никновения энтропии и феноменологических законов были найдены общие уравнения динамики необратимых процессов. Наиболее исчерпывающее решение проблемы было дано Эккартом (1940 г.).

В 1931 г. Онзагером на основе общих положений статистической механики была создана теория кинетических коэффициентов, давшая достаточно общий, хотя и приближенный, метод решения различных задач. Основное положение теории – теорема взаимности – устанавливает ряд соотношений между перекрестными коэффициентами линейных феноменологических законов необратимых процессов.

Работы по обоснованию и применению теории Онзагера (Казимир, Каллен, Мейкснер, Ландау и Лифшиц, Денбиг, Дерягин и Сидоренков, де Гроот и др. – начало 40-х годов) открывают заключительный этап в становлении термодинамики необратимых процессов. С этого времени началось ее систематическое развитие.

Благодаря работам Мейкснера с начала 40-х годов, несколько позже – Пригожина, де Гроота и их сотрудников, к середине 50-х годов была построена согласованная феноменологическая теория необратимых процессов, охватившая как теорию Онзагера, так и теории, базирующиеся на уравнении баланса энтропии.

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ON ERRORS AND INCONSISTENCIES CONTAINED IN EINSTEIN'S 1905 PAPER "ZUR ELEKTRODYNAMIK BEWEGTER KÖRPER"

1. MAXWELL's creation of the theory of electromagnetic field in 1873 was the crown of a very significant period in the development of physics in which the theoretical contribution of FRESNEL and the experimental investigations of BIOT, SAVART, OERSTED and FARADAY played a fundamental role. In 1892, H.A.LORENTZ generalized the electromagnetic theory of MAXWELL[1] and created the theory of electrons in which the later represented the basic elementary particle of matter and the ether played the role of absolute space as a substratum of the physical reality. In order to bring his theory of electrons in accordance with the negative result of the terrestrial optical experiment of MICHELSON (1881), making in principle possible the determination of the velocity of the earth relative to the hypothetical ab-

solutely immovable ether, Lorentz introduced (1892) the hypothesis that all bodies in translation moving with the velocity V relative to the immovable ether must be contracted by the factor $\sqrt{1 - \frac{V^2}{c^2}}$ in direction of the motion.[2] The mathematical problem of invariance of the equations of his theory, as the expression of the objective validity of basic physical laws, begun to occupy Lorentz in 1895.[3] In 1904 he established[4] that in order to achieve the invariance of his equations there must be introduced, besides the hypothesis of contraction, the transformation

$$x' = klx, \quad y' = ly, \quad z' = lz, \quad t' = k^{-1}lt - klw^2c^{-2}x,$$

l being a constant, w the constant velocity of the system K, which is with respect to another system k in uniform straightline motionalong the X-axis of the reference system K. To the variable t' Lorentz gave (1895) the name 'local time',[5] which had for him only a mathematical sense. In the system k as well as in the system K the velocity of light has, according to Lorentz the same constant value c. To this physical proposition, expressed by Lorentz explicitely in connection with the problem of invariance of his equations, gave Einstein later (1905) the name "the principle of the constancy of the velocity of light".[6] Lorentz never succeded to establish the complete invariance of his theory of electrons. This had been done first by Henri Poincare (1905) who gave in 1904 the explicite formulation of the principle of relativity in the invariant theoretical sense[7] and in the § 1 of his paper 'Sur la dynamique de l'électron' to the transformation (*), in which x is replaced by x - wt, the name "Lorentz-transformation".[8]

2. In 1905 appeared also the paper of A.Einstein 'Zur Elektrodynamik bewegter Körper'.[9] In this paper which in the following will be analyzed Einstein formally took over the 'Principle of Relativity' of Henri Poincare[10] and the

principle of the constancy of the velocity of light contained already in the papers of Lorentz and promised to start in his considerations and deductions from the three axioms: 1) the principle of relativity (p.891), according to which a basic physical law in all Gallileian systems of reference has the same analytical form, 2) the principle of the constancy of the velocity of light in vacuo (p.892), according to which the velocity of light coming from a source of light has in all Galileian systems of reference the same constant value i.e., it is independent on the relative velocity of such systems, or what is the same on state of motion of the source of light, 3) the linearity of transformation connecting any two Galileian systems of reference (p.898/899). In the § 3 the theory of coordinate- and time transformation connecting any two Galileian systems of reference is given. In the following this theory, in which the three above axions are applied will be analyzed. Starting from his method of synchronization of clocks, the first of which being situated in the origin and the other in the point x' of the moving system k, and supposing that measured from the system K 'at rest' the velocity of light will be V - v and V + v, according to the case where the light-ray travels from the origin of K to the point x' or inversely, being reflected in x', he obtains the partial differential equation

$$\frac{\partial \tau}{x'} + \frac{v}{V^2 - v^2} \frac{\partial \tau}{\partial t} = 0 \qquad (1)$$

