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The Connection of Physical Fields with Material Media: The Nature and Origins of Dark Matter And Dark Energy

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Abstract— Investigation of the mathematical physics equations, which describe material media such as thermodynamic, gas-dynamic and cosmic and other media, shows that they possess hidden invariant properties. Such properties correspond to that of field theory equations, which describe physical fields. This discloses a mechanism of physical fields generation by material media. Such specific properties of mathematical physics equations are connected with conservation laws. They are described by skew-symmetric differential forms which properties correspond to conservation laws.

Keywords—conservation laws; evolutionary relation; the physical structures; unobservable quantity

1. Introduction

It is well known that the mathematical physics equations, which describe material media, are composed of the equations of conservation laws for energy, momentum, angular momentum, and mass, which are conservation laws for material media. The field theory equations such as the Einstein, Maxwell, Schrödinger and other ones, which describe physical fields, are also based on the properties of conservation laws. However the conservation laws for physical fields are conservation laws that claim a presence of conservative quantities or objects (structures). That is, they are another conservation laws. They are described by closed exterior skew-symmetric forms.

The mathematical physics equations for material media possess a certain peculiarity. From the mathematical physics equations it follows the evolutionary relation from which are obtained closed exterior forms that describe conservation laws for physical fields. This points to a connection of physical fields with material media. Such a connection is realized discretely in evolutionary process which is described by evolutionary relation. The evolutionary relation discloses a mechanism of the emergence of physical structures that made up physical fields and an advent of a dark energy and a dark matter.
Such results were obtained with the help of skew-symmetric differential forms that describe the properties of conservation laws.

2. Specific properties of conservation laws

A. *Conservation laws for physical fields: closed inexact exterior forms*

The conservation laws for physical fields are conservation laws that state the presence of conservative quantities or objects (structures). They are described by closed exterior skew-symmetric forms.
The exterior skew-symmetric differential form of degree p (p-form) can be written as [1, 2]

$$\theta^p = \sum a_{i_1 \cdots i_p} dx^{i_1} \wedge dx^{i_2} \wedge \ldots \wedge dx^{i_p} \qquad 0 \le p \le n \tag{1}$$

Where,

$$dx^i \wedge dx^i = 0$$

$$dx^i \wedge dx^i = -dx^j \wedge dx^i, \;\; i \neq j$$

The differential of the exterior form is

$$d\theta^p = \sum da_{i_1 \cdots i_p} dx^{i_1} \wedge dx^{i_2} \wedge \ldots \wedge dx^{i_p}$$

(2)
(Here the differential of the basis is equal to zero since the manifold is integrable)

The closed exterior form obeys the condition $d\theta^p = 0$, in other words, this form is a conservative quantity**.** ***It can correspond to a conservation law***.

The closed inexact exterior form (closed on a pseudo-structure only) obeys the conditions $d\theta_\pi^p = 0$, $d^*\theta_\pi^p = 0$, in other words, this form is conservative object – pseudo-structure with conserved quantity. ***It can also correspond to the conservation law.*** (Here $*\theta_\pi^p$ is a dual form that describe a pseudo-structure π.)

Conservation laws for physical fields (conservative quantities or objects) **are such conservation laws.** **(**The Noeter theorem is an example.)

B. Conservation laws for material media. Evolutionary relation

Conservation laws for material media is conservation laws for energy, linear momentum, angular momentum, and mass. The conservation laws for material media turn out to be non-commutative.
This follows from the analyses of the mathematical physic equations that are composed of the equations of conservation laws for energy, linear momentum, angular momentum, and mass.

It should be noted a feature of present investigation: *the conservation law equations are transformed into equations expressed in the terms of* **state functional**. (Since the physical quantities of material media, such as temperature, energy, pressure, density, relates to a single material medium, a certain connection between them should exist. Such a connection is described by state functional.) The functionals such as **wave function, entropy, the action functional, the Pointing's vector, the Einstein tensor** and so on, which are the field-theory functionals, are also functionals of the equations describing material media.

