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Semi-Analytical Established Factors in Modern Theory of Fluid Mediums Thermomechanics

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For virtual limits of the Knudsen's scales of nearness to wall the interaction of fluid and *smooth* solid phases is selected quasi-pellicle/conservative part of the viscous under-layer. For this part qualitatively formalism of dependence of the fundamental matter-field substances: density, increment of internal energy and component of specific momentum,-is realized as functions from time and distances relatively wall into under-net indicated intervals with entering universal functions of it approximation.

On conceptual level and within the framework of the continuous medium hypothesis is offered procedure of semi-analytical shorting of frequency-wave spectrums of unknown basis substances of medium change: density, increment of internal energy and momentum. This process is realized by means in view of action on indicated variables of intra-net random disturbances from *measured* functions of field, including effects appearance of roughness of the real solid fragments of flow boundaries, on base of Monte Carlo method of mathematical statistics and theory of probabilities. It was distinguished qualitatively bands of spectrum fluctuations action for physically measured random quantities: pressure, temperature, components of a velocity.

Chooses three groups fields of the dissipated perturbations for under-grouse very/extreme right intervals of frequency-wave numbers.

It's concretizes diapasons of activation of the under-grid clusters perturbation of the distinguished and measured thermomechanical functions with their description as following random fields:

- Of defect of the continuous medium hypothesis with estimate interval of spectrums between the lowest and the greatest frequency-wave numbers of physical point;
- Of defect of the accounting completeness of turbulent mini-moles with estimate interval of spectrums between the greatest frequency-wave numbers of turbulent mini-moles which are considered by four-measuring 4D of a rated grouse and it lowest values for physical point;
- Of imitative 4D fluid layer with action, which is much like of the real roughness appearance on solid fragment of the laundries in rated flow field.

The present actions are interpreting by random variables as one-dimensional, founded and continual, including derivatives from its up to second order inclusively.

For good reason of essential deficiency of the experimental values object of the study are regarded mainly at set up plan.

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I. Introduction

Present sufficiently expanded presentation possibly to consider on conceptual level of opinions in the capacity of completion of the series of presentations [1-9]. Its papers forms on total foundations of the modern theory of continuous mediums thermomechanics and which we are assumed as known. Developing further highly non-ordinary paradigm satisfies in the large of these sence, aims and arrangements which are presented in primordial work by this global subject [1] however with their following partial correction and extension, on which author leaves behind yourself the right as was marked in published – forerunner [1].

Subjects of current investigation are half-analytical means of description in functions of action[7] especially specific factors which requires under-net approximation and by the need of additional determination. The term «semi-analytical» in title of this paper instead of the term «semi-empirical», which we exploits, for example, in theory of turbulence, is accepted at consequence of this that deductive further relations which requires, of course, of its own verification and attendant of it experimental redefinition its has nevertheless sufficiently common character and only indirectly are bounded with concrete kind of under consideration domain of a flow.

Under the circumstances of evidently existing deficit of empirical data considered material presents chiefly in contextual statement.

Of special note is that non-formal perception of the present development contents demands of the preliminary and attentive first-hand acquaintance with works [4,8] including accepted in its notations.

Contents of the represented material is the following.

- These parathion and quality mathematical description of the basic substances of a medium ρ, ε, $\vec{\upsilon}$[2] into interior/conservative part of the viscous under-layer, i.e. in limits of the Knudsen's scales of a fluid and *smooth* solid phases of nearness to wall interaction at accompanying by it circumstance condition ξϵ [0^+, ξ_{kn}] for distance from wall [8]. This is particularly important item in aspect of a numerical realizations of proper initial and boundary problems.

Stated in the following result of the formalization will permit in many to avoid purpose of necessary but appearing extremely thick four-dimensional rated net («damnation» of dimensional) for micro- and middle-scale of a computer solution procedures of near-wall interaction with expected sufficiently reliable result of its reproduction.

Recall that indicated part of the viscous under-layer in its own surface of contact S_f directly adjoins on wall S_w (here accepted smooth) and combined attractable electromagnetic field strongly interacts with it from virtual boundary of demarcation S_{wf}/S_{fw}. There foreover system disturbance, i.e. fluctuations from outward flow, appear to be as its hows experimental data, well low with very small, as a rule, amplitude of matter-field function fluctuations.

So far as describe later procedure of a modelling to a considerable extent unification it application demonstrates on the most complex example of vector substance approximation, namely, specific refer to unit mass momentum $\vec{\upsilon}$.

- Recording in the generalized form additional dissipated disturbances of pressure *p*', temperature *T*', components of a velocity $\upsilon'_i(i=\overline{1,3})$, which we are assigned to one-dimensional, bounded and continuous, including derivatives from its at to (x_i, *t*) until of second order inclusively, random fields and admitted at experimental precision measuring at properly modal filtration of proper spectral expansion of the *full* function, *p, T,* υ_i. These disturbances onto own spectral parts of determination enters into terms of action functions of the termomechanics fundamental laws with physical modules /coefficients/parameters depending from *current* and also *total* meaning of the basic substances*ρ, ε* [2].

We mention in passing that condition of the one-dimensional of random variables appears definitely restrictive. In particular, stochastic out comes of the components velocity $\vec{\upsilon}$ pulsations are regarded as independent from each other. It is expedient too call to that used further marks «Λ», «V», «∀» means «and», «or», «any».

Indicated stochastic perturbations occurs on its far right/high-level/under-net meaning of frequency-wave numbers (*FWN*) $\omega_{s.}\wedge æ_{s.j}, j=\overline{1,3}$ (see lower) and are characterized of very small amplitude of oscillations but with inherent of this background *intensification* values of derivatives by arguments (x_i, *t*) in *E-system* of counting. These in many sporadic winkling(at some extent as relic noise) in turn and according to algorithm described in work [4] acts upon distributions of basic substances*ρ, ε,* $\vec{\upsilon}$ in *L-system* of counting.

Given in article [4] mechanism of a back bat continuously *smoothing* transfer of random fluctuations to the left along frequency-wave spectrums (*FWS*) in the direction all more scales is *filter effect* inherent to fluid mediums.

Later on are given off three type in principle differing of random fields.