τ being the time and ξ, η, ζ the coordinates of the 'moving system k; t the time and x, y, z the coördinates of the system k 'at rest', v the relative velocity between these two systems of reference, V the velocity of light in vacuo and $x' = x - vt$ (2)

As a necessary consequence of the method of syncronization, (1) represents the basis of Einstein's theory of coordinate - and time - transformation in the § 3 of his paper which will be now critically discussed. Taking into account the axiom of linearity of transformation (p.898/899) connecting the coordinates and times of the systems K and k, from (1) it follows as the integral of it

$$\tau = a \left(t - \frac{v}{V^2 - v^2} x'\right) \qquad (1^*)$$

a being an unknown function $f(v)$.

On the p.898 below, Einstein points out that the principle of the constancy of the velocity of light will be applied, assuming that measured from the system K 'at rest' the velocity of light relative to the origin of k is V - v and V + v, according to the case where the light-ray travels from the origin of k along the X-axis to the point x' or inversely, being reflected in x'. In fact this supposition means that he supposes the validity of the theorem of addition of velocities of Classical Mechanics $\dot{\xi} = \dot{x} - v$, which is a direct consequence of the classical Galilei-Newton-transformation $\xi = x - vt$, $\tau = t$ based on the hypothesis of the existence of the absolute time of Newton! Thus Einstein, in his deduction of the coordinate - and time-transformation given in the § 3 of his paper supposes implicitly the classical Galilei-Newton transformation Einstein's assumption, that measured from the system K 'at rest', the velocity of light relative to the origin of the system k is V - v and V + v, means that the velocity of light would be dependent of the relative velocity v of Galileian systems of reference what obviously contradicts to the formulation of this principle given by Einstein on the p.892 above, in accordance to which the velocity od light must be independent on the relative velocity of such systems having in any Galileian system of reference the same constant value V, concretely in the system K and k : $\dot{x} = \dot{\xi} = V$ respectively. The last relation

$\dot{x} = \dot{\xi} = V$, expressing analytically the axiom of the constancy of the velocity of light in vacuo, is not compatible with the theorem of addition of velocities of Classical Mechanics, i.e., with the classical Galilei-Newton transformation, since substituting $x = V$ in $\dot{\xi} = \dot{x} = v$ we get $\dot{\xi} = V - v$ and not the relation $\dot{x} = \dot{\xi} = V$, expressing analytically this principle. Thus we have discovered a contradiction in Einstein's deduction given in the § 3 of his paper. In the following we shall show that Einstein has made an error in calculation and we shall discuss the result obtained by means of such an error. On the p.899 he supposes that in the origin of k for $\tau = 0$ it will be $t = 0$. Then in k, for a light-ray moving in k along the ξ - axis with the velocity V, one gets

$$\xi = V\tau \, , \tag{2*}$$

or respecting (1*)

$$\xi = aV \left(t - \frac{v}{V^2 - v^2} x'\right) \tag{2**}$$

Einstein says further: As measured from the system K "at rest" the light-ray is moving relative to the origin of k with the velocity V - v, such that the relation

$$\frac{x'}{V - v} = t \tag{3}$$

is valid. Then he continues: Substituting this value of t in the equation (2**) for ξ it follows

$$\xi = a \frac{V^2}{V^2 - v^2} x' \, , \tag{4}$$

By consideration of the light-rays moving along the other axis we find in analogous way $\eta = V\tau = aV \left(t - \frac{v}{V^2 - v^2} x'\right)$,

where $\dfrac{y}{\sqrt{V^2 - v^2}} = t \, , \quad x' = 0$

i.e., $$\eta = a \frac{V}{V^2 - v^2} y \, , \quad \zeta = a \frac{V}{V^2 - v^2} z \tag{5}$$