Commonly the mathematical physics equations are written in the inertial frame of reference (the Euler frame of reference is an example of such a frame). In the present case, in addition to the inertial frame of reference it will be used the accompanying frame of reference that is connected with the manifold made up by the trajectories of material system elements (the Lagrange frame of reference is an example of such a frame). In the accompanying frame of reference the equation of energy and the equation for linear momentum may be written in the form [2]

$$\frac{\partial\psi}{\partial\xi^1} = A_1 \qquad (3)$$

$$\frac{\partial\psi}{\partial\xi^v} = A_v, \;\; v = 2, \ldots. \qquad (4)$$

Here ψ is the state functional, A_1 and A_v are the quantities that depends on specific features of material medium and accordingly on energy actions and force actions onto the material medium, ξ^1 and ξ^v are the coordinates along the trajectory and in the direction normal to the trajectory. Since equations (3) and (4) are expressions for derivatives along different directions, they can be convoluted into the relation

$$\omega = A_\mu d\xi^\mu \qquad (5)$$

Relation (5) can be rewritten as

$$d\psi = \omega \qquad (6)$$

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Here $\omega = A_\mu d\xi^\mu$ is the skew-symmetric differential form of the first degree. (A summing over repeated indices is carried out.)

Since the conservation laws equations are evolutionary ones, the relations obtained are also evolutionary relations, and the skew-symmetric forms ω are evolutionary ones. (The first principle of thermodynamic is an example of evolutionary relation.)

Evolutionary relation (6) has been obtained from the equations of conservation law for energy and momentum. In studying a consistence of equations for energy, linear momentum, angular momentum and mass the evolutionary relation will be written as

$$d\psi = \omega \qquad (7)$$

here ω^p is the form degree p (p takes the values $p = 0,1,2,3$). [A concrete form of relation (7) is presented in papers [1, 2]. In the paper [2], relation (7) for $p = 2$ was considered for electromagnetic field. In this case the functional ψ is the Pointing' vector. The relation for the Einstein tensor is obtained when integrating the evolutionary relation for $p = 3$.]

The evolutionary relation obtained $d\psi = \omega^p$ possesses nontraditional peculiarities that disclose implicit properties of the mathematical physics equations corresponded to field theory equations.

The evolutionary relation appears to be nonidentical. The skew-symmetric form, which is on the right-hand side, is not a closed form (its differential is not equal to zero) and cannot be a differential like the left-hand side. This relates to the fact that the evolutionary form, as opposed to exterior form, is defined on non integrable manifold. This form is defined on accompanying manifold, which is a deforming non integrable manifold. The evolutionary form differential, in contrast to exterior form differential (see (2)), will contain an additional term which relates to differentiating the basis and is nonzero. The evolutionary form differential cannot be equal to zero. For this reason the evolutionary form cannot be closed and be a differential [2].

The non-identity of evolutionary relation point to the fact that the conservation law equations appear to be inconsistent. And this means that the conservation laws turn out to be non-commutative. Non commutatively, as will be shown later, regulates evolutionary processes and emergence physical structures, forming physical fields.

3. Peculiarities of evolutionary processes in material media

As it is well known, the equations of mathematical physics for material media describe a motion of material medium and changes of its physical quantities such as temperature (or energy), pressure and density. However, it turns out that the mathematical physics equations possess properties that allow a description of evolutionary processes in material media and an emergence of various structures. Such properties follows from evolutionary relation and are caused by inconsistence of conservation law equations and non-commutativity of conservation laws.

C. Non equilibrium state of material media and the transition to locally equilibrium state

Material media undergo various external (with respect to local domains) actions such as energetic, force, **quantities** (pressure, density, temperature) **of material medium itself** since they are non-potential and do not correspond to the nature of material medium. They are **accumulated** in material molecular and others.

