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TRUTH EPISTEME IN CONTINUOUS MEDIUMS DYNAMICS

ABSTRACT

The disapearance divergence fundamental causal and affectal principle of "action – rate of change" factors ratio is framed as the accomplishment of entity result of the fundamental laws of continuous medium mechanics. The integral and differential forms of records of the laws in conditions of the truth of the hypothesis for the local thermodynamic quasi-equilibrium on space-time scale of the physical point are given.

KEY WORDS

Continuous medium, action, rate of change, physical substances, principle, null divergence, functional, fundamental laws, mechanics, mathematical formalism, integral, differential forms.

1. INTRODUCTION

The imperative of the accepted in theory [1] (assumed as known including nomenclatures mentioned in it) comprehensive approach to the formation of the physic-mathematical models of the continuous mediums dynamics which exist in different aggregative states caused need for qualitative generalization of the classic Hamilton's principle of *least action*. This energy principle is normally used in the theory of rigid and deformable bodies and is necessary but insufficient for more veracious description of space-time $(\vec{x}, t) \ni 3D_t$ cause-effect *relations* (in epistemological meaning) between *actions* of definitive intrinsic or artefactual nature, and the *results* of those actions appearing at different forms of continuous mediums motions.

2. MAIN TEXT

Staying within frameworks [1-3] for physical models of continuous mediums (symmetrical dynamics, fixed mass etc.),which, however, do not exclude their desirable or necessary extensions, let us define the *divergences* $\mathcal{D}_k$ in respect some combination of *k action* factors $\mathcal{A}_k$ (for a fixed-mass particle δm) separated from continuous mediums of spatially distributed at a time external energy-mechanical fields with logical connections of *rates of change* $\mathcal{R}_k$ of physical substances of the said particle corresponding to indicated perturbations

$$\mathcal{A}_k \setminus \mathcal{R}_k \sim \mathcal{D}_k,\ k = 1,2,\ldots \tag{1}$$

In relations (1) the symbols \, ~ are set-theoretic difference and equivalence with their possible "drift" at the level of the limitations admitted in [1].

Further on, on grounds of statement specified in the stage part of the work [1] regarding a physical point as marginally small space-time material formation for which a hypothesis for local thermodynamic quasi-equilibrium [4] is still satisfied, let us embed virtual representation about "physical" null $0_.$ and eternity $\infty_\bullet = 0_\bullet^{-1}$ in concepts of differentials and derivatives. They differ fundamentally from corresponding abstract and strict mathematical definitions of those limits.

Let us introduce functional

$$\Phi(\mathcal{D}_k) = \int_{t_1}^{t_2} \sum_k |\mathcal{D}_k|\, dt_\bullet, t_2 \geq t_1; 0_\bullet \leq t_1 \wedge t_2 \wedge [t_1, t_2] < \infty_\bullet \tag{2}$$

and represent the following *principle of disapearance divergence* of "action – rate of change" relations:

Of all hypothetically possible in dynamics energy-mechanical conditions of continuous mediums the condition is realized wherein at any interval $[t_1, t_2] \in [0_\bullet, \infty_\bullet]$ **the functional (2) is equal to "physical" null.**

Therefore,

$$\mathcal{A}_k \setminus \mathcal{R}_k \sim 0_\bullet. \tag{3}$$

The *disprovable* fundamental laws of mechanics (I. Newton, J. Lagrange, L. Euler, A. Einstein…) and laws established by secular sciences of the universe (at least in $3D_t$ space of present existence of terrestrial civilization) meet the conditions (3). According to these laws at *measures* of volume $d\mathrm{v}$ surface areas δs separated from the continuum of media particles known to *exceed* virtual space-time *scales* $d\mathrm{v}_\bullet \wedge ds_\bullet$ of physical points for fundamental substances of matter – field (see e.g., [5]): mass, energy, quantity of motion and its' moment (so as in (1) – (3) $k = \overline{1,4}$) the following balance equations in the dynamics and their invariance/ change are valid

$$\mathcal{A}_1 \setminus \mathcal{R}_1 \sim \frac{d}{dt_\bullet} \int_{\delta \mathrm{v}} \rho\, d\mathrm{v}_\bullet = 0_\bullet; \tag{4}$$

$$\mathcal{A}_2 \setminus \mathcal{R}_2 \sim \frac{d}{dt_{\bullet}} \int_{\delta v} \rho E dv_{\bullet} = \int_{\delta v} \rho \vec{F} \cdot \vec{v} dv_{\bullet} + \int_{\delta s} \vec{p}_n \cdot \vec{v} ds_{\bullet} + \int_{\delta v} \rho q dv_{\bullet}; \quad (5)$$

$$\mathcal{A}_3 \setminus \mathcal{R}_3 \sim \frac{d}{dt_{\bullet}} \int_{\delta v} \rho \vec{v} dv_{\bullet} = \int_{\delta v} \rho \vec{F} dv_{\bullet} + \int_{\delta s} \vec{p}_n ds_{\bullet}; \quad (6)$$

$$\mathcal{A}_4 \setminus \mathcal{R}_4 \sim \frac{d}{dt_{\bullet}} \int_{\delta v} \vec{x} \times \rho \vec{v} dv_{\bullet} = \int_{\delta v} \vec{x} \times \rho \vec{F} dv_{\bullet} + \int_{\delta s} \vec{x} \times \vec{p}_n ds_{\bullet}. \quad (7)$$

Where $E = \varepsilon + v^2/2$ is integrated specific (referred to unit mass) energy of the media, $\vec{p}_n$ is stress vector to ds with outer unit normal $\vec{n}$, $q = q_{cd} + q_r$ is specific power of heat energy form.