Finally says Einstein: Substituting the value of x' ≪ (in accordance to (2) in (2**) and (4)) ≫ we obtain

$$\tau = \varphi(v)\beta(t - \frac{vx}{V^2}), \qquad \xi = \varphi(v)\beta(x - vt),$$

$$\eta = \varphi(v)y, \qquad \zeta = \varphi(v)z, \quad \text{with } \beta = \frac{1}{\sqrt{1 - \frac{v^2}{V^2}}} \ll (6)$$

The last assertion of Einstein, that substituting the value of x' = x - vt in (1*) - (5), there must follow (6) is false, since in reality from (1*) - (6) we get

$$\tau = \varphi(v)\,\frac{t - xv/V^2}{1 - v^2/V^2}; \qquad \xi = \varphi(v)\,\frac{x - vt}{1 - v^2/V^2};$$

$$\eta = \varphi(v)\,\frac{y}{\sqrt{1 - v^2/V^2}}; \qquad \zeta = \varphi(v)\,\frac{z}{\sqrt{1 - v^2/V^2}} \qquad (7)$$

which represents a transformation absolutely different from the transformation (6). As we see Einstein made an error in his calculation! Knowing in advance the form of Lorentz-transformation he came to the false conclusion that from the above mentioned expressions given on the pages 899 and 900 there must follow the Lorentz transformation.

In order to determine in (6) the unknown function $\varphi(v)$ Einstein introduces a third system of reference K' with coordinates x', y', z', t', being relative to the system k with coordinates ξ, η, ζ, τ in parallel translation, such that its origin moves along the ξ - axis with the velocity -v, and assumes that the length of a definite rod, which is orthogonal to the X-axis, does not depend on the direction and the sense of relative velocity of the system of reference. Thus he obtains the relations $\varphi(v)\varphi(-v) = 1$ and $\varphi(v) = \varphi(-v)$ and finally $\varphi(v)=1$. For $\varphi(v) = 1$ the transformation (7) which really follows from Einstein's expressions given on the pages 899 and 900 of his paper, represents obviously the Palacios-transformation, which is a very surprizing result,[11] whereas the falsely 'deduced' transformation (6), is for $\varphi(V) = 1$ identical with the Lorentz-transformation.

$$\xi = \frac{x - vt}{\sqrt{1 - \frac{v^2}{V^2}}} \qquad \eta = y \qquad \zeta = z$$

$$\tau = \frac{t - \frac{vx}{V^2}}{\sqrt{1 - \frac{v^2}{V^2}}} \tag{8}$$

Taking into account the fact pointed out above that Einstein in his deduction of transformation connecting k and K supposed implicitely the validity of the classical Galilei-Newton - transformation, we come to the result that he really wanted to deduce the Lorentz-transformation (8) by means of the Galilei-transformation! On the other hand taking into account the very known theorem of mathematical logic that from a contradictory set of propositions any proposition i.e., also a true proposition can be deduced[12], one must not wonder if from the Einstein's set propositions (taken by him explicitely and implicitely in the analyzed paper) for which we have proved that it is contradictory, one can deduce also the Lorentz-transformation.[13] The question, how is it possible that the contemporaries of Einstein did not seen the contradictions and errors in the discussed paper of Einstein[14] cited after its publication in the Annalen der Physik' inumerable times in the physical literature, is not only a problem of the history of science but above all a psychological and moral problem, which will be not treated here.

3. In connection with the analysis of Einstein's paper 'Zur Elektrodynamik bewegter Korper' it must be pointed out that to suppose the validity of the principle of relativity, as formulated by Poincare or Einstein means:
1) to suppose the existence of Galileian systems of refe-