These actions **cannot** ***(due to non commutativity)*** **directly convert** into the media as **immeasurable (inobservable) quantity**. ***Such an immeasurable quantity, which is described by the commutator of evolutionary*** **form,** acts in material medium as ***internal force*** responsible for nonequilibrium processes. This is described by the evolutionary relation.

The evolutionary relation contains a differential of functional $d\psi$ that specifies a state of material medium. Availability of the differential of functional $d\psi$ means that there exists a state function, and this point out to equilibrium state of material medium. But since evolutionary relation turns out to be non-identical, from that it is impossible to obtain the differential. **This means that a material medium is in non-equilibrium (**under the action of internal forces**) state.** However, as follows from evolutionary relation, the material medium can go into a local equilibrium state.

Under degenerate transformation that does not conserve differential (due to degrees of freedom of material medium) from the evolutionary form ω^p (whose differential is not zero) **the closed inexact exterior form** ω_π^p (whose differential is zero) and corresponding **the closed dual form** $*\,\omega_\pi^p$, describing pseudo structure**, are realized.** It means that on a pseudo-structure from non-identical evolutionary relation $d\psi = \omega^p$ it follows the relation $d_\pi\psi = \omega_\pi^p$ which occurs to be an identical one, since the closed form ω_π^p is a differential. From identical relation one can define the differential of the state functional $d_\pi\psi$, and this points out to a presence of the state function and the transition of material medium from non-equilibrium state into locally equilibrium one (only on pseudo-structure).

D. Emergence of observed formations: waves, vortices, fluctuations and so on. The dark energy and dark matter

The transition of the material medium from non-equilibrium state to locally equilibrium state means that unmeasured quantity, which is described by the commutator of the evolutionary form and act as internal force, converts into a measured quantity of material medium. This reveals in emergence of some observed formations in material medium. Waves, vortices, fluctuations, turbulent pulsations and so on are examples of such formations.

However, since this proceeds only locally only a part of unobservable and immeasurable quantities converts into measurable quantities (observable formations and physical structures, as will be shown) and a remainder part of unobservable and immeasurable quantities is kept in material medium. ***The dark energy*** and ***dark matter*** form ***such immeasurable*** and ***unobservable quantities.***

E. Emergence of physical structures

Transition of the material medium to the locally-equilibrium state and an emergence of observable formations is related with the realization of **dual form** and **closed inexact exterior form.** The closed inexact exterior form (which is a conservative quantity since its differential equals to zero) and relevant dual form (the pseudo-structure which is a metric form of manifold) made up a differential-geometrical structure that describes a physical structure, namely, a pseudo-structure with conservative quantity. **The structures that made up physical fields are such structures.** And this follows from conservation laws.

As it has been shown, the conservation laws for physical fields are conservation laws that state the presence of conservative quantities or objects (structures). The physical structures, i.e. pseudo-structures with conserving quantity, are conserving objects. This is, they subject to conservation laws for physical fields. It can be shown that **the solutions of the field theory equations** are **closed external forms** that describe conservation laws for physical fields – availability of conservative objects.

Massless particles, wave fronts, and so on are examples of physical structures. Physical structures and observed formations are not identical objects. Whereas the wave is an observable formation, the physical structure forms the wave fronts. And at the same time they are a manifestation of the same (photon) and as a wave.

Thus one can see that in evolutionary processes proceeded in material media the physical structures that made up physical fields arise. This points out to the fact that physical fields are generated by material media.

4. Conclusion

It was shown that material media generate physical structures from which physical fields are made up. This points to a connection of physical fields with material media.

As it has been shown, the evolutionary processes proceeded in material media discloses a mechanism the advent of a dark energy and a dark matter.

Here it should be noted that the field theory equations cannot describe a dark matter and a dark energy as well as an advent of physical structures since they doesn't possess evolutionary properties. For example, the Einstein equation, which contains only covariant tensors, cannot describe the evolutionary processes and the emergence of physical structures and pseudo-manifolds. The Einstein equation can describe only observable measurable cosmic matter and relevant space-time. But, the dark matter does not accounted by the Einstein equation.

5. References

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