- *Group* of thermomechanics actions subjects to simulation as stochastic functions on scales of a physical point (PP*),* i.e. in diapason *FWS*

$$[\omega_{s.}\wedge æ_{s.j}]^{PP}_{inf} < (\omega_{s.}\wedge æ_{s.j}) < [\omega_{s.}\wedge æ_{s.j}]^{PP}_{sup} \qquad (1)$$

with appropriate *«laws» of distribution* $\mathfrak{R}_{dhc}$ of continuous random quantities $p' \vee T' \vee \upsilon'_i$ from spectral *FWC* in accordance to (1). Inequalities (1) we can be treated as consequence from hypothesis about *local thermodynamics quasi-equilibrium*(*LTDQE*) with just now marked spectral intervals of discrepancy. We will call of this group under-net perturbations by fields for a compensation of *hypothesis continuous defect* (subscript *dhc*).

Note, that distributions $\mathfrak{R}_{dhc}$, if registration of given aspect in principle is expedient, must to be appeared with certain intensity at every, among them static condition of continuous mediums. Here can to detect mental analogy with appearance of a «relic radiation».

- *Group* representations and too by continuous random distributions of turbulence pulsations also in under-net parts of *FWS* but for intervals

$$[\omega_{s.}\wedge æ_{s.j}]^{trb}_{sup} < (\omega_{s.}\wedge æ_{s.j}) < [\omega_{s.}\wedge æ_{s.j}]^{PP}_{inf} \qquad (2)$$

with *«laws»* $\mathfrak{R}_{dmt}$ of distribution of the quantities $p' \vee T' \vee \upsilon'_i$ from indicated range in the capacity of approximate way to fulfill of loss-of its action in cutted off turbulence minimum moles in moles overlarge-scale[4]. Here under term *turbulent mole* should be realized the limit small material formation, until scale most fine $3D_t$computation net, which is bearer of noted pulsations. First term at (2) defines the right boundary *FWN* of the direct modeling of turbulence. Superscript *trb* is reduction from *Lat. turbulences*.

Present group under-net disturbances it is possible to distinguish as the fields *of compensation defect at description of turbulent moles action*(hence is followed subscript *dmt*).

Next observe, that putting in algorithm of computing programs intervals (1), (2)practically totally, but approximately locks spectrum distribution of the functions of matter and field by strongly disturbed dynamics continuous mediums outside of zones of among phases interaction.

- Group stochastic mimicking of perturbations actions on stream from surface of real solid fragment of boundaries, i.e. with roughness, being investigated various domains motion of a fluid mediums with *«laws»* of $\mathfrak{R}_{asp}$(index from L at. *asperitas* – roughness).

In studies effects of asperity we leave aside problem questions at motion present mediums on hyper- or super- scales of being, in particular, tasks of hydro- and meteorology. Then in overwhelming majority cases, at least, at practical applications solid boundaries have industrial making and its contact surfaces are characterized of technical roughness with varied local drift of form, height of lugs, depth of hollows, its substantively non-predicted of configurations together with concentrations of scattering in date factors on each unit of solid boundary area. Thereby detailed description topology of non-polished roughness appear is extremely complicated and escorts by appearance of known effect of the *fractal uncertainty* at all greater growing small of observation scales (see, for example, [10], p.63-65). According to noted representation about degree regularity of solid boundaries S_w– *real* and its exhaustive description in strict mathematical meaning in point of fact loses its definiteness. In such a situation is lose rational possibility to operate with similar boundary as with analytical 2Dsurface of Liapunov's S_w– *ideal* at simple established normal $\vec{n}$ in every point $\forall \vec{\mathbf{x}} \in S_w$– *ideal* independently from direction of approach at to it.

Presented ascertaining evidences about that in common case possibility *direct* modeling of element asperity exponents and its immediate action on near wall motion of a fluid phase is representation highly problematical, unless to tell unreal. Thus we suppose be in order at least in the immediate prospect to mimic present kind of locations of strongly sharp heterogeneities also by *random* disturbances. These effects are concentrated in its layer as *source* of active show of the roughness factor.

Mentioned perturbations we will consider in the capacity of *addition* to outcome of *smooth-wall* binary interaction of the contact surfaces of solid and fluid phases. Clearly, that spatial mutually adjusted interconnection S_w – *real* ∧ S_w – *ideal,* as well as geometric characteristic properties of a asperity layer requires special determination (see below). It is clear also, that *properly* asperity factors of perturbations can, as rule, to be taken stationaries. However practically always (apparently except for creeping flows) introduces in motion near to wall four-dimensional bifurcations.

Returning now to common characteristic properties of the three indicated groups of random fields we shall underline, that the set of *«laws» distribution* $\mathfrak{R}_{dhc}$, $\mathfrak{R}_{dmt}$, $\mathfrak{R}_{asp}$ by meaning of its introduction are relative to *causative* functions of action [7]. Further, its represents themselves in an explicit from simple, rate fixing and *definitely positive* from established above continual random quantities but with concrete view of these consistencies. Present correspondences *parametrically* depends from current meaning of the basic substances $\rho, \varepsilon, \vec{v},$ as well as from certain specific exponents mainly for group $\mathfrak{R}_{asp}$ (see later).

In further out reason of the presentations compact and if not special indications in common part of description procedures of random outcome identity in *«laws»*$\mathfrak{R}$ lower indexes are omitted and stochastic fields p', T', v_i' are marked as Φ' or in rate fixing recording over φ'.

II. Main Part

We shall become now directly to consideration of each from *two*, outlined into introduction at common context (see identations selected at the left by symbols .,..), of subjects for investigation. One again we will underline that non-formal perception of the contents of the present investigation possible at preliminary and attentive acquaintance with works [4, 8] including accepted in its designations.

- On Fig.1 for *interior* part of a viscous under-layer and at fixed moment of a time is shown one from possible variants epure of a velocity in local orthogonal coordinate system *(LSC)*$\xi_k, k = \overline{1,3}$ with bench-mark $\vec{j}_k$ and ort of a interior normal $\vec{j}_1 \ni (\vec{\xi}_1 = \vec{\xi} = \vec{j}_1 \xi)$ to *smooth-wall* fragment S_w of a boundary S of rated flow in some domain $\overline{V} = V \cup S$. This normal $\vec{j}_1$ restores by two main radiuses of a curvature in some point $\forall \vec{\mathbf{x}} \in S_w$ of a global Cartesians coordinate system. In addition on boundary of phases demarcation we have (see Fig.1)

