Unified Physics

and

Properties of Elementary Particles

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Abstract

It is demonstrated how to unify all physics on the basis of general relativity. Electrodynamics is revealed to be part of general relativity, as already seen by RAINICH. The properties of elementary particles follow from the equations of the unified theory. The way of calculating these properties is indicated, and successful applications of this method are referenced. These insights and results have inevitably to be joined with a criticism of contemporary physics.

Keywords: General relativity, Electrodynamics, Particle properties.

Introduction: Problems in contemporary physics

Contemporary physics is divided into many specialized fields like mechanics, thermodynamics, astrophysics, quantum physics, solid state physics or elementary particle physics. This specialization is owed to the diversity of phenomena being studied in above-named disciplines of physics. However it would be desirable that all physical disciplines are founded on a common, basic theory. There is only one all-encompassing nature and there should be one basic description concept. That was the case until the end of the nineteenth century where classical mechanics was the basis of thermodynamics and astronomy for example. With the advent of EINSTEIN's special and general relativity and quantum mechanics in the twentieth century, the disciplines drifted away from each other. Particle physics has gone its own way by its "standard model" which uses a phenomenological theory with adjustable parameters. It would be very desirable if the microcosm could be explained on a basis which is also

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used in other disciplines, because we see that the standard model comes more and more to its limits.

There were some attempts to unify quantum mechanics with EINSTEIN's relativity, however this was only achieved with special relativity from which the DIRAC equation follows [1, 2]. There was no successful way of including general relativity in quantum physics because the concepts of both are too different. The usual way of quantizing physical quantities does not work for RIEMANNian geometry [3] (which is the basis of general relativity), i.e. in curved spaces. Some theorists are looking for solutions in higher dimensions, for example by projective theory [4], or string theory [5]. However, the string theory needs at least 11 dimensions to come to mathematically manageable results, which are arbitrary for mathematical reasons, and therefore irrelevant. Consequently, the string theorists themselves have to admit that there is no chance to ever relate their theory to any measurable physical parameters. This is a state of natural philosophy we last had in mediaeval times! Physicists have made themselves comfortable in their disciplines and only few of them think about ways to come back to a unified view of science as it existed until about 1900.

A hint how to avoid the shortcomings of Einstein's general relativity

In order to develop a path to a new unified physics, we first consider the general relativity of Albert EINSTEIN and its relation to electrodynamics. In his famous four lectures on theory of relativity, EINSTEIN quoted the covariant ("relativistic") MAXWELL equations, and remarked on the connection of these equations with his gravitational field equation [6] (not literally):

If we set the sources (distributed currents and charges) to zero, the gravitational equation is fulfilled with the electromagnetic energy tensor[3] exactly.

This statement dates back to a work by RAINICH which we will mention below. It means that we have force equilibrium respectively conservation of energy and momentum only if the sources are zero. That is a condition which is also mathematically necessary for the BIANCHI identities [3] to be fulfilled. The BIANCHI identities are the mathematical expression of the force equilibrium in

[3] The energy tensor contains besides the energy 3 momentum and 6 stress components

general relativity, because Einstein and Grossmann found the gravitation equation just under aforementioned premise [6]. As well, the divergences of any energy tensor must vanish [6, 7], which is consistent with all laws of nature. The Bianchi identities resp. the always vanishing divergences of the energy tensor contain the simple conservation rules of mechanics and electromagnetism.

Considering the condition mentioned by Einstein, we obtain a set of tensor equations for 14 components, where only 10 equations are independent. They are quoted in [7, 8, 9]. Fields different from zero result only with non-zero integration constants. They enter the initial conditions of these tensor equations. Initial and boundary conditions have to be specified for the solutions of the combined field equations. The most important integration constants are mass, spin, electric charge, and magnetic moment [7, 9].

