"ON THE POSSIBILITIES OF OPTICAL-FREQUENCY GRAVITATIONAL RADIATION"

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ABSTRACT:

Attempts, so far, to understand the cause of the diurnal variations and sudden pulses in the self-potential of certain semi-conductors have met with little success. Experimental results have strongly suggested the possibility of an (as yet) unidentified penetrating flux which apparently acts upon massive high-K dielectrics, including complex silicates, lavas and clays. Because of the great penetrability, it has been suggested that neutrino flux or (optical-frequency) gravitational radiation may be involved, but the findings must, of course, be supported by adequate theory.

It is the hope that this paper will stimulate interest toward this end.

GRAVITATIONAL WAVES:

The existence of gravitational radiation from space, as predicted by Einstein in General Relativity, appears now to be widely accepted among theoretical physicists. Confirmation by empirical methods, such as by mechanically resonant sensors, has not as yet been accepted. The investigations of Joseph Weber * et al have produced questionable results, not as yet confirmed by the experiments of others working with similar electro-mechanical sensors.

THE WEBER EXPERIMENTS:

Using large resonant metallic cylinders, discs or the like, Weber endeavored for a number of years to detect low-frequency gravitational waves (approx. 1750 Hz) by the so-called "ringing" of the cylinder. In most of these experiments, piezoelectric sensors encircling the cylinder, together with associated amplifiers, have been used to detect the ringing of the cylinder.

If the cylinder is shock excited, a ringing at the natural period results. Weber and his colleagues reasoned that if a gravitational pulse having the same frequency as the cylinder is received, the cylinder will "resonate" and this vibration can be electrically detected.

WEBER'S RESULTS:

It is reported that "events" occur which were at first believed due to the reception from space of gravitational wave pulses. Subsequent observations have thrown doubt upon these results. It is paradoxical that actual "ringing" (decremental decay) of the cylinder does not occur. The event is observed rather as a sudden spike or "glitch" in the electronic circuitry. Histographic analysis of these events, according to Weber, appears to indicate predominance in the direction of the center of the galaxy. Weber interprets this to mean that these events represent gravitational wave pulses which originate in or near the center of the galaxy.

* Weber, J. 1960 Phys. Rev. 117:306

SEARCH FOR AN EXPLANATION:

The scientific community, after due reflection, has not come to accept Weber's vibrating-cylinder tenet. The existence of events or "glitches", however, has not been explained. It is entirely possible that these sudden electrical surges in the detection system may be due to another cause as yet not identified or understood. Consideration has been given to electromagnetic pulses or other phenomena which occur more or less at random. The alleged correlation with the center of the galaxy appears to be wholly unexplained.

OTHER POSSIBLE EXPLANATIONS:

The hypothesis presented in this paper takes a new approach. It continues to postulate the existence of gravitational waves, but the difference is in the method of detection and, equally as important, the range of frequencies presumed to be present in the gravitational wave spectrum.

It is not unreasonable to believe that the spectrum of gravitational radiation extends not only from extremely low frequencies (ELF) thru microwave (UHF)* to the extremely high frequencies of infrared, light, ultra-violet, x-ray and perhaps even gamma radiation. As such, the gravitic spectrum would be analogous to the electromagnetic spectrum. The two would have a parallel relationship. In other words, visible light would have a homologue in the gravitic spectrum. The same might also be said of infrared, x-rays, etc. For the present, we might call the gravitic homologues "quasi-infrared" and "quasi-light", until some better name can be found.

DETECTION OF QUASI-LIGHT:

It is obvious that no mechanical (inertially-limited) system, such as that of Weber et al, can be used. Such systems cannot mechanically vibrate at such high frequencies. There must be a direct conversion of gravitic energy into electrical energy. Such conversion of energy may be similar to photoelectric conversion. We may call it "gravitoelectric conversion". Whereas, photoelectric conversion is responsible in the first case, gravitoelectric conversion is conceived as being responsible in the second case. In a broad sense, even the methods of conversion are homologues of each other.