$$(\xi = 0^-) \in S_w \wedge (\xi = 0) \in S_{fw} \wedge (\xi = 0^+) \in S_f .$$

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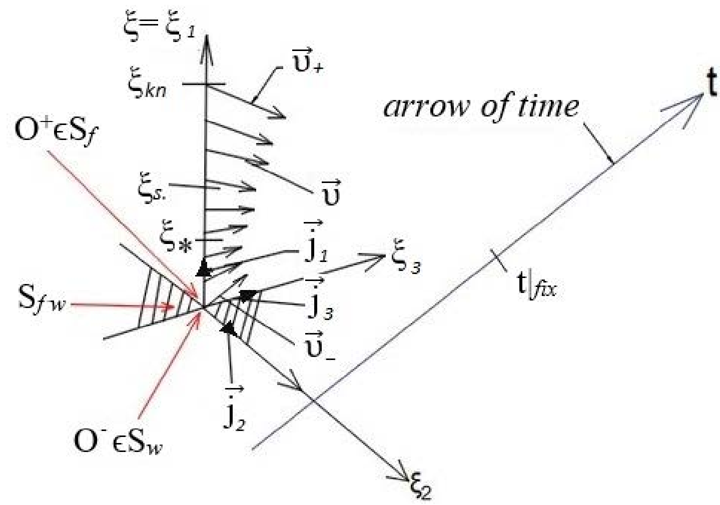

Fig. 1: Possible qualitative form of a velocity $\vec{\upsilon}$ epure in conservative part of a viscous under-layer and in fixed time moment $\boldsymbol{t} = \boldsymbol{t}\Big|_{fix}$

We remained meaning appearing on the Fig.1 and next in text designations (see too [8]): -, + - are velocities on the contact surface $S_{fw} = S_f \cup S_w$ and on upper boundary $_{kn}$ conservative part of viscous under-layer; ξ_{kn}, $\xi_{s.}$,$\xi_*=\zeta\xi_{s.}$, $0 < \zeta < 1$ – are respectively distance from S_{fw} of a long-, middle- and near-action of attractive force field $\vec{F}_a$ from two phases interdependence in immediate proximity to wall. Indicated geometric exponents, among other things, depends from $|\vec{\upsilon}_+|$ and requires its experimental establishment. Evidently, that exponent ξ_{kn} can be accepted as virtual *thickness* of a conservative part of a viscous under-layer. Velocity v- defines from procedure of establishment of the boundary conditions on the wall [8], and velocity v+ sets to iterative scheme of a computation in accordance algorithm stated in work [4].

At present we will approximate dependence of velocity v from time t and coordinate $\xi \in [0^+, \xi_{kn}]$ with beginning of count in some point $x \in S_f$ by following monotonically changing on both quantity and direction to relation

$$\vec{\upsilon}(\bar{\xi},t) = \vec{\imath}(\bar{\xi},t)\left[\upsilon_+(1,t)f_+(\bar{\xi}) + \upsilon_-(0^+,t)f_-(\bar{\xi})\right], \bar{\xi} = \xi/\xi_{kn} \in [0^+,1], \tag{3}$$

where

$$\vec{\imath} = \vec{j}_k i_k, i_k = m(\bar{\xi},t)\left[i_{k+}(1,t)W_{i_+}(\bar{\xi}) + i_{k-}(0^+,t)W_{i-}(\bar{\xi})\right], \tag{3a}$$

$$m = \left[\sum_{k=1}^{3}(i_{k+}W_{i+} + i_{k-}W_{i-})^2\right]^{-\frac{1}{2}}, \vec{\imath}_\pm = \vec{\upsilon}_\pm/\upsilon_\pm, W_{i+} + W_{i-} = 1 \ni |\vec{\imath}| = 1, \tag{3b}$$

$$f_+ = \bar{\xi}W_{f+}(\bar{\xi}), f_- = (1-\bar{\xi})W_{f-}(\bar{\xi}), W_{f+} + W_{f-} = 1. \tag{3c}$$

Here:
$\vec{\imath}, \vec{\imath}_\pm \wedge i_k, i_{k\pm}$ are orts to direction of vectors $\vec{\upsilon}, \vec{\upsilon}_\pm$ and its projections on axes *LSC* with orts $\vec{j}_k$; *m*- multiplier of the norm; $f_\pm$are universal functions only from one argument $\bar{\xi}$; $W_{i+\vee f+}$ are weight coefficients equal 0, 1/2, 1 at $\bar{\xi} = 0, \bar{\xi}_*, 1$ respectively and having non-negative of first derivative and also the point of bend at $\bar{\xi} = \bar{\xi}_*$ [8]. Concrete form presented in relations (3) – (3c) functions from $\bar{\xi}$ among indicated marks as well should be stipulated on base of special experimental investigations with super-resolving thinness of measurements. Cases $(\upsilon_+ \vee \upsilon_-) = 0$ requires attraction of procedure indeterminacy for elimination for instance by Liouville method.

On Fig.2 we represents one from possible modifications of functions $W_{i+\vee f+}, f_\pm$ change. In this connection position of the point $\bar{\xi}_{s.}$ On absciss axis is shown conditionally.

At approximation of scalar functions ρ, ε we are used expressions (3), (3в) with replacing by $\upsilon_\pm$ *on* $\rho_\pm, \varepsilon_\pm$and of first cofactor$\vec{\imath}$in (3) on unit.

At present objectively it is not known how for described model of approximation of the base substances ρ(ξ), ε(ξ), $\vec{\upsilon}(\xi)$, at$\xi \in [0^+, \xi_{kn}]$ is in good agreement with the reality and in what extent essentially influence of reliable distributions of indicated functions in bounds conservative interval of viscous under-layer on evolution exterior macro-motion.

