

GRAVITY RESEARCH FOUNDATION  
New Boston, New Hampshire

SELECTED ESSAYS FOR 1963

Bostick, W.H. THE INFLUENCE OF THE ELECTRICAL ASYMMETRY OF MASS ON  
RIGHT HANDEDNESS AND LEFT HANDEDNESS

The  $\Theta$  pinch which produces two force-free-type plasma vortex rings one at each end of the coil, is a faithful macroscopic analogue of beta-decay. Ring #1 is right handed (+ helicity) in all three respects,  $v$  (spin) +  $v$  translational,  $v + v$  poloidal,  $B + B$  poloidal. Ring #2 is left handed in all three respects. It is shown that the creation of these rings and their helicity can occur only when the positive ion mass is substantially greater than the electron mass and that substitution of anti-matter plasma for ordinary matter plasma, (charge conjugation) changes right handedness to left handedness. The recognition of the importance of this asymmetry in the masses of positive and negative electricity is the justification for writing this essay.

DeBeauregard, O. Costa. TRANSLATIONAL INERTIAL SPIN EFFECT. A DEDUCTION FROM FIRST PRINCIPLES.

Two "mathematically equivalent" energy-momentum tensors, with a divergenceless difference will not in general be "physically equivalent" if they are attached to test bodies with finite dimensions. In the case of the electron cloud inside a ferro or ferrimagnetic test-body, due to the well-known Tetrode formula  $T^{ij} - T^{ji} = \partial_k \sigma^{ijk}$  the different energy momentum tensors  $\Theta^{ij} = aT^{ii} + bT^{jj}$  defined from the Tetrode asymmetrical tensor  $T^{ij} = -(ct/2) \nabla^i \delta^j - L \delta^i \gamma^j$  are of course mathematically equivalent. It is shown from first principles of Quantum theory that Tetrode's genuine tensor  $T^{ij}$  must be physically the "good one". The introductory remark yields the principle of an experimental test.

Djuric, Jovan. GRAVITATION AND ELECTROMAGNETISM.

The set of the symmetrical Maxwell equations and the fundamental Newton laws of motion are formally postulated as a basis for a unified field theory which can logically and consistently summarize and classify the classical Newton Gravitational and the Maxwell electromagnetic field theory with all experimental laws and facts from those two theories.

Englert F. and Brout, R. GRAVITATION AND MASS THROUGH GAUGE INVARIANCE.

We explore the meaning and consequences of "gauge invariance of the second kind" as applied to the theory of gravitation. This generalizes the usual Lorentz invariant theories to theories which are covariant in the sense of general relativity as well as scale invariant. We are led to a formulation which on a macroscopic scale leads to Einstein's theory but with a self consistently determined coupling constant. It is also possible that the origin of the masses of the elementary particles is found in this formulation of the theory.

Finzi, A. ON THE HYPOTHESIS OF THE VARIATION OF THE GRAVITATIONAL CONSTANT, AND ON SOME OF ITS CONSEQUENCES.

While the constancy of  $e^2/kc$  and of the coupling constants of strong interactions seems to be essential for the consistency of general relativity there are not equally cogent reasons for ruling out a variation of the gravitational constant  $k$ . We consider, in particular, the hypothesis that  $k$  varies according to a law

$$k_1 = k_0 (1 + a V/c^2),$$

where  $a$  is a constant of the order of unity, and  $V$  is the gravitational potential. The observation of white dwarfs within galactic clusters could provide a test of the hypothesis.

We point out further that the problem connected with the existence of a critical mass for neutron stars may perhaps be solved by using the same hypothesis.

Forward, Robert L. ULTRACOLD NEUTRONS AND THEIR POTENTIAL VALUE IN GRAVITATIONAL RESEARCH.

This essay studies the properties of cold neutrons and the problems involved in the generation of an ultradense neutron gas suitable for experiments in gravitation. New methods for obtaining large numbers of ultracold neutrons are proposed. It is shown that the Fermi exclusion principle presents an obstacle to the condensation of the cold neutrons into a dense form of matter, but two possible mechanisms for bypassing this limitation through the formation of bosons are pointed out. Even assuming that a stable, ultradense neutron gas can be formed, it is shown that in order to generate a strong artificial gravitational field, even over a very small region, it will be necessary to wait for the development of fusion power sources which produce large numbers of neutrons during their operation.