* Press & Thorne "Gravitational-Wave Astronomy" P. 342

MASSIVE HIGH-K DIELECTRIC SENSORS:

In experiments dating back almost 50 years,* at the Naval Research Laboratory in Washington, D. C. and elsewhere, the author conducted studies on the "Anomalous behavior of massive High-K dielectrics" **. Evidence was revealed concerning sidereal diurnal variations which are markedly similar to the histograms that Weber published in recent years (1970). These early studies revealed changes in resistance, readily observable in massive high-K dielectrics. Subsequently, it was determined that these same materials exhibit variations in self-potential which accompany the changes in resistance. In short, it now appears that the sensors useful in detecting quasi-light may, in fact, be massive high-K dielectrics. Such materials, one must admit, are a logical choice - in that they combine high-density (gravitational factors) and high dielectric constant (electrical factors), thus satisfying the two basic requirements for gravitoelectric coupling.

In recent years, various ceramic materials have been developed which exhibit very high dielectric constants ($K > 10^3$) and are quite heavy (sp. gr. > 5). Barium titanate is an example.

Ceramic capacitors of such materials, combining high density and high dielectric constant appear promising as gravitoelectric sensors.

GRAVITOELECTRIC CONVERTERS:

Studies to date would seem to indicate that gravitoelectric converters also exist in nature. The two-fold requirement, mass (high density) and high-K (electric permittivity) are found in many terrestrial rocks such as granite and various basalts. Rocks may serve as gravitoelectric converters, and this is the research which is occupying our attention at the moment.

Various rock specimens, varying in size and composition, have been tested. Both electrical resistance and self-potential have been measured, and the two factors appear to be related. It has been surprising to discover, however, that no two rocks behave similarly. Each acts with individual characteristics. There are significant differences in the diurnal patterns and changes in amplitude (secular variations) which are readily apparent. No one factor, such as temperature, pressure, electromagnetic noise, etc. is adequate. Another explanation must be sought, and these studies are continuing.

*Private laboratory, Zanesville, Ohio 1926 - 1930
** NRL (classified) 1931 - 1933
Naval Field Stations
Ohio 1937
Penna. 1939

ROCKS ARE NOT ALL ALIKE:

In the course of these studies with rocks from various locations (Hawaii and mainland USA) it appears that the self-potential signatures of various rocks are quite different, one from the other. It is difficult to explain these individual differences unless one postulates a resonance characteristic inherent in the crystal structure of the rock. Such resonance may make the rock susceptible to only a specific, relatively narrow spectral band of the incoming gravitic radiation. It is assumed, in this connection, that the natural gravitational radiation from space is a "white" or "noise" radiation of exceedingly broad frequency range. Individual rocks may resonate only on a relatively narrow band width, such as quasi-red, quasi-green or quasi-violet, with relative amplitudes which are continually changing. This could account for the wide variety of secular and diurnal patterns in self-potential exhibited by various rock specimens.

PENETRABILITY OF GRAVITIC RADIATION:

By the very gravitational nature of this elusive form of radiant energy, and also perhaps one of the reasons it has not been detected or used heretofore, is its extreme penetrating power. Gravitational radiation is said to be almost as penetrating as neutrinos, passing readily thru the Earth - almost as if it were not there. However, it goes without saying that this radiation probably is not perfectly penetrating and is, to a certain limited extent, absorbed by massive materials (proportional to mass), the absorbed energy being converted into another form. The absorbed percentage may be very small indeed. However, the small amount which is absorbed is converted (we believe) into electromagnetic energy within the mass or crystal structure. This conversion takes place only within a relatively narrow spectral band to which the body of the rock or its electronic structure is resonant. Each rock then (because of its natural resonance) is able to convert only a small portion of the incident gravitic radiation flux.

NO CHANGE IN FREQUENCY:

There are reasons to believe that individual rocks or domains within individual rocks resonate with certain frequencies of the incoming flux to produce, within these domains, a confined electromagnetic flux at primarily the same frequency. Rectifying action within the crystal structure would convert this em flux into dc which would be evident and measurable as self-potential.