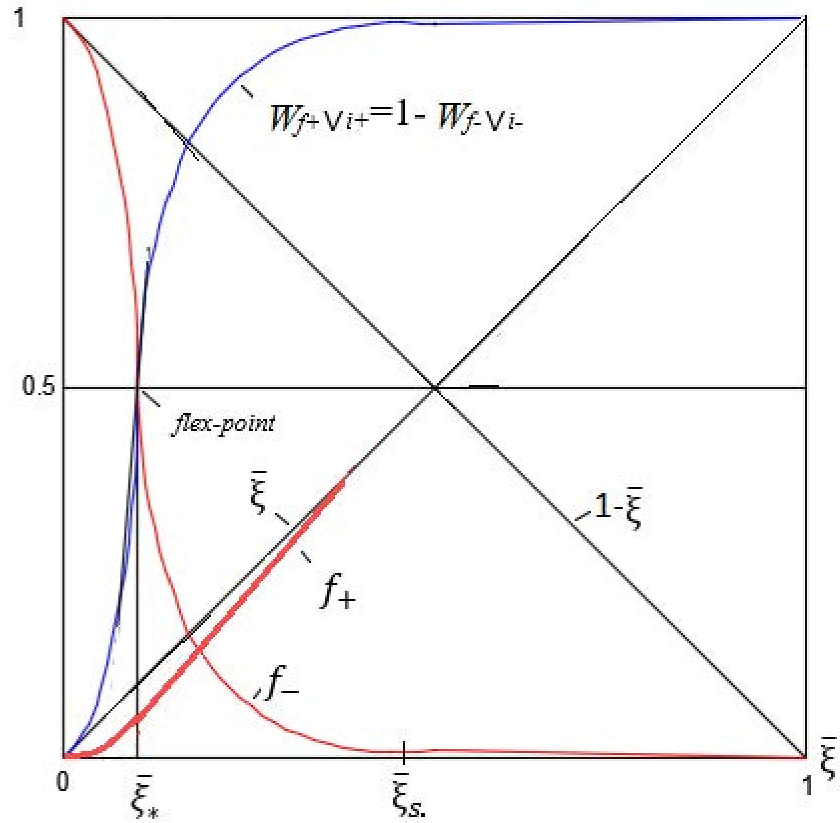

Fig. 2: To be expected typical change of weight $W_\pm$ and universal functions $f_\pm$ in conservative part of a viscous under-layer

•• Passing now to matter of a modeling of stochastic processes for chosen earlier of two first group of continuous, random quantities $\Phi^{'}$ (marked previously common designation) we will be to suppose that densities/ «laws» of its distribution $\Re$ (also common designation) are integral *non-negative* functions from $\Phi^{'}\in[\Phi^{'}_{inf},\Phi^{'}_{sup}]$, monotonically decreasing (as a rule) at to boundaries of the stated physically bounded from the left and on the right range.

At present we will convent attention on next circumstance. It is customary at issue in guidebook by theory of probabilities and mathematical statistic methods of determination and analysis of outcome for different sort of continuous random processes, at given density of distribution for the proper stochastic quantities, operated mainly with moments of its quantities, characteristic and productive functions from moments, semi-invariants, i.e. with definite *integrated* indicators of prognosis of a possible fall of one event or another. However in accordance to aims of the present investigation it is required attraction of the formalism which permits with physical plausible reliability *to reproduce properly* the random perturbation.

As is known such, to a considerable extent effective, acceptance of approximate realization action of phenomena by stochastic character is totality of Monte Carlo methods. We uses one from its modification in which the key link makes perfect computer program of random quantity *generation* distributed *evenly* and *continuously* on closed interval of the own meanings G ∈ [0,1].

We will notice that interval [0,1]by of the simple linear operator can be transformed in the diapason $[-1,1]$.

Further we accepts not principal condition

$$(sgn\Phi^{'}_{inf} = -sgn\Phi^{'}_{sup}) \wedge \quad |\Phi^{''}_{inf}| = \Phi^{'}_{sup},$$

which is fulfilled in much applications. Now we makes use to non-dimensional recording of a random quantity

$$\varphi' = \Phi^{'}/\Phi^{'}_{sup}, \; \varphi' \in [-1,1],$$

where parameter $\Phi^{'}_{sup}$ establishes from physical concepts with attraction of directs or indirect (at forced cases) experimental data for each concrete object of study.

Then for *current integral* function of distribution $\Psi(\varphi')$ with norm || Ψ||=1 we obtain

$$\Psi(\varphi^{'}) = \int_{-1}^{\varphi^{'}} \Re(\varphi^{'})d\varphi^{'}, \Re(\varphi^{'}) = r(\varphi^{'})/\int_{-1}^{1} r(\varphi^{'})\,d\varphi^{'},$$

where $(\varphi^{'})$ is a prescribed under-integral and in common case non-norm density of a random value depending from $\varphi^{'}$ distribution with indicated earlier properties. Function (φ') generates a distribution «law» $\Re(\varphi')$

In each moment of time number G supposes equal of a instantaneous value of the function Ψ so that

$$\int_{-1}^{\varphi'} \Re(\varphi')d\varphi' = \text{G}. \qquad (4)$$

If in accordance to (4) to take in the capacity of a *direct* transformation quantity φ', *monotonically* varying on opened to the right interval $[-1,\varphi'[$, in current value of the function Ψ action of the operator

$$\mathcal{L}[\cup] = \int_{-1}^{\cup} \Re(\cup)\, d\cup \ \ni \mathcal{L}[\varphi'] = \Psi, \qquad (5)$$

than inverse transformation is possible symbolically to write in the form

$$\varphi' = \mathcal{L}^{-1}[\Psi] \ni \varphi'|_t \longleftrightarrow \Psi|_t = \text{G}\,. \qquad (6)$$

On Fig.3 obviously demonstrates of stated transformations. One-to-one correspondence of the presented operations is supported, as marked, by *definitely increasing* relationship $\Psi(\varphi')$ at any φ' from range $-1 \le \varphi' \le 1$.

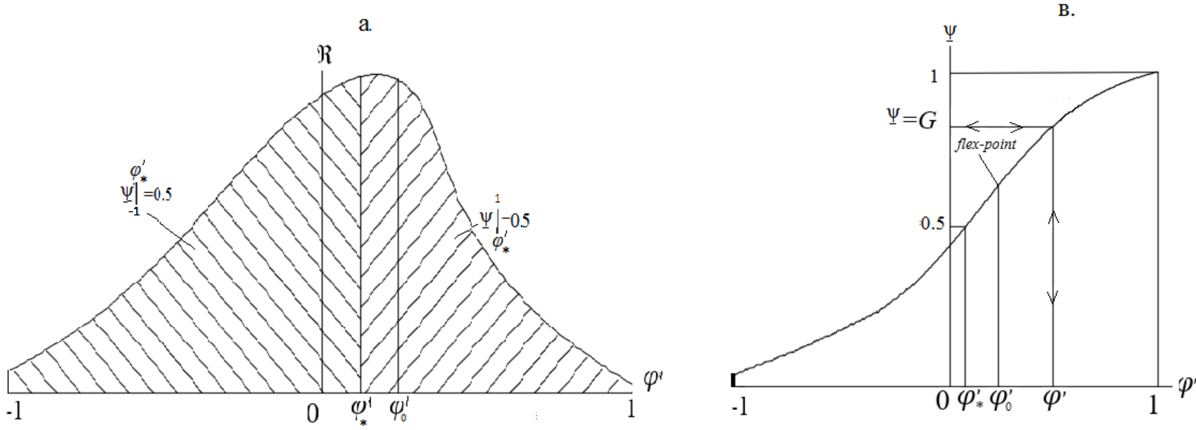

Fig. 3: Illustration of one-to-one correspondence for integral function of distribution Ψ from random quantity φ`. Here: a – variant of "law" $\Re(\varphi$`); в– proper graph of a relation $\psi(\varphi$`)

In cases of appropriateness use some kind of classical distribution "law" $\Re_c$ from its general totality with possible one or two infinite limits of integration, so that $\varphi'_c \in [0,\infty[\ \vee\ ]-\infty,\infty]$, transition from φ'_c at to φ' is realized expression

$$\varphi' = (\varphi'_c - 1)(1+\varphi'^2)^{-1/2} \ \vee\ \varphi'_c(1+\varphi'^2_c)^{-1/2}$$

respectively.

