Superslow Processes

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Preface

Below, we bring a cycle of papers used in the special seminar "*The Differential Forms in Micro- and Nanocanals*" that was read for several years to students at the Mathematical Department at Volgograd State University (Russia).

Superslow we call processes which values change so little that they seem nearly unrecognizable in comparing them to the error of measurement. Slight changes become noticeable only after a long period of time.

Numerous examples could be found in the aging processes of living organisms. However, *superslow* are not only physiological processes, but a whole range of tiny real-life changes. These changes fall out from traditional scientific researches for the reason of their supersluggishness. The reader could easily point out such gaps in astronomy, physics, mechanics, economics, linguistics, ecology, and etc.*

For instance, liquids, flowing inside long and narrow tubes, form so called stagnation zones, the distances where the flow becomes almost immovable. If the ratio of the length and diameter of the tube is high, than its potential function and its stream function stay almost unchanged on very continuous distances. This situation seems not to be so interesting; however, if we recall in memory that such tiny movements happen on superlong time intervals, then we will find here the whole sequence of first-class tasks demanding elaboration of special mathematical methods.

A priori information on stagnation zones could optimize our calculations if we replace the values of desired functions in such zones with corresponding constants. Sometimes, such move makes it possible to reduce the entire amount of calculations essentially, for example, in approximate calculations of conformal mappings of very stretched rectangles.

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*) We do not focus here on the causes that imply such gaps. We only mention their entire existence among the others (ecological problems, financial crisises), which demonstrate youthfulness of our civilization, weakness of the above-governmental structures, and underestimation of the jeopardy when demanding "all and at once". In case when a particular person for some reason is not capable of predicting distant consequences of his/her actions, and when particular governments have been preoccupied with the prosperity of "here and now", then overstate institutions must be able to resolve occurring problems and figure out the ways to stop those especially zealous members of the society. That is the main reason why the governments consciously sacrifice wholeness of their sovereignties when grouping into associations.

Obtained results are particularly useful for applications in economic geography. In such case, when a function characterizes intensity of barter in certain geographical area, theorems about its stagnation zones allow to estimate geometrical size of economical space with few restrictions depending on a chosen model. For example, if a subarc of the domain boundary has zero transparency and a flow of the vector field gradient of the function through the remaining part of the boundary is relatively small, then such domain is a stagnation zone of this function.

Stagnation zones theorems are closely related to pre-Liouville theorems, i.e. estimates of solution oscillations, which direct corollaries are different versions of the classic Liouville Theorem about transformation of the entire double-periodical function into identical constancy.

Knowledge of the parameters impacting the sizes of stagnation zones opens possibilities for practical recommendations on configuring, i.e. resizing, of such zones.

The described here theory brings the light upon only one group of questions discussed during the seminar *"Superslow Processes"*. For more information about other inclusive topics, please visit Appendix. The study of micro- and nanoflows implies mathematical settings, very distant from the traditional. If the microscope were invented three hundred years earlier its actual release date, then we would be dealing today with the other type of mathematics, significantly different from the modern.

We will be happy to see that our collection of works catches the interest of the young scientists and helps them to locate and research the described type of gaps in modern natural science.

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Papers:

1. V.M.Miklyukov, *Stagnation Zones of Laplace-Beltrami Equations on Long Strips*. Mathem. Trudy, v.5, n.1, Novosibirsk: Izd-vo In-ta math., SO RAN, 2002, 84-101.

Abstract. We introduce a concept of stagnation zones of superslow processes and bring some estimates of their sizes for solutions of Laplace-Beltrami equations on long strips.

2. V.M.Miklyukov, *S-Zones of Harmonic Functions in Narrow and Long Bands.* In sb. Mathem. i Prikladn. Analysis. n.1. Tyumen. Gosudarst. un-t. 2003. 89-118.

Abstract. Stagnation zone (or s-zone) of a function is called a domain, where the function is different from its identical constant less than s. In the article we bring sizes of some stagnation zones of harmonic functions on narrow and long bands. Connections with superslow processes in the gas dynamics, geology, economic geography are discussed.

3. V.M.Miklyukov, S.-S.Chow, and V.P.Solovjov*, Stagnation Zones of Ideal Flows in Long and Narrow Bands*. International Journal of Mathematics and Mathematical Sciences. 2004. v.62. 2004. 3339-3356.

Abstract. We investigate stagnation zones of flows of ideal incompressible fluid in narrow and long bands. With the bandwidth much less than its length, these flows are almost stationary over large subdomains, where their potential functions are almost constant. These subdomains are called s-zones. We estimate the size and location of these s-zones.

4. V.M.Miklyukov, *Multi-dimensional Weak Solutions Close to Non-transparent Boundary*. In sb. Notations of Seminar *Superslow Processes*. N.1. Volgograd: Izd-vo VolGU. 2006. 58-73.

Abstract. We study multi-dimensional weak solutions close to non-transparent boundary.

5. V.M.Miklyukov, *Sizes of Stagnation Zones for Solutions with Singularities*. In sb. Notations of Seminar *Superslow Processes*. N.1. Volgograd: Izd-vo VolGU. 2006. 90-92.

Abstract. We discuss some problems of stagnation zone sizes for solutions with singularities.

6. V.M.Miklyukov, *Stagnation Zones of Almost Solutions*. In sb. Notations of Seminar *Superslow Processes*. N.1. Volgograd: Izd-vo VolGU. 2006. 101-106.

Abstract. Investigated are the stagnation zones of almost solutions on n-dimensional domains.

7. V.M.Miklyukov, *Local Time, Superslow Processes, and Stagnation Zones*. In sb. Notations of Seminar *Superslow Processes*. N.1. Volgograd: Izd-vo VolGU. 2006. 131-137.

Abstract. We consider some problems arising from analysis of superslow processes in natural and social structures.

8. V.M.Miklyukov, *Some Questions Arising from the Problem of Triangulation of Boundary Layer.* In sb. Notations of Seminar *Superslow Processes*. N.1. Volgograd: Izd-vo VolGU. 2006. 154-162.

Abstract. We formulate some questions related to the problem of triangulation of boundary layer.

9. V.M.Miklyukov, *'Thick' Boundary.* In sb. Notations of Seminar *Superslow Processes*. N.2. Volgograd: Izd-vo VolGU. 2006. 17-20.

Abstract. Discussion is built upon some mathematical problems of borderlands.

10. V.M.Miklyukov, *A-Solutions with Singularities as Almost Solutions.* Mathem. Sb. V.197. N.11. 2006. 31-50.

Abstract. We introduce almost solutions of quasilinear differential equations with partial derivatives and bring conditions where solutions with singularities are almost solutions.

11. V.M.Miklyukov, *Maximum Principle of Almost Solutions of Elliptic Equations*. Vestnik Tomsk. Gosud. Un-ta. Mathem. i Mechan. N.1, 2007, 33-45.

Abstract. An analogy of the maximum principle is proved for the differences of almost solutions of p-harmonic equations, for the minimal surface equation, and the gas dynamics equation.

12. V.M.Miklyukov, *Stagnation Zones of A-Solutions*. Georgian Mathemat. Journal. v.14. n.3. 2007. 519--531.

Abstract. We investigate stagnation zones of solutions of partial differential elliