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SOVIET RESEARCH ON UNIFIED FIELD THEORIES, FALSE VACUUM STATES, AND ANTIGRAVITY (U)

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SUMMARY

(U) The Soviets appear to have made significant theoretical progress in dealing with unified field theories or the unification of the four forces of nature. They have been in the active areas of grand unified theories (GUT), supergravity theories (SGT), quantum gravity, and superstrings. The Soviets have made use of gauge theories and Higgs fields to develop unified field theories and "superstrings" which could possibly incorporate the GUT and SGT theories. Although any application of these theories in the foreseeable future is out of the question, Soviet progress in this area should be carefully followed. Advancements in this work may provide the basis for whole new concepts in weapons systems, transportation, propulsion, space travel, and others.

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All potentials in this restricted class are said to belong to the Lorentz gauge. They relate the scalar wave to the potentials.

APPENDIX I

FAR-FIELD APPROXIMATION FOR MAXWELL'S EQUATIONS

(U) For the case far away from the source, **E** = 0, **B** = 0, and $\nabla \times \mathbf{A} = 0$, then equation (1) becomes;

$$-\nabla\phi - 1/c\ \partial\mathbf{A}/\partial t = 0$$

This equation can always be satisfied with a scaler field, S;

$$\mathbf{A} = \nabla S \qquad (10)$$

and

$$\phi = -1/c\ \partial S/\partial t \qquad (11)$$

If equations (10) and (11) are substituted into equation (7), one obtains;

$$\nabla^2 S - 1/c^2\ \partial^2 S/\partial t^2 = 0 \qquad (12)$$

which is the wave equation for S.

(U) In the Aharonov-Bohm effect, the phase change of an electron can be represented by

$$\Delta\Theta = e/\hbar c \oint d\mathbf{l}\cdot\mathbf{A}$$

as the line integral around a closed path for the interference effect. When dealing with phase changes over a time period this effect can be represented by the time integral of the scalar potential

$$\Delta\Theta = e/\hbar c \int_{t_1}^{t_2} dt\ V(\mathbf{x},t).$$

(U) But, $\oint \nabla S\cdot d\mathbf{l} = 0$ around any closed path according to Stoke's theorem. So, the scalar field takes on real significance over a time domain or perhaps coupled to other fields over a time oscillation period.

(U) In the absence of **E** and **B** fields, the vector potential can be represented by the gradient of a scalar field. The vector potential and scalar fields then are the primitive fields from which one can derive the **E** and **B** fields. The scalar fields in equation (12) replace the potential when the physical **E** and **B** fields are zero.

(U) Quantum Mechanics requires the use of potentials rather than forces; i.e., **E** and **B** in the case of the electromagnetic fields. The vector potential **A** and the scaler potential ϕ are related to the **E** and **B** fields by;

$$\mathbf{E} = -\nabla\phi - 1/c\ \partial\mathbf{A}/\partial t \qquad (1)$$

$$\mathbf{B} = \nabla \times \mathbf{A} \qquad (2)$$

(U) Electromagnetic theory predicts the existence of potential waves traveling at the speed of light. If equations (1) and (2) are substituted into Maxwell equations;

$$\nabla\cdot\mathbf{E} = 4\pi\rho \qquad (3)$$

$$\nabla\cdot\mathbf{B} = 0 \qquad (4)$$

$$\nabla \times \mathbf{B} = 4\pi/c\ \mathbf{J} + 1/c\ \partial\mathbf{E}/\partial t \qquad (5)$$

$$\nabla \times \mathbf{E} = -1/c\ \partial\mathbf{B}/\partial t \qquad (6)$$

And making use of the Lorentz guage condition,

$$\nabla\cdot\mathbf{A} + 1/c\ \partial\phi/\partial t = 0 \qquad (7)$$

one obtains two source free potential wave equations;

$$\nabla^2\phi - 1/c^2\ \partial^2\phi/\partial t^2 = 0;\ \text{Scalar potential} \qquad (8)$$

$$\nabla^2\mathbf{A} - 1/c^2\ \partial^2\mathbf{A}/\partial t^2 = 0;\ \text{Vector potential} \qquad (9)$$

Equations (7), (8), and (9) form a set of equations which are equivalent in all respects to Maxwell's equations.

(U) To demonstrate what is termed the guage invariance of ϕ and **A**, let's perform a guage transformation of the following type;

$$\phi' = \phi - 1/c\ \partial S/\partial t \qquad (1a)$$

$$\mathbf{A}' = \mathbf{A} + \nabla S \qquad (2a)$$

Guage invariant transformation of ϕ and **A**.

Then demanding that **A**' and ϕ' satisfy the Lorentz condition, equation (7), gives;

$$\nabla\cdot\mathbf{A}' + 1/c\ \partial\phi'/\partial t = 0 = \nabla\cdot\mathbf{A} + 1/c\ \partial\phi/\partial t + \nabla^2 S - 1/c^2\ \partial^2 S/\partial t^2 \qquad (3a)$$

$$\nabla^2 S - 1/c^2\ \partial^2 S/\partial t^2 = -(\nabla\cdot\mathbf{A} + 1/c\ \partial\phi/\partial t) \qquad (4a)$$

(U) **A** is perhaps the field that imparts phase shifts to matter proportional to the rate at which **A** changes over distance/time and it could be detected by means of quantum interference devices (SQUIDs). The scalar waves S are so naturally elusive they are called scalar vacuum waves. The scalar field is already known to physicists in the context of quantum field theory as the Lorentz gauge which treats ϕ and **A** on the same footing and is a concept independent of coordinate systems. The reader is referred to references 63 and 64.