We should remind about agreement of concluding indentation of the introductory division by present investigation according which under φ' and $\Re$ it should be read next variants their concrete purpose

$$\varphi' = \rho' \vee \varepsilon' \vee v'_i (i = \overline{1,3}), \qquad \Re = \Re_{dhc} \vee \Re_{dmt}\,.$$

Establishment define or even if suggested kinds of distribution density be represented labour-intensive theoretical and experimental task with far non-simple complex scientific, among them empirical, findings in difficult of access ranges of *FWS* (1), (2). It is required large-scale and multiparametric statement and reliable physical fixation $3D_t$ change under consideration here functions for limits high value *FWN* in its spectrums moreover separately marked is important for supercritical regimes motion of a fluid mediums. Correct processing required and, most likely, colossal volume of a further (besides existing) experimental information by modern effective methods of mathematical statistics will be enable bring in, within certain limits, clarity in problems of distribution "law"$\Re_{dhc}$, $\Re_{dmt}$ of forming at accompanying the most problem estimate of the $\Phi'_{sup} \wedge \Phi'_{inf}$ meaning.

In addition to that with respect to its two groups of the random fields can be a priori expressed the following qualitative judgements conditionally illustrated on Fig.4.

Possible appearance fields of the hypothesis of continuous defect (*dhc*) discovers in accordance inequalities (1) only at extreme high values FWN and with the most probable very small random deviation from zero meanings. Consequently at tuning out from pulsation with FWN large of proper number for left boundary $[\omega_{s.} \wedge æ_{s.j}]^{pp}_{inf}$ of a physical point PP permissibly to expect of tendency of "law"$\Re_{dhc}$ transformation by form of Dirac's δ -function (see dotted lines along of ordinate axis on Fig.4).

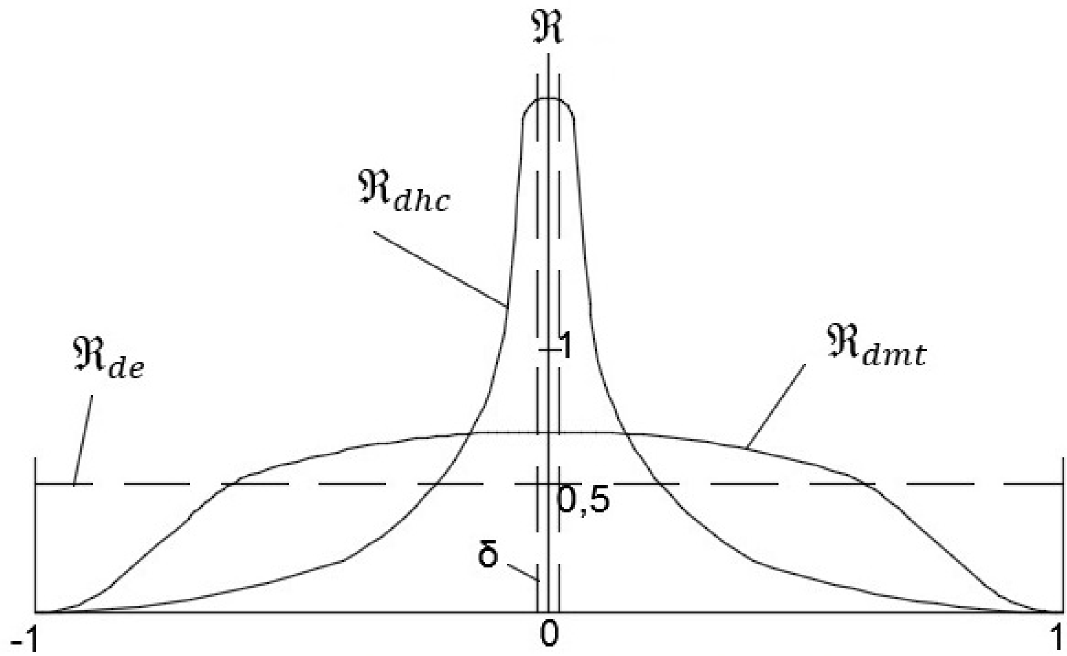

Fig. 4: Supposed partial kinds of even distribution "laws" for first and second groups of a random fields

Other of declivity degree and direction of change of outlines will have prognostic "law"$\mathfrak{R}_{dmt}$ for values *FWN* selected by inequalities (2). From qualitative consideration of experimental oscillogram for turbulence pulsations of components velocity presents in literature, usually selectively and most often in the capacity of examples their level and species (see, for example, [11]), is acceptable nevertheless to compose of opinion about expectation of more filled and gentle relation $\mathfrak{R}_{dmt}$ from φ'. In so doing it's appearing not inconsistent to expect approach of given function, as far as of the sequential evolution all more small-scale turbulence and property of *quasi-isotropy*, to "law" of a *uniform* distribution (see on Fig.4 horizontal dotted line). By this point we are concluded treatment of *two first* groups of random processes.

We will refer now to analysis of *third* group of stochastic actions. No smaller but most likely larger difficulty, as underlined into introduction, represents task of quite acceptable modeling influence on stream of a *roughness* at the real solid fragments of boundary S_w – *real* for domains various kind flows. In following for reasons, stipulated previously, is regarded set up in which present actions are reproduced approximately by continuous and one dimensional random perturbations *each*, in establishing aspect are *measured experimentally*, function of field $p \vee T \vee v_i$. This perturbations concentrated in 3D layers of asperity V_a of some, strictly speaking, *virtually* (from Lat. *virtualis* – possible) thickness $h_{a.s}$ (see lower).

We will be and other parameters/exponents/functions involving directly to effects of roughness to separate (at necessity) by lower index a, replaced, in particular, for simplicity designation $\mathfrak{R}_{asp}$ **onto**$\mathfrak{R}_a$.