rence and 2) to suppose the existence of the basic physical laws in nature. Consequently if one supposes explicitely the principle of relativity in the sense of the theory of invariants as a fundamental axiom of his theory, then he must start from a definite basic physical law, concretely in the case of an electrodynamical foundation, from the Maxwell's equations of the electromagnetic field[15,16]. From the axiomatic standpoint it must be established that Einstein was inconsequent, since he did not start in his considerations given in his mentioned paper from such a law as demanded by his formulation of the principle of relativity. In fact in his 'deduction' of Lorentz-transformation he did not apply this principle nowhere. What Einstein did is that he has correctly shown that the expression $x^2 + y^2 + z^2 = V^2t^2$, as well as the Maxwell's equations of the electromagnetic field are invariant with respect to the Lorentz-transformation (p.901), which as we have seen, he has falsely deduced or exactly speaking not deduced. The supposition of the existence of the absolute time of Newton is in contradiction with the Lorentz-transformation, which Einstein formally takes as basis for the theory of the Doppler-effect and aberration of light. Our exact analysis of the basic propositions in Einstein's 1905 paper shows that the theory of Einstein, as given in his paper 'Zur Elektrodynamik bewegter Körper' is not consistent. The general assertion in the physical literature that Einstein has deduced the Lorentz-transformation from the principle of relativity, the principle of the constancy of the velocity of light in vacuo and the linearity of transformation connecting the coordinates and times of any two Galileian systems of reference, and also that he had founded the special theory of relativity is historically false. Neither Lorentz nor Poincare and Einstein had given a deduction of the Lorentz-transformation as it is generally asserted in the physical literature. The axiom called by Einstein 'principle of the constancy of the velocity of light' which in fact in the mentioned paper had been falsely interpreted by him, is in contradiction with the correct interpretation and formulation of this principle expressed by the relation $\dot{x} = \dot{\xi} = V$, since he assumes for the velocity of light V - v and V - v, in accordance with the addition-law of velocities of Classical Mechanics. What Einstein in his mentioned paper has really contributed to the special theory of relativity is that he has correctly deduced by means of the expressions for Lorentz-transformation (which he had not deduced!): a) the expressions for the addition-law of velocities, b) the expressions for the Doppler-effect and Aberration of light, c) that the Maxwell's equations of the electromagnetic field are invariant with respect to the Lorentz-transformation.[8]

4. Our analysis shows that Einstein in his 1905 paper on relativity did not succeeded to deliberate completely his consciousness from the old notions of the Classical Physics, since he could not think exactly within the new category of notions necessary for comprehension and investigation of the new hierarchy of structures of the physical reality the existence of which he surely feeled. Objectively considered, the mentioned Einstein's paper is more a testimony of an intellectual fight in the conquest of the new unknown structures of the precisely analysable and mathematically describable physical reality showing and affirming the historical fact that great creative thinkers can make errors and failures. In order to reach the 'inner' i.e., logical perfection of the theory of special relativity it was necessary still a long way of investigations of other research workers.

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К ИСТОРИИ СПЕЦИАЛЬНОЙ ТЕОРИИ ОТНОСИТЕЛЬНОСТИ

1. В истории создания специальной теории относительности (СТО) совершенно недостаточно освещен начальный период формирования ее исходных идей. Только в 1954 году Э. Уиттекер [1], обратив внимание на решающее значение работ Пуанкаре 1901–1904 годов, в которых принцип относительности формулировался как строгий и универсальный закон природы, выступил против широко распространенной недооценки начального периода в истории создания теории относительности. Возникшая в связи с этим дискуссия [2–6] лишь подтвердила необходимость дальнейшего анализа истории формирования идей СТО, которую не следует путать с историей признания этих идей научной общественностью.

Конечно, публикация совершенно новой, радикальной идеи имеет решающее значение для всего дальнейшего развития теории. Сам факт ознакомления широкой общественности с публикацией, содержащей ключ к разгадке некоторой проблемы, не может не оказать явного или неявного влияния на ход поисков отдельных выдающихся ученых, занятых решением той же проблемы. Но та же первая публикация исходной идеи теории может совершенно не повлиять на последующий процесс признания новой теории.

Исходные идеи СТО на самом деле были выдвинуты А. Пуанкаре еще раньше и в более полном виде, чем это отмечено в книге Э. Уиттекера. Идея о строгой независимости оптических явлений от абсолютного движения была высказана им в работе 1895 года [7], посвященной развитию идей Лармора. А в 1898 году в статье "Измерение времени", формулируя постулат постоянства скорости света, Пуанкаре делает важнейший вывод об отсутствии абсолютного времени и одновременности [8]. Эти фундаментальные идеи Пуанкаре отстаивал и в последующих своих работах. Особенно важную роль в их распространении, безусловно, сыграли курс лекций, прочитанный в Сорбонне в 1899 году [9], и получившая широкую известность книга "Наука и гипотеза" [10].