As soon as we accept Einstein's suggestion of using the electromagnetic energy momentum tensor in the field equations (never realized by him), we have a unified theory of gravitation and electromagnetism. It is the "already unified theory" according to Rainich [10, 11], although Einstein never cited Rainich directly. The consequences are:

1. The solutions of the equations are not completely determined a priori.
2. According to a theorem of Einstein and Pauli [12], stationary solutions of the above field equations lead always to singularities where the field quantities (like force fields) exceed all limits.
3. Mach's Principle has to be re-interpreted to be consistent with the unified approach.

The problem described in the first point can be circumvented in the same way as for gravitational solutions of the field equations. Additional relations can be defined, for example special relations for metrics. But one should not confuse the additional relations with the relations of covariance. The principal property of covariance is that the field equations maintain their form for all choices of coordinates, what has nothing to do with additional relations.

The second point means that we will have to handle singularities if we want to have stationary solutions which is the case here. Therefore we have to introduce singularities, for example to define point masses or point charges. These singular points, however, are mathematically and physically problematical. Consequently, we have to exclude such points from the validity range of the field equations. In general relativity, the type of symmetry that such points create is used to construct suitable solutions everywhere in space except at the singularities. Inconsistencies are avoided in such a way. On the other hand, the energy momentum tensor is different from zero only at the singular points. Thus the energy tensor of the gravitational field is de facto excluded from the theory of general relativity. The question is whether it makes sense to write such a term into the field equations if it is effective nowhere. This holds for the gravitational case. However, the electromagnetic energy tensor is different from zero in the electromagnetic field so that it is applicable in EINSTEIN's gravitation equation.

Physicists are not ready to accept the second consequence, because one cannot imagine infinite physical quantities. Singularities are only seen as imperfect mathematical models. However, with intelligent reflection it is possible to find a solution for this problem. We shall find the singularities in physically irrelevant regions according to observer's coordinates. The observer uses coordinates in a tangent (asymptotic) space around the particle (with the singularity). The coordinates of the observer are projected onto the space-time around the particle. We have a physically irrelevant region where this projection is not possible. The physically irrelevant regions are "behind" a geometric limit, which is the limit for this projection.

The greatest obstacle for a geometric theory is the third point above, MACH's principle. According to this principle the geometric structure of four-dimensional space-time is determined by the distribution of masses. MACH's principle was heuristically helpful to find the field law of gravitation [6], however, here it is mingled geometry, i. e. the field is combined with a quantity (the masses) which we do not know what it is. That is illogical. In addition, conservation of energy and momentum is not valid (as in the electromagnetic field with distributed charges and currents), because the divergences of the energy tensor of distributed masses do not vanish.

There is a further reason for the necessity dealing with the integration constants, and why the assumption of sources, like distributed charges and masses, is based on a fallacy. We will explain it by a strongly simplified example:
From electrical engineering we know KIRCHHOFF's current law. As a result, the total current vanishes in each node of a current mesh. With the transition

to very small meshes (what becomes the field), physicists are satisfied with the statement that the divergence of the current density vanishes. This condition is not sufficient. The current *density* itself must vanish everywhere! That is an analogy to the force equilibrium and a condition for achieving it, see the above discussion of the BIANCHI identities.

A Solution of the problem

The solution of this problem has been found by RAINICH already in 1924 [10, 11], see also [8]. He used the homogeneous (source-free) MAXWELL equations and the electromagnetic energy tensor (with the components by LORENTZ [6]) which contains the field terms exclusively. Then he inserted this tensor into EINSTEIN's gravitational equations. This proceeding implies pure RIEMANNian geometry [8]. Unfortunately, EINSTEIN did not pursue this idea although he saw the energy conservation (see above) so that he could not find the unified theory.

With mentioned reservations, physicists confined general relativity to astrophysics and introduced virtual "forces" or "actions", in order to save the energy conservation in their models, and to describe the quantum phenomena. Rules for the quantum phenomena are introduced as postulates, and particle quantities like masses as adaptable parameters. These methods were introduced by BOHR, HEISENBERG, and others [13]. Richard P. FEYNMAN postulated that each phenomenon needs its own mathematical method [14]. All these arbitrary methods perform the nowadays accepted "physical method". This method succeeded in many parts of physics, just quantum physics. However, it comes more and more to its limits. The worst limit is that the particle masses are not predictable. Physicists can only take notice of a "particle zoo", obtained by extremely expensive experiments. – We see weighty reasons for a paradigm change.