Besides we will leave out of the way deep questions of analytical geometry connected with present subject of discussion and requiring in perspective, namely at development of computing algorithms, of the attentive to its accesses.

Thus, reasoning from hypothetic and deductive considerations we will set that for definite categories configuration of the solid parts of boundaries in some domains of flow with asperity from category of it typical kinds there exist possibility to establish comparatively small two-dimensional, but *united 2D control element* (*UCE*) $\delta\mathbf{s}$. This in its own way conditional *controller* play a key role of the indicator of roughness local geometrical properties. Element $\delta\mathbf{s}$ we will represent as an of a perfectly smooth surface element with norm No$=\|\delta\mathbf{s}\|$ and with regular contour admitted of it breaking up on finite get of identical and true, but provided with indices polygons $d\mathbf{s_m}$, $m=\overline{1, m_s} \ni \sum_{m=1}^{m_s} d\mathbf{s}_m = \delta\mathbf{s}.$

Characteristics of a roughness surface liable to concrete definition emerges on the cuts $h_{a,j}$ by controller *UCE* of each local *j*-th volume layer $\delta\mathbf{v}\mathbf{a.j}$ with thickness $h_{a.s,j} = \delta\mathbf{v}_{a.j}/\|\delta\mathbf{s}\|$. These cuts on indicated local section is *near-parallel* of conditional, but analytical lower S_{wf} and upper S_{fw} boundaries of a *full* layer of roughness by volume V_a (see then) .

According to combinations and views of solid and fluid *spots* on obtained by marked way of totality of "*portraits*" from some number of cuts $h_{a,j}$ $[0,h_{a.s,j}]$ composes judgement about specific levels of roughness properties for each section of a solid boundary. To wards mentioned showing besides of the thickness $h_{a.s,j}$ we will refer *contour* ledges and hollows with norm, for example, by there relative radiuses of curvature $r_a/\|\delta\mathbf{s}\|$, as well *concentration* $æ_m$ of solid disseminations/tracks for each mini-element $d\mathbf{s} \in \delta\mathbf{s}$, where $æ_m$ means number of these spots.

Stated two *showings* we will represent in generalized form by coefficients $\boldsymbol{a}_r$ and aæ, depending from groups of proper numbers of its estimate. That estimate demands of methodical systematization and identification on base of preliminary deductive analysis as averaged along $\delta\mathbf{s}$ and $h_{a.s,j}$ of face-values of unevenness forms and distributions in its j-th local volume $\delta\mathbf{v}_{a,j}=h_{a.s,j}\delta\mathbf{s}$ (later on, if not of the special indication index j for local volume layer $\delta\mathbf{v}_{a,j}$ omits without loss for clarity of the presentation).

Now with a view of more thorough perception furthest opinions we cite following illustrative material.

On Fig.5 represented selection from transverse cutting of some part of solid (here plane) flooded by liquid boundary with real rough contact flooring S_w-*real*.

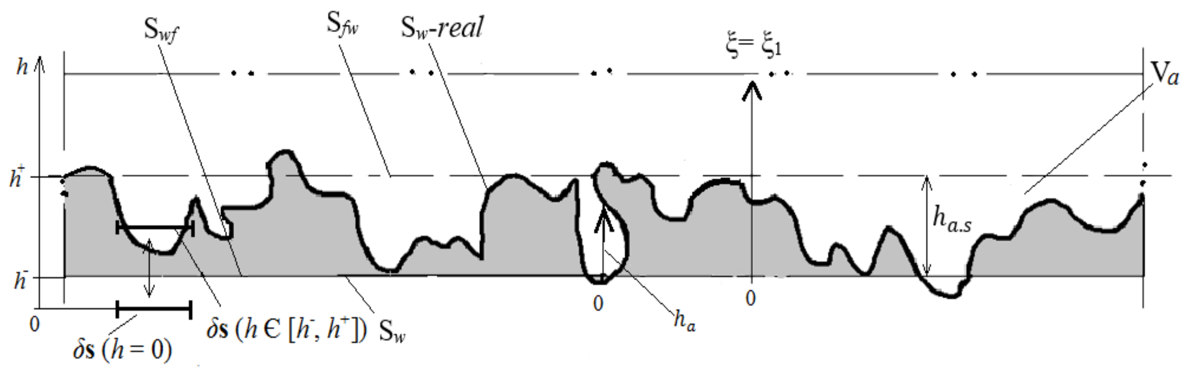

Fig. 5: Fragment of filling of a regular selection for solid technically roughness boundary S_w – real

Here introduced designations meaning of which are clarifications: $S_{wf} \wedge S_{fw}$ are conditional lower and upper boundaries of a roughness in the form analitic jointed on these boundaries and in pairs "*near-parallel*" each other of totalities *USE*, i.e. by ratio towards every pair elements $\delta\mathbf{s} \in S_{wf} \wedge \delta\mathbf{s} \in S_{fw}$ from similar points on $S_{wf} \wedge S_{fw}$. In addition distances $h_{a.s}$ between $S_{wf} \wedge S_{fw}$ are taken for thickness of the layer of roughness on each binary element from its marked of joining up on chosen part of the solid boundary. Stated index/showing for each j-th element of a layer can be determined by relations

$$h_{a.s}=h^{+}-h^{-},h=h^{+}\vee h^{-}\ si\sum_{k=1}^{k_s}\overline{\partial\mathbf{s}}_{w.k} \leq \varepsilon_w \vee \sum_{l=1}^{l_s}\overline{\partial\mathbf{s}}_{f.l} \leq \varepsilon_f; \quad (7)$$

$$\overline{\partial\mathbf{s}} = {}^{\partial\mathbf{s}}/_{\delta\mathbf{s}},\ \delta\mathbf{s}_{w\vee f} = \sum_{k\vee l}\partial\mathbf{s}_{w.k\vee f.l},\ \delta\mathbf{s}_w + \delta\mathbf{s}_f = \delta\mathbf{s}, \quad (7a)$$

Here and too on Fig.5 is marked: h is current distance from *UCE*, established on certain fixed level of *comparison* (h =0) "near-parallel" with respect to $S_{wf} \wedge S_{fw}$; si – from Lat if; $\partial\mathbf{s}_{w\vee f}$– solid (index *w*) or fluid (index *f*) square of spits on cuts of roughness in sections h=const;$\varepsilon_{w\vee f}$– given small positive numbers; $\delta\mathbf{s}_{w\vee f}$– joint squares by proper spots in each section. Relations (7a) with consideration (7) are evidently. Axis $\xi = \xi_1$ is orthogonal to $\mathbf{S}_{wf}$ direction which is defined in common (of not plane) case by two main of radiuses of a curvature *UCE* $\delta\mathbf{s}$ for it weighted condition into fragment of a roughness layer $\delta\mathbf{v}_a$.