Let us recall that owing to accepted in [1] frame of symmetrical dynamics of continuous mediums the equation (7) reduces to the conclusion of symmetry of stress tensor **P** and further is not included in the general analysis structure.

Henceforth differential form (but in previously mentioned tractability) of mathematical expression of the law (4)-(6) is used. The transaction to such form is implemented in a regular manner i.e.: introduction (on the ground of fixed mass δm) of the operator $d/dt_{\bullet}$ within integral sign, transformation by Ostrogradsky-Gauss theorem of the integrals over ds to the integrals over dv and determination of the scale randomness fact of isolated media parties "on the left" $dv > dv_{.}$. Henceforth the inferior point index in the nomenclatures 0ШГ used by necessity and differentials for simplification of the records is omitted.

Keeping in view mentioned circumstances let us write balance equations of conservation (4-6) in the following form of Lagrange-Euler idea of motion. The law of conservation of mass

$$\frac{d}{dt} \ln \rho = -\vec{\nabla} \cdot \vec{v}, \quad \vec{\nabla} \cdot \vec{v} = \dot{I}_{s.1} = \dot{s}_{ii}, \quad \frac{d}{dt} = \frac{\partial}{\partial t} + (\vec{v} \cdot \vec{\nabla}). \quad (8)$$

Expressions used in [1] follow from (8) including acceptability of sequence permutation of specific in $(\vec{x}, t)$ and only spatial derivation of components of position vector $\vec{x}$ physical point [5]

$$d \ln \rho = -d(\vec{\nabla} \cdot \vec{u}), \; \vec{\nabla} \cdot \vec{u} = I_{s.1} = s_{ii}, \quad \vec{u} = \vec{u}_0 + \int_0^t \vec{v} dt \ni d\vec{u} \parallel \vec{v}; \quad (8а)$$

$$\frac{d^2}{dt^2} \ln \rho = -\vec{\nabla} \cdot \vec{a}, \; \vec{\nabla} \cdot \vec{a} = \ddot{I}_{s.1} = \ddot{s}_{ii}, \; \vec{a} = \frac{d\vec{v}}{dt}. \quad (8б)$$

The law of conservation of energy is the equation of internal energy change ε [5]

$$\rho \frac{d\varepsilon}{dt} = \mathbf{P} \cdot\cdot \dot{\mathrm{S}} + q. \qquad (9)$$

The first term on the right of equation (9) is written in the form of biscalar product of stress tensors and stress velocity tensors. It represents negative power of internal forces in physical point. The addend is associated with amount of specific energy to unit time; it is predominantly thermal and brought to physical point from the outside.

The law of variation of quantity of motion

$$\rho \frac{d\vec{v}}{dt} = \rho \vec{F} + \vec{\nabla} \cdot \mathbf{P}, \qquad (10)$$

where $\vec{F}$ – is known function in $(\vec{x}, t)$, stress tensor $\mathbf{P}$ – is self-adjoint.

3. CONCLUSION

The system of equations (8) – (10) is written in relation to three fundamental substances: density ρ, velocity $\vec{v}$ and internal energy ε, and generates defining collection of links between them. It is apparently nonlinear and not isolated.

Reasonable variation of the closure of this system and matter of principles of its study are set out in works [1-3].

NOMENCLATURE*

$3D_t \sim (\overline{x}, t)$	Space – time;
$\vec{F}$	Vector of mass forces;
$I_{s.1}, \dot{I}_{s.1}, \ddot{I}_{s.1}$	First invariants of strain tensors $\boldsymbol{S}$, strainrate $\dot{\boldsymbol{S}}$ and acceleration $\ddot{\boldsymbol{S}}$ tensors;
$\vec{a}$, $\vec{u}$	Vectors of acceleration, displacement (including deformation);
$s_{ij}, \dot{s}_{ij}, \ddot{s}_{ij}$	Components of tensors $\boldsymbol{S}, \dot{\boldsymbol{S}}, \ddot{\boldsymbol{S}}$;
$q_{cd,} q_r$	Specific power of conductive and radiant energy transfer;
$\vec{x}$	Radius vector;
$\vec{\nabla}$	Hamilton operator;
0	Under symbols – initial meaning;
$\wedge$	Logical symbol “and”.

* The rest marks are generally accepted, or are stipulated in text.

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