Fox, William. ON THE ANTIGRAVITATIONAL FORCE AT THE LINE OF CONTACT OF THREE PHASES.

The antigravitational force at the line of contact of three phases is accounted for by introducing into the considerations the concept of conservation of edge forces. The equations, derived by describing physically possible situations, define the spontaneous tendencies for mass movement with a change in the contact angles of the system, and the tendencies for mass movement after the interfaces are in their equilibrium relationship. The equations are independent of gravitational fields or the orientation of the interfaces in space; and are therefore applicable to account for, and predict the behaviour of fluids under conditions that relate to space vehicles.

Gardner, J. W. GRAVITY AND THE IMPERMANENCE OF MATTER.

The essay considers the implications for gravitational theory of the concepts of continuous creation and continuous extinction of matter. If it be admitted that matter could have a finite life-time, some hitherto baffling aspects of gravity fall into place and the way is opened for unification of gravitational theory with the rest of physics. The deeper understanding following such a unification would enable us to answer the questions: What is gravity?, How does it work? How (if at all) may it be controlled?

Gradecak, V. GRAVITATION AND CERTAIN CLASS OF NUCLEAR PULSATIONS.

The object of this essay is to first review and discuss energy, mass, and gravitation from both the classical and relativistic points of view, to the extent of correlating some of their respective fundamental theoretical and experimental results.

The purpose of this correlation is to establish a link between these views and then to consider against this background a specific class of nuclear pulsations as a possible intrinsic mechanism of gravitation and finally to suggest, as a next step, an approach for investigation the validity of the underlying assumptions.

Harwit, Martin. QUANTUM MECHANICAL ZERO POINT ENERGY IN THE THEORY OF GRAVITATION.

We examine the physics of zero-point energy by considering the specific case of electromagnetic radiation. It is then possible to cite a concrete example in which zero point energy can be converted into useful work. This indicates that the zero point energy should be included in Einstein's field equations and in fact, the paper restricts itself to the scope of these equations. We postulate that the zero point energy is most naturally incorporated in the energy stress tensor and find then that it is essential to include the cosmological constant when dealing with a homogeneous isotropic space. Furthermore, we find that if the zero point energy follows geodesics -- as is implied by assigning frequency, directionality position, and polarization properties to phase cells -- then the only homogeneous isotropic space compatible with the existence of zero point energy is a space described by the deSitter metric.

Just, Kurt W. GRAVITY AS PURE INTERACTION.

After formal preparations we have proposed a principle of "no sourceless radiation" defining the fields of electrodynamics and gravity explicitly by those of matter. Here we give a survey of results and problems encountered so far.

Since the underlying formalism is not developed or known too well we also present preliminaries, which are independent of our modification. Details are given in other papers, which contain further references.

Kahn, Debi Charan. TIME VARIATION OF THE GRAVITATIONAL "CONSTANT".

One of the main consequences of Dirac's hypothesis is that the gravitational constant 'G' varies with time. The importance of this principle in the investigation of gravitation is discussed. The inverse proportionality of 'G' with time is derived for the most generalized case directly from Dirac's hypothesis. The new proportionality constant is calculated. The application of this principle to the geo-physical problems of formation of continents is studied.

Krause, H.G. RELATIVISTIC PERTURBATION THEORY OF AN ARTIFICIAL SATELLITE IN AN ARBITRARY ORBIT ABOUT THE ROTATING OBLATED EARTH SPHEROID AND THE TIME DILATATION EFFECT FOR THIS SATELLITE.

In this paper Einstein's general theory of relativity (gravitational theory) is applied to the motion of an artificial satellite revolving in an arbitrary orbit around a central body and the time dilatation effect for this satellite is given. This relativistic perturbation theory is based on Einstein's general field theory, differential geometry of non-Euclidian spaces potential theory, and celestial mechanics. The short periodic perturbations are excluded by using time average values over a revolution. The secular and long periodic (non-relativistic as well as relativistic) perturbations of the osculating orbital elements, which represent deviations from the elliptic orbit, are presented here for case of a rotating, non-homogeneous, oblated spheroidal central body. This is an extension of the work of Einstein (1915) who considered motion around a mass point as well as the work of deSitter (1916) and independently of Lense and Thirring (1918) who treated the relativistic motion around a rotating, homogeneous, spherical central body, omitting the terms due to the square of the angular velocity.