Later on surface $\mathbf{S}_{wf}$ is treated in the capacity of solid *smooth* wall $\mathbf{S}_w$ of a common boundary of designed flow domain.

Controller *UCE* s in each elementary volume $\delta\mathbf{v}_a$ must own in addition by next physical and geometrical properties: of

- *flexibility* but without of *tension;*
- *one-valued* establishment of curvature main radiuses and consequently of bench –mark$\vec{j_k}$, $k = \overline{1,3}$ of the local Cartesian's coordinates system *LSC* with radius-vector $\vec{\xi} \in \delta\mathbf{s} \in \delta\mathbf{v}_a$;
- *connexion continuity* of own contour with contours of its boundaries identities up to derivatives of second order from $\mathbf{X}_l$ *by* ξ_k, $l \wedge \mathrm{k} = \overline{1,3}$ ($\vec{\mathbf{x}}$-global Cartesian's coordinates system).

On Fig.6 demonstrates imitation of a developed turbulent flow along wall at limits of conditional viscous under-layer (*VUL*) for selection by Fig.5. Presented here only qualitatively are epure time-averaged (by Reynolds) velocity $\vec{\upsilon}_{vl}$ and instantaneous sporadic distribution of pulsations $\vec{\upsilon}'_a$ as own from turbulization of a flow so and from action asperity approximately be modeled by means of developing here conception (see also lower). In immediate closeness to S_w by dark background is selected superthin layer $h_c = \xi_{kn}$ of a conservative part of a viscous under-layer h_{vl} with velocities $\upsilon_{-}(\xi = 0^{+})$ and $\upsilon_{+}(\xi = \xi_{kn})$ (see also Fig.1).

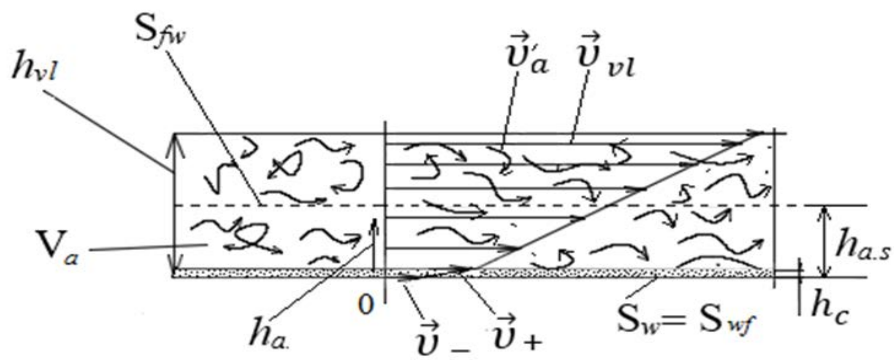

Fig. 6: Scheme of dynamics imitation of asperity actions by stochastic field of velocity $\vec{\upsilon}'_a$ for a developed turbulent flow of main stream

Analysis represented above permits to propose in principal plan of the following procedure of perturbation account from roughness actions. At mentioned previously common conditions (see in introduction article chosen from the left by two thickened points ••) to direct and back transformations (5), (6) are set up *one-to-one* correspondence between certain current random φ' and proper bu it prescribed "law" of distribution $\Re(\varphi')$ also current but integral function distribution Ψ (see too Fig.3). Then, *for imitation of random acperity disturbance sources in each j-th elementary volume* $\delta\mathbf{v}_a$ *of full layer of roughness* V_a *but for concrete cut* $\bar{h}_a = h_a/h_{a.s}$ *hasin*$\delta\mathbf{v}_a$ *with virtual focus* $\vec{\mathbf{x}}_f$ *placed in it cut UCE* $\delta\mathbf{s}$, can be composed, *on condition of achieved at to present time but far not full knowledge about subject of study and therefore in many symbolically and along form recording structurally,* functional

$$\Phi'_a = \Phi'_{a.\sup}\{\bar{h}_a, \boldsymbol{a}_r, \boldsymbol{a}_{æ}; Rg^*\} \cdot \mathcal{L}^{-1}\{\Psi_a[\Re_a(\varphi'_a|_{[-1,1]}; \bar{h}_a, \boldsymbol{a}_r, \boldsymbol{a}_{æ}; Rg^{**})]\}; \quad (8)$$

$$\Phi'_a = p'(\vec{\mathbf{x}}_f, \boldsymbol{t}) \vee T'(\vec{\mathbf{x}}_f, \boldsymbol{t}) \vee \upsilon'_i(\vec{\mathbf{x}}_f, \boldsymbol{t});\ \vec{\mathbf{x}}_f \in \delta\mathbf{s} \in \delta\mathbf{v}_a \in \mathbf{V}_a;\ \Psi_a = \mathrm{G}. \quad (8a)$$

Functional Φ'_a at not principal restrictions $\Phi'_{a.\sup} > 0$, $|\Phi'_{a.\inf}| = \Phi'_{a.\sup}$, in particular for law"$\Re_a$ as even function from φ'_a, reproduces changes indicated in (8a) random qualities and represented in view product of the two factors. First factor in expression (8) is, as indicated previously, estimate of above of a random pulsation for one from quantities Φ'_a (see (8a)) in points $\vec{\mathbf{x}}_f$. Second factor represents result of transformation by operator $\mathcal{L}^{-1}$of integral functions of distribution Ψ_a in represented by norm random qualitied φ'_a. Both factors parametrically depends from characteristics of roughness $\bar{h}_a, \boldsymbol{a}_r, \boldsymbol{a}_{æ}$ and also by some generalized way from functions of flow regime Rg^*,Rg^{**} on upper boundary $\mathbf{S}_{fw}$ of layer V_a (see Fig.6). Its functions are defined by current estimates of fundamental substances $[\rho(\vec{\mathbf{x}}_f, \boldsymbol{t}), \varepsilon(\vec{\mathbf{x}}_f, \boldsymbol{t}), \vec{\upsilon}(\vec{\mathbf{x}}_f, \boldsymbol{t})]|_{\bar{h}_a=1}$.