LATTICE VIBRATIONS IN CRYSTALS:

According to Nagibarov & Kapvillem (1967) and Braginskii & Rudenko (1970), a graviton (in rotational levels of a molecule) could stimulate an electromagnetic transition so as to produce a photon.

Such atomic and molecular processes, converting gravitons into photons, may be operative in granitic and basaltic rocks.

SOURCES OF GRAVITIC RADIATION:

One of the most fascinating aspects in the study of gravitational radiation, perhaps the most important, relates to the identification of possible sources and an estimation of the energy involved. If gravitational radiation from the depths of space does exist, an entirely new astronomical discipline may be born. This is the subject of a remarkable prediction, "Gravitational Wave Astronomy" by Press and Thorne.* The thought is that we are now on the threshhold of new astrophysical discoveries concerning possible new radiations from binary stars, black holes and the interiors of supernova. As Press and Thorne have stated "with gravitational wave astronomy we are ---- adding another window -- a particularly important window, because it will allow us to observe phenomena that cannot be studied adequately by other means."

LOW-FREQUENCY GRAVITATIONAL WAVES:

So far, low-frequency and intermediate-frequency gravitic radiation has received the most attention, largely because current cosmological theory appears to recognize its probable existence. Accelerating masses create gravitational waves, and stellar explosions, rotation of binaries, neutron stars and pulsars are theoretical sources. In short, these sources have a "mechanical" origin and it follows, naturally, that resonant mechanical sensors have been proposed to detect them. The Weber detectors (in the wave band 1580 - 1661 Hz) are examples, but it must be recognized that such mechanical detectors would completely miss radiation at other (higher) frequencies.

ULTRA HIGH-FREQUENCY GRAVITATIONAL WAVES:

Investigators in this field have given consideration to the possible generation in nature of gravitic radiation in the microwave frequencies. Such frequencies are believed to originate in various cosmological processes, but their detection here on Earth presents technical problems not as yet resolved.

* Press & Thorne "Annual Review of Astronomy and Astrophysics Vol. 10 (1972)

GENERATION OF OPTICAL-FREQUENCY GRAVITATIONAL RADIATION BY BLACK HOLES:

Supra UHF (including optical-frequency) gravitational radiation is believed to be generated as electromagnetic radiation attempts to leave a black hole. According to Gertsenshtein (1962) and Vladimirov (1964).. "When an electromagnetic wave propagates thru a region with a static or electromagnetic field, the electromagnetic wave gets coherently (but slowly) converted into gravitational wave .... If strongly charged black holes ($e \sim M$ in the notation of Christodoulou & Ruffini 1971) can exist, despite their intense electrostatic pull on surrounding plasma, then as an electromagnetic wave propagates outward from near the surface of the hole toward infinity, its conversion into a gravitational wave will be nearly 100% effective".

In other words, light and heat in attempting to leave a black hole may be converted into gravitational radiation of the same frequency, which readily escapes the intense gravitational field of the black hole. Hence, tremendous amounts of energy may be escaping a black hole or clusters of black holes without gravitational restraint. This energy, in the form of "quasi-heat and quasi-light", may pervade all space, bathing the Earth from every direction but possibly with greatest intensity from the region near the center of our galaxy, where the population of black holes, etc., may be greatest.

It is the author's belief that the total energy so received at the surface of the Earth may equal or exceed that of all other forms of radiation received from cosmic space. It might even represent a new source of energy useful for mankind.

GRAVITATIONAL RADIATION AS AN ALTERNATE ENERGY SOURCE:

If continuing observations of petroelectricity, so-called "rock electricity", indicate that substantial currents may (someday) be available and if cosmological theory supports the thesis that adequate energy of this nature is generated (possibly by black holes) and if the radiation can reach the Earth in useful amounts, a new energy source may become available. With the inevitable depletion of fossil fuels and the present controversy over the safety of nuclear energy, an additional energy source would, indeed, be welcome.