Montgomery, P. O'B. THE INFLUENCE OF GRAVITY ON BIOLOGICAL CLOCKS.

Gravity is a constant terrestrial force of unknown character. It's constancy and magnitude may be a factor in the temporal regulation of some types of biological clocks. Experiments conducted in our laboratory indicate that increasing the gravitational field in which bacteria are grown results in a decrease in their division rate without a concomitant decrement in growth capacity. This effect is identical to the effect of certain wave lengths of the electromagnetic spectrum on living cells of other types. The possibility now exists that biological experiments may be designed so as to provide a direct association between gravity and the electromagnetic spectrum.

Moritz, Helmut. AN APPLICATION OF THE TERRESTRIAL GRAVITY FIELD IN PROBLEMS OF MEASUREMENT.

The gravity field of the earth has a peculiar and unique significance for geodetic measurements. In principle, we might almost completely replace the conventional distance and angle measurements by measuring the quantities connected with the gravity field such as the gravity potential and the gravity vector. Some implications of this fact are shown; one of them is the possibility of testing Newton's (and Einstein's) theory of gravitation in the neighborhood of extended masses.

Sciama, D.W. RADIATION DAMPING AND THE EXPANSION OF THE UNIVERSE.

When a body emits gravitational waves it is presumably acted on by an irreversible radiation damping force. The sign of this force is not known from observation, and has not yet been determined by theory. We study here the simpler problem for the electromagnetic case. The sign of the damping force is not determined if we restrict ourselves to Minkowski space, since the past and future light cones have the same properties, and an irreversible force cannot be derived. We resolve this problem by working in an expanding world-model. Presumably the gravitational case can be solved in a similar way.

Utiyama, Ryoyu. WHAT IS GRAVITY?

Investigations have been made with respect to the validity of the concept of gravity in a microscopic space. The conclusion obtained is that the gravitational field is a well-defined physical entity only in a macroscopic world and can be regarded as a phenomenological concept. Some approaches to the essential feature of gravity are suggested on the basis of the statistical view-point. One of these is a modification of the old ether theory of gravity with the substitution of the neutrino for the old ether atom.

Weinberg, J.W. and Tauber, Gerald E. GRAVITATIONAL STABILITY OF LARGE MASSES.

In the gravitational equilibrium of white dwarf stars, instability sets in at  $1.44 \times \text{sun's mass}$  for reasons based on special relativity. The radius of stars of nearly the limiting mass is determined by two predictions of general relativity that have never been subject to experimental test - gravitation of stress up to first order in the gravitational constant G, and curvature of space up to the second order in G. It is suggested that the correlated distribution of masses and radii of stars of this kind will provide a new experimental test of general relativity.

Wellner, Marcel. SCALAR GRAVITATION.

Nordstrom's scalar theory of gravitation is discussed from a modern point of view, and compared with some aspects of general relativity. We discuss the equations of motion for test masses, the field equations in the presence of matter, the extent to which the principle of equivalence, Mach's principle, and the expansion of the universe are contained in this model. The theory implies what amounts to a Riemannian metric. The question is considered whether this model leaves any room for antigravity.

Wormel, R. L. THE RATIONALE OF GRAVITATION.

Wave-particles are described in terms of a vertical and forward motion through space-time, which accounts for their identity and preservation as well as for the observed direct proportionality of energy to frequency. The concept also accounts for the existence of a wave-particle domain of specific diameter, and the progress of this from its point of origin sets up the tension known as gravitation; this is directly proportional to the angle between diameter and origin. When the theory is checked by applying known atomic diameters and the observed distance from the origin, a calculated value for the gravitational constant may be obtained which is in remarkable agreement with that experimentally derived.

Yilmaz, Huseyin. ON THE CONVARIANT SCALAR FIELD THEORY OF GRAVITATION.

The covariant scalar field theory of gravitation proposed by the author (Phys. Rev. 111, 1417, (1958)) predicts correctly the red shift experiment of R. V. Pound and G. A. Rebka, (Phy. Rev. Letters 4 274, (1960)) and the isotropy of V. W. Hughes et. al. (Phys. Rev. Letters 4, 342, (1960)). These experiments and the fact that this theory is a natural unification of the Einsteinian idea of space-time curvatures and the Newtonian concept of the scalar field is elaborated. It is also established (for the first time) that in this theory the geodesic equations of motion to a point particle follows rigorously from the equations of the field.