The alternative consists in the geometry, going the way which EINSTEIN has not finished. As well, we have to see how to deal with above mentioned geometric equations. The mathematical method must correctly describe nature. Since the "relativistic" models in astrophysics work (mostly), we will confine ourselves to the calculation of particles.

The geometric equations [7, 8, 9] consist of a set of sophisticated tensor equations. Commonly, these cannot be solved with an analytical method. However, the second derivatives in the tensor equations appear always linearly. That opens up a viable possibility of solving tensor equations numerically. For this purpose, we replace the differential quotients by related difference quotients [7, 9]. If we introduce a calculational grid (with discrete coordinate values), we can separate the second derivatives first, and after that separate the quantities to be just determined. So we obtain recursion formulae for all field quantities. For particles, we take a central grid and begin the calculation outside in the electrovacuum around the particle, and continue towards the centre (see Fig. 1). – This method is described in detail in [9].

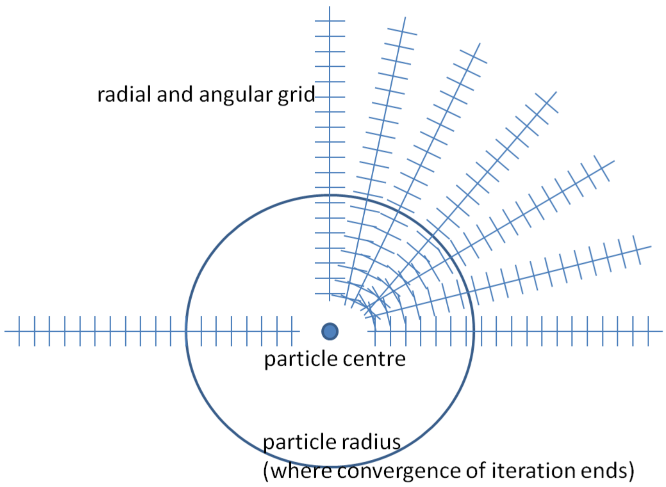

Figure 1: Iterative method of investigating the convergence behaviour of field equations on a grid. The particle centre is outside the calculation range.

The relevant parameters of particles: mass, spin, electric charge, and magnetic moment, are integration constants in the underlying geometric theory. We have to insert values of the integration constants into the initial conditions. If we search for relevant values, we have to do lots of tests. How do we find these values ?

The recursion formulae behave chaotically [9]. As well, the field quantities diverge during the computation in a varying way, dependent on the parameters. The computation is stopped as soon as the first field quantity reaches a geometric limit. The step count till then is a measure of stability, and the maxima of it correlate highly significantly with the physical values of particles. Clear results have been achieved for masses of nuclei [15], and the magnetic moment of the electron [7]. The nuclear masses have been tested up to the oxygen nucleus. It should be possible with appropriate effort to test the whole periodic system of elements, including predictions about its end. Moreover, masses of supposed neutrinos have been predicted [9].

Fig. 2 (quoted from [9]) illustrates with an example how one can see discrete parameters of particles, in this case masses of supposed neutrinos. The visualization of the results of computation is described in [9]. Essentially the thickness of points stands for the quality of convergence. Therefore the thickest points represent physically relevant values.

