.
- (2) The gravitational field is proportional to the mass of the body producing it, and since all of the mass of any object is concentrated in atomic nuclei and electrons, it is suggested that processes characterizing these are responsible for the field.
- (3) Processes occurring in the nucleus and in the neighborhood of elementary particles are distinguished from those producing electro-magnetic forces in that creation and annihilation of charged particles may occur; hence, it is suggested that such processes may be responsible for the gravitational field.

It is proposed here to emphasize further the role of the electromagnetic field by incorporating another property into its structure. One assumes that the virtual charge creation and annihilation is not a consequence of the interaction between source and electromagnetic field. Instead, it is assumed that such processes are an intrinsic part of the motion of the real electromagnetic field. The average effect of a great number of creations and annihilations is the electromagnetic field described by the Maxwell equations and propagated with velocity c ($c = 3 \times 10^{10}$ cm/sec). It is assumed that creation and annihilation processes proceed without cessation.

It is suggested that one has now obtained a field which exhibits the properties of radiation (in the Maxwell sense) and of matter as different aspects of the same field. Einstein's relation between energy and momentum is preserved for a particle at rest, and approximately so for particles at "low" velocities. For energies much greater than the rest mass of the particle, one must expect to see departures from Einstein's relation owing to the creation and annihilation processes which then being to dominate the motion.

The existence of particles as an integral part of the real electromagnetic field leads to the conclusion that those particles are effectively bound to the field. Yet it seems likely that there remains a small probability of the particles leaking away from the bound state. In particular, a ray traversing interstellar space would thereby lose a measurable energy. The effect can be calculated and shown to be precisely the same value as the red shift customarily presumed to indicate an expansion of the universe.

Also, since a light signal is accompanied by a complex structure of virtual processes, there should be an attractive force between it and a material body.

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The extension of the sub-nuclear gravitational domain is $l = 10^{-33}$ cm, i. e., the proton and electron are each 100 billion times greater than l .

Dayton C. Miller, from 1922 to 1926, redid the Michelson-Morley experiment concluding "there is a positive, systematic ether-drift effect, corresponding to a constant relative motion of the earth and the ether, which at Mt. Wilson has an apparent velocity of 10 kilometers per second."

The sole reason for the speed of light entering into the equation of velocities of two physical bodies is required by the universal medium within which they move. This is ether under the disguise of light velocity.

Einstein's relativistic and Gerber's nonrelativistic theory furnish identical results. It is simply due to the fact that both theories are based on the assumption of ether, contained in the relativity implicitly, and stated by Gerber explicitly.

It would seem that ether gradients in some such form as a variable ether pressure and density distribution are much more likely to exist in view of the existing bodies ranging in size from nuclei to galaxies, which can be viewed as singularities in space structure. The origin of matter can, therefore, be investigated from the standpoint of localized ether stresses, i. e., ultimate ether quanta which enter into mutual relationship resulting eventually in such gigantic superstructures as electrons.

Possible structure of ether: The transmission of light shows that the ether must possess a structure exhibiting properties akin to rigidity and inertia. The rigidity may be understood hydrodynamically as a vortex circulation having a velocity of the same order as that of the transversal waves which the medium transmits. The inertia perceived in matter may then be an effect of the motion of electrons, atoms, molecules and microscopic bodies through ether. The granular structure of ether may be of a linear dimension of the order of 10^{-30} or 10^{-33} cm. But how the ether is tied into knots, we call electrons, remains to be discovered. The assumption that the formation and the existence of an electron sets up a radial tension all around it, accounts for gravitational and other phenomena.

In case of galactic and extragalactic distances, Newton's law breaks down if the vast spacial extensions contain masses of finite density. If, however, a kind of gravitational absorption in the universal medium as well as in the interposed celestial bodies takes place, then the difficulties in generalization of the gravitational law disappear if the Newton's equation is modified to read:

$$F = G \frac{Mm}{r^2} e^{-\alpha r}$$

where α is the coefficient of gravitational absorption. In that case the

motion of the bodies remains unaffected by very distant masses due to the complete damping of gravitational waves by means of energy absorption. In other words, if gravitational absorption exists there should also exist island universes, a conclusion born out by astronomical observations.

An experiment by Majorana gave a value of $\alpha = 2.8 \times 10^{-12}$ per unit of mass acted on, per unit of density and per unit of thickness of the shielding mass. This experiment was performed by surrounding a measured mass with a sphere containing 10 tons of mercury and noting the apparent loss of weight of the experimental mass.

All the foregoing considerations have now prepared the ground for reviewing Arthur Korn's theory of gravitation based on the hypothesis of universal vibrations, a concept which ascribes to matter as property of atomic interaction due to subnuclear pulsations.

On the basis of the concept of universal vibrations as well as Bjerknes' experiments it is possible--according to Korn--to establish a theory of gravitation by making use of hydrodynamic analogy. To this end, Korn considers the results obtained by Bjerknes' experiments with pulsating spheres submerged in water. Two such pulsating spheres attract each other according to an equation analogous to Newton's law of gravitation providing that the phases of the pulsations are the same.

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