No estimate, at this time, can be ventured as to the amount of energy which could be so derived. The phenomenon would have to be intensively studied. The outcome, as in the case of nuclear energy, would depend on future R & D and the extent of the funding which may be made available. Even though at present the electrical output is minuscule, one need only recall that the first evidence of atomic fission (1934-1939) appeared on sensitive cathode ray oscilloscopes of Enrico Fermi, Lise Meitner and others. The pioneers had no idea at that time of the tremendous power of atomic bombs or of the use to which atomic power could be put in the years to come. Petroelectricity may be in that same position today.

CONVERSION INTO HEAT (energy conservation):

If heavy materials (rock) of this nature acquire energy from an outside source, they must re-radiate to maintain energy equilibrium. Re-radiation presumably may be either electromagnetic or gravitic. If it is (in part) electromagnetic, heat is created. Where self-potential is present, electrical resistance can result in Joule heating. The rock actually could become warmer than the ambient.

At this point I refer to the research of Charles Francis Brush*, "Retardation of gravitational acceleration and the spontaneous evolution of heat in complex silicates, lavas and clays." The calorimetric determinations of this heat were confirmed by Harrington (National Bureau of Standards).

GRAVITATIONAL RADIATION FLUORESCENCE:

Pursuant to the hypothesis developed above, the requirements of energy conservation would dictate that any mass must re-radiate all of the energy it receives in order to maintain equilibrium. As indicated above, a small portion of this re-radiated energy may be electromagnetic, manifested as heat or electrical output. A major portion of the re-radiated energy may be gravitic. The frequency of the re-radiated gravitic energy may be determined by the natural resonance or resonances of the emitting mass. The re-emission would be characteristic of the material (very much as mineral fluorescence from ultra-violet light).

This hypothesis provides basis for some interesting speculation:

1) If the rocks of the Earth absorb (in small part) gravitic radiation from space, do they concurrently re-emit gravitic radiation at the rock's characteristic frequency (ies)?

2) Do mountains of granite (such as Half Dome, Yosemite Valley) emit this secondary gravitic radiation. Can it be detected?

3) Are there domains on the surface of the Earth, where the ambient secondary radiation differs in frequency bands or amplitude? Can such domains (if they exist) be surveyed by prospecting instruments and charted? Could such surveys reveal sub-surface features, mineral deposits or geothermal reservoirs?

4) Is it possible that animals can perceive secondary gravitic emission from various regions of the Earth's crust so as to direct their migrations? How about birds in flight, or the homing phenomenon of pigeons?

5) Can gravitic light and heat explain variations in the growth rate or flowering of plants? Are human beings unknowingly influenced in any way?

Brush, C.F. Phys. Rev.(many references)

POSSIBLE EFFECTS ON ANIMALS:

One of the most intriguing bits of speculation in the whole idea of quasi-heat or quasi-light is the possibility of effects on animals. Such effects may, in fact, be present but so obscured by ordinary heat, light and other factors as to escape attention.

There is, for example, strong evidence of a correlation between lunar cycles and human affairs. Lunar cycles are apparent in police records, hospital attendance, death records, mental conditions and serious crime. In economics, fluctuations exist which are difficult to explain by economic factors alone. Mass changes in human emotion are often blamed. Shifts in the delicate balance between optimism and pessimism, so noticeable in the financial markets, occasionally trigger wild changes in stock prices. Could this be caused in part at least by nationwide fluctuations in the intensity of a penetrating radiation?

BONES AS GRAVITIC RADIATION RECEPTORS?

In the foregoing sections of this paper, it has been reported that granitic and basaltic rocks display self-potential. Compressed calcareous sand (Hawaii), during the tests conducted in 1975-6, likewise produced self-potential but somewhat less. This brings to mind that bones - perhaps human bones - (being calcareous) may also produce a voltage.

Is it possible that the bone marrow, lying centrally within such an electrical field, could be affected? Could the formation of blood cells and the generation of complex body hormones in the bone marrow be so influenced?

These are only some of the many interesting facets of gravitic research. The possible influence of quasi-heat and quasi-light may reach deeply into many life processes.

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