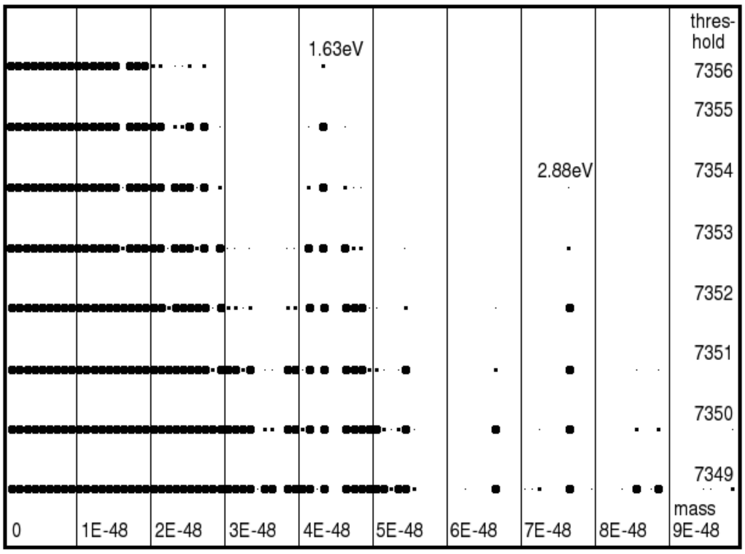

Figure 2: Tests for the electron neutrino, masses $< 4\,\mathrm{eV}$. Initial radius 5, 99 values, 9 times piled (891 tests)

Additional remarks

The power of the geometric theory of fields is not exhausted with the calculation of particles. We refer for example to the geometric interpretation of electrical conductivity, including superconductivity [7]. An argument against a geometric theory, the well known wave-particle dualism, is refutable with classical methods. Afshar [16] demonstrated that light is clearly a wave, and Al Rabeh suggested a numerical simulation of the double-slit experiment that reveals electrons to behave as classical particles [17]. Their wave behaviour with de Broglie frequency needs not to be used at all.

Many theories developed from the standard model (string theory etc.) predict deviations from Newton's gravitational law in the submillimetre range. All experimental tests of these deviations involved negative results up to now [18]. The geometric theory does not predict measurable deviations in this range.

Conclusion

It could be demonstrated that, contrary to widely accepted claims, the unification of all physics is possible. This unification is based on General relativity, and means not only electromagnetism but also all quantum phenomena. The material world is revealed to be pure geometry.

Appendix: Basic formulae of general relativity

The tensor calculus is a lot more clear than conventional vector analysis so that the formalism of the general theory of relativity is reduced to few formulae: The Bianchi identities

$$(R_i^k - \frac{1}{2} R \delta_i^k)_{;k} = 0$$

are always fulfilled by

$$R_{ik} = 0 \quad .$$

Therefore, only 6 independent equations exist for 10 components g_{ik}. If we set (Einstein & Grossmann)

$$R_{ik} - \frac{1}{2} R g_{ik} = -\kappa T_{ik} \quad ,$$

the divergences of the energy tensor must vanish

$$T_{i\ ;k}^{k} = 0 \quad ,$$

as dictated by nature. For the variables in the energy tensor, separate conditions follow, which do not take the place of the lacking conditions in metrics.

The divergences of the energy tensor of distributed mass

$$T^{ik} = \sigma \frac{\mathsf{d}x^i}{\mathsf{d}s} \frac{\mathsf{d}x^k}{\mathsf{d}s}$$

with the mass density σ are

$$T^{ik}_{;k} = \sigma k^i$$

with the (space-like) curvature vektor **k**. Since the curvature vector of any time-like curve in space-time is different from zero in general, σ must be zero everywhere. Distributed mass does not exist.

There is an exception when we start from discrete masses (which can be only integration constants). The force to a body with the mass m then were

$$K^i = mk^i \quad .$$

For force equilibrium it must be $k^i = 0$. That results in four equations of motion. The curve described by the body in space-time is a geodesic.

The electromagnetic energy tensor (Lorentz)

$$T_{ik} = F_{ia} F_k{}^a - \frac{1}{4} g_{ik} F_{ab} F^{ab}$$

would result in a force density

$$T^{ik}_{;k} = F^i{}_a S^a \quad ,$$

i. e. **S** must be zero. That means, there are no distributed charges and currents. Discrete charges are analogous to discrete masses. Equations of motions result together with the mass (the curves are no geodesics then).

From this we see:

1) Complete determinacy is not given.
2) There are no distributed charges and masses (sources).
3) Only the electromagnetic energy tensor is applicable in Einstein's gravitational equation.
4) In order to calculate fields (gravitational and electromagnetic), we have to deal with integration constants instead of sources.

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