Short communication

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# Landau vs Einstein: mathematics represents the universe

## Abstract

The modern theory of gravity is the Einstein space theory, which is described by mathematical methods of tensor analysis of Riemannian geometry. Einstein built on this basis one of the most successful and amazing theories. Complexity theories often lead to the extraction of foundations and, as is customary in theory, to obtaining meaningless results. Now the entire intellectual power of numerous researchers is directed at alternative theories, often based on erroneous ideas about Einstein's theory. An example of this is the catastrophic error in the definition of the coordinate transformation in the top manual on theoretical physics by L. D. Landau and E. M. Lifshitz.

**Keywords:** Landau, Lifshitz, Einstein, coordinate transformation, covariant tensor, transformations

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## Introduction

In 1914[1] Einstein defines a covariant 4-vector $A_i$, or a first-order covariant tensor, if for an arbitrarily chosen line element $\partial x^i$ the sum

$$A_i \partial x^i = \Phi \quad (1)$$

is an invariant (scalar).

The law of transformation of coordinates of a 4-vector follows from this definition

$$A_i = \frac{\partial x'^k}{\partial x^i} A'_k \quad (2)$$

Einstein drew attention to the obvious linearity of coordinate transformations of tensors.[1]

Then, despite the arbitrariness of the coordinates, the transformations themselves are not arbitrary. Nonlinear transformations should be excluded from consideration.

However, the meaning of this transformation was not explained then. In the modern interpretation, in the general case, a linear transformation of a differential is written

$$dx^i = \frac{\partial x'^k}{\partial x^i} dx'_k \quad (3)$$

That is, differentials are preserved under linear transformation, and therefore the fundamental metric tensor in the new coordinates is preserved.

$$ds^2 = g_{ij} dx^i dx^j = g_{ij} du^i du^j \quad (4)$$

From a physical point of view, such a coordinate transformation does not change the reference system. This property makes the linear coordinate transformation indispensable when studying the reference system in different coordinate systems. On the other hand, a nonlinear transformation cannot be implemented using the Jacobian matrix, even if such a matrix exists.[2]

## Erroneous extension of coordinate transformations

The coordinate transformation (2) is linear, despite the arbitrariness of the linear element $\partial x^i$.

However, the authors of the well-known work[3] "extend" the definition of transformation as arbitrary, including nonlinear. We read in § 83. Curvilinear coordinates:

"Let us consider the transformation of one coordinate system $x^0, x^1, x^2, x^3$ into another $x'^0, x'^1, x'^2, x'^3$:

$$x^i = f^i\left(x'^0, x'^1, x'^2, x'^3\right),$$

where $f^i$ are some functions".

This transformation is generally nonlinear and has nothing in common with Einstein's definition of a linear transformation. Unlike Einstein's definition of a linear coordinate transformation, the "generalized" definition of the authors[3] through an arbitrary function allows the transformation of an arbitrary tensor into any other, making the coordinate transformation meaningless. Indeed, all metrics cannot be equivalent reference frames at the same time. For example, there is no linear transformation of Cartesian space into spherical space.[2]

The given definition is not a random slip of the tongue; the authors repeatedly give examples of arbitrary transformations and repeatedly repeat the thesis about the admissibility of an arbitrary transformation.[3] (§ 100. Centrally symmetric gravitational field):

"But, due to the arbitrariness of the choice of the reference system in the general theory of relativity, we can still subject the coordinates to any transformation that does not violate the central symmetry $ds^2$ this means that we can transform the coordinates r and t by means of the formulas

[1]To my surprise, non-mathematicians are often simply not familiar with the concept of "linearity". Let me remind you that the operator A is linear if two equalities always hold: a) $A(x+y) = A(x) + A(y)$; b) $A(\lambda x) = \lambda A(x)$ for any $\lambda$.

$r = f_1(r', t'), t = f_2(r', t')$ ,

where $f_1$ and $f_2$ are any functions of the new coordinates $r', t'$ ".

Of course, such statements are incorrect, because only linear coordinate transformations that do not change the reference system are permissible. It is not surprising that sometimes certain people apply such "rules", especially when this confirms their absurd statements. Unfortunately, this is not the only example of such an error by the authors.[3] Perhaps the authors, considering a finite region of curvilinear space, noticed that as the size of the region decreases, the image of curved lines begins to resemble straight lines. Based on this visual effect, the authors could make the strange conclusion[3] that some local transformation of the system with a gravitational field into an inertial system takes place. Read[3] § 85. Covariant differentiation (snapshot):

Formula (85.15) enables us to prove easily the assertion made above that it is always possible under condition (85.16) to choose a coordinate system in which all the $\Gamma^i_{kl}$ become zero at a previously assigned point (such a system is said to be *locally-inertial* or *locally-geodesic* (see §87)).

In fact, let the given point be chosen as the origin of coordinates, and let the values of the $\Gamma^i_{kl}$ at it be initially (in the coordinates $x^i$) equal to $\left(\Gamma^i_{kl}\right)_0$ . In the neighbourhood of this point, we now make the transformation

$$x'^i = x^i + \frac{1}{2}\left(\Gamma^i_{kl}\right)_0 x^k x^l \text{ . (85.18)}$$

In fact, the curvature at a point is not related to the size of the region surrounding it. In addition, the proposed transformation (85.18) is a nonlinear operation of replacing coordinates with their differentials and, therefore, is not an admissible coordinate transformation.

In the well-known work of C. Møller,[4] clearly under the influence of work,[3] a "local transformation" is introduced, or more precisely, replacing coordinates with their differentials.[5,6]

## Conclusions

Of course, a nonlinear local transformation is not a coordinate transformation in the general theory of relativity. One can only speak of the local equivalence of a system with gravity and an inertial system.[2] Thus, the Minkowski tangent space to the Riemann spaces in a small neighbourhood of the tangent point is equivalent to this Riemann space.

All this, to our great regret, casts a shadow on the best publication devoted to theoretical physics. It should be noted that despite this, there are apparently researchers who understand that coordinate transformations in the general theory of relativity must be linear. "Generalization" of this principle leads to catastrophic errors.

All this, to our great regret, casts a shadow on the best publication devoted to theoretical physics. It is difficult to estimate the number of works and reviews that used erroneous transformations or a "local inertial coordinate system". It should be noted that despite this, there are researchers who understand that coordinate transformations must be linear.

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## Conflicts of interest

The authors declare that there is no conflict of interest.

## References

1. Einstein A. The formal basis of the general theory of relativity. *Meeting area Prussian Akad, Wiss*. 1914;2:1030–1085.
2. Morozov VB. Various problems of general relativity with and without a gravitational field. 2024.
3. Landau LD, Lifshitz EM. The classical theory of fields. Vol 2, 4th Ed. Butterworth–Heinemann; 1975.
4. Møller C. Theory of relativity. 2nd Ed. Oxford University Press; 1972.
5. Landau LD, Lifshitz EM. Course of theoretical physics, quantum mechanics non-relativistic theory. Vol. 3. Pergamon; 1991.
6. Landau LD, Lifshitz EM. Quantum electrodynamics. Course of theoretical physics 4 pergamon international library of science, technology, engineering, and social studies. Vol 4, 2nd Ed. Pergamon; 1982.