Regarding measure of determination dependences of functional Φ'_a and "laws" $\Re_a$ from indexes $\bar{h}_a$ in present time permissibly reasoning only from physical premises to assume that

$$\Phi'_{a.s}|_{\bar{h}_a=0} < \Phi'_{a.s}|_{\bar{h}_a>0},\ \Phi'_{a.s}|_{\bar{h}_a=1} > \Phi'_{a.s}|_{\bar{h}_a<1},\ \Re_a(\varphi'_a \in [-1,1])|_{\bar{h}_a=0} = \tfrac{1}{2},$$

Where index $s = sup$.

It is clear that concrete definition representations (8), (8a) possible only by results of a statistical analysis of experimental information about specifically and will posed measurements of pulsatile quantities in immediate closeness at to ledges of a roughness. In range $0<\bar{h}_a<1$ the most simple approximation of functions in presented relations evidently is its linear dependence from $\bar{h}_a$.

At development of computer algorithms obtained on base of the stated concept fields of random quantities in one way or another of inter – or extrapolation are translated on fixed 3Drated net of the *E-system* of count.

Considered stochastic quantities naturally enters into kinematic, force, moment and heat functions of action, i.e. into terms of the left part of thermomechanics fundamental equations marked at work [9] by numbers (I) - (IV) in right column of table contained into it publication. It is important to keep in mind, that present quantities are appearing directly just on greatly high interval *FWS* in accordance of estimates (1), (2) and also in a layer of roughness $\mathbf{V}_a$ with "laws" of distribution $\Re_{dhc}, \Re_{dmt}$, и $\Re_{asp} = \Re_a$ accordingly.

To this end, we will state the next of no small importance remark. In our work [8] in sufficiently expanded appearance considered problem of the binary interaction smooth-wall solid and fluid phases. However, concrete mean of the description for electromagnetic by force and volume action of field $\vec{F}_w$ on the conservative part of the fluid viscous under-layer was omitted.

Necessity into immediate account of the indicated effect is emerged at development in present time of algorithm for computer realization of developing by author's theory.

Experience shows that both for interior and for exterior tasks of fluid stream dynamics at until and over critical conditions of streams, including turbulence, by steady and instability flows exists however zones with *extremely high* wall layer gradients of fields functions at current without breaking-off: parts of discharge into canal, vicinity of the braking points, transitional processes and other.

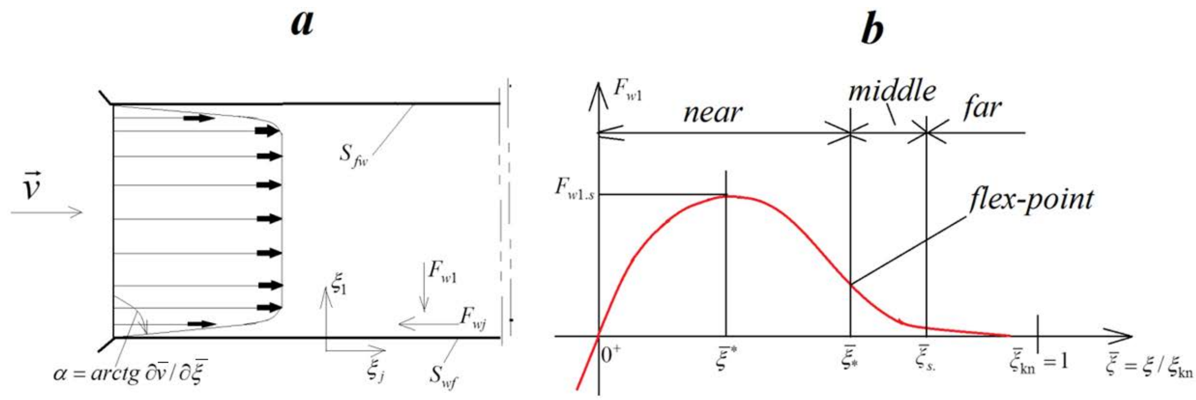

Fig. 7: To account of two-phase interaction of the smooth wall solid surface with fluid layer ($\bar{\xi}_1 = \bar{\xi}$)

On Fig. 7a is shown epure of a velocity at *smooth* but *intensive* discharge flow into canal with primary stage of boundary layer formation and consequently at an angle α ≈ π/2 for non dimension gradient of velocity on $\bar{\xi}$.

Noted fact provide a explained by attractable operation of the interphase force field $\vec{F}_w$. It field substantially counteract, i.e. are opposite in sign, super high repulsion shear stress in noted layers of fluid mediums (see [8], subscript *a* replaced by *w*). On Fig. 7b is given quality representation of component F_{w1} of function $\vec{F}_w$ by normal surface S_{wf}. Corresponding terms, occurring only in the layer $\bar{\xi} \in [0^+,1]$, for equation of a momentum balance (see table and equation II in work [9]) at quasi-linear statement and at restriction by consideration only properly of elementary particles deformation from adjoined on wall liquid layer S_{fw} in local Cartesian's coordinates system we can to down takes the next forms

$$\vec{F}_w = i_k F_{wk},\ k = \overline{1,3};\ F_{w1} = \kappa_{w1} G_n(\bar{\xi})\bar{u}_{d1};\ F_{wj} = \kappa_{wj} G_s(\bar{\xi})(1-\bar{\xi})\bar{u}_{dj},\ j = 2,3; \quad (9)$$

$$\bar{u}_{d1} = u_{d1}/\xi_{kn} = \xi_{d1}/\xi_{kn},\ \bar{u}_{dj} = u_{dj}/u_d^*,$$

where κ_{wk} - collapse-functions (see [9]), u_d^* - critical meaning of a shear deformations on wall, $\vec{F}_w = 0$ at $\bar{\xi} > 1$.

Clearly that concrete aspect and meaning marked on Fig. 7b parameters of near - $[0^+, \bar{\xi}_*]$, middle - $[\bar{\xi}_*, \bar{\xi}_{s,}]$ and far - $[\bar{\xi}_s, 1]$ action of the component F_{w1} , and also coefficients $G_n = \rho g_n$, $G_s = \rho g_s$ (*Dim* $g_{n\vee s} = \text{м/c}^2$.), parameters ξ_{kn}, u_d^* are requiring of own experimental establishment.

III. Conclusion

From contents of text it follows extraordinary complexity of random effects consideration even on level of qualitative estimates and semi-analytical acceptances of its under-net sources of perturbation.

Approach at to desired can be achieved only on the basis of system statement and careful realization of complex and precision physical experiments with particularly high resolving ability. In this connection no doubt attraction of modern and powerful computer software, in particular, for probabilistically statistical machining treatment obtained empirical of material and it of consequent methodical study.

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