PART A

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THE EIGHTH
MARCEL GROSSMANN MEETING

On Recent Developments in Theoretical and Experimental General Relativity, Gravitation, and Relativistic Field Theories

Proceedings of the Meeting held at
The Hebrew University of Jerusalem
22–27 June 1997

Editor

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1999

World Scientific
Singapore • New Jersey • London • Hong Kong

UNIFICATION OF GRAVITATION AND ELECTROWEAK INTERACTIONS

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Via the use of new mathematics, we present a resolution of the main incompatibilities between gravitation and electroweak interactions and submit an apparently consistent grand unification.

Some of the main problems for the inclusion of gravity in unified gauge theories [1] are due to: (1) **Curvature.** Electroweak theories are structured on *Minkowskian* axioms, while gravitation is formulated via *Riemannian* axioms, a disparity which is magnified at the operator level because of known technical difficulties of quantum gravity); (2) **Antimatter.** Electroweak theories are *bona fide* relativistic theories, thus characterizing antimatter via *negative-energy* solutions, while gravitation characterizes antimatter via *positive-definite* energy-momentum tensors; (3) **Fundamental space-time symmetries.** Electroweak interactions are based on the axioms of the special relativity, thus verifying the Poincaré symmetry $P(3.1)$, while such a basic symmetry is absent in contemporary gravitation.

In a contribution to mg7 [2a] we submitted the classical and operator *isominkowskian representation of gravity*, that is, its representation via conventional Riemannian metrics factorized in the form g(x) = T(x)m, where m = Diag. (1, 1, 1, -1), is the Minkowski metric and T(x) is a 4x4 positive-definite matrix, while the conventional unit of the Riemannian geometry, I = Diag. (1, 1, 1, 1), is lifted into the expression $\hat{I}(x) = 1/T(x)$. Jointly, the underlying mathematics is lifted for consistency into a form called *isomathematics* [2b] which admits $\hat{I}(x)$ as the left and right unit,thus implying simple yet significant liftings of numbers, Hilbert and Minkowski spaces, differential calculus, geometries, Lie's theory, etc.

We showed that the lifting of the unit $I \to \hat{I}(x)$ implies the regaining of the *Minkowskian* axioms for all possible *Riemannian* metrics, resulting in a novel conception of gravity in which conventional Einstein's (or other) field equations remain essentially unchanged, yet they acquire a universal *invariance* (rather than covariance), the *isopoincaré symmetry* $\hat{P}(3.1)$ which is isomorphic to P(3.1) [2c, 2d].

In turn, the latter achievement is sufficient to provide realistic hopes for a *classical and operator* formulation of gravity which verifies the axioms of the *special* relativity, only reformulated with respect to $\hat{I}(x)$. In particular, this assures axiomatic consistency of the operator formulation of gravity *ab initio*.

More recent studies [2e] have indicated the apparent *necessity* for the isominkowskian representation of gravity in order to achieve a theory with invariant units of space and time, which is a notorious pre-requisite for applications to real measurements. In fact, the current formulation of gravity at the classical (quantum) level is *noncanonical* (*nonunitary*), thus lacking invariant units in its very foundations. By comparison, the isominkowskian representation of gravity has been conceived and constructed [2a] to possess invariant units.

Additional problematic aspects for the conventional treatment of gravity have

emerged in regard to antimatter. It has been recently understood [2f] that the operator image of the Riemannian representation of antimatter *is not* an antiparticle, but merely an ordinary particle with opposite sign of the charge.

A resolution of the latter impasse has been reached via the *isodual isominkowskian formulation* of the gravity of antimatter [2f] which is based on the so-called *isodual map* $\hat{I}(x) \to \hat{I}^d(x) = -\hat{I}^\dagger(x) = -\hat{I}(x)$. Jointly, the original isomathematics (including numbers, spaces, differential calculus, geometries, algebras, symmetries,etc.) is reformulated into a form called *isodual isomathematics* [2b] which now admits the *negative* quantity $-\hat{I}(x)$ as the left and right unit. The emerging isodual theory of antimatter begins at the purely classical level, admits its own quantization, and persists at the operator level where it results to be equivalent to a charge conjugated theory [2f].

In this contribution to mg8 we present, apparently for the first time, the *Iso-Grand-Unification* (IGU), namely, a grand unification formulated in terms of the isominkowskian formulation of matter for both electroweak and gravitational interactions, and its isodual for antimatter, which does indeed appear to resolve problematic aspects (1), (2), (3) above.

It should be noted that the isotopies of gauge theories were first studied in the 1980's by Gasperini [3a], followed by Nishioka [3b], Karajannis and Jannussis [3c] and others. However, these studies were defined on conventional spaces over conventional fields and via the conventional differential calculus. As such, they *are not* invariant, as we learned recently in memoirs [2e].

In this contribution we introduce, apparently for the first time, the *isogauge theories* formulated in an invariant way, that is, on isospaces over isofields and characterized by the isodifferential calculus of memoir [2b]. The *isodual isogauge theories* have been apparently introduced at mg8 for the first time.

A detailed construction of the proposed grand unification is presented elsewhere [2g]. We here mention that the same construction can be achieved via the systematic application to conventional gauge theories of a *nonunitary* transform $UU^\dagger = \hat{I}(x)$ under which numbers are lifted into isonumbers, spaces are lifted into isospaces, etc. The invariance of the theory under additional nonunitary transforms then follows (provided that the transforms are properly written on isohilbert spaces over isofields).

The above construction also shows that the IGU for matter and, independently, for antimatter are due to hitherto unknown degrees of freedom of the Hilbert and Minkowskian invariants which have remained undetected in this century because they required the prior discovery of *new numbers*, those with arbitrary positive and negative units, respectively.

In this and the extended presentation [2g] we only study the *axiomatic* consistency of IGU. To ascertain the *physical* consistency, one should known that IGU has a number of far reaching implications, such as [2i]: a new conception of spacetime in which the novelty rests in its *units*; the admission of arbitrary maximal causal speeds under suitable local conditions (e.g., in the core of stars); the prediction that antimatter experiences antigravity in the field of matter; the prediction that antimatter emits a new light which is repelled by matter; the characterization of a new cosmology in which the universe has *null* total characteristics of mass, energy,

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It should be also noted that IGU is a particular case of the unifications permitted by the broader *genomathematics* [2b] (which is recommendable for the invariant formulation of open-nonconservative-irreversible settings, e.g., that of [3i]) and of the still broader *hypermathematics* [2b] (recommendable for complex, multivalued and irreversible structures, e.g., of biological type).

In closing, we would like to convey the possibility that *gravitation has always been present in unified gauge theories although embedded where nobody looked for, in the "unit" of gauge theories.*

The author has no words to express his deepest gratitude to all mg8 organizers as well as to Prof. Dr. F. W. Hehl of the University of Koel, Germany, who presented the transparencies of his talk at mg8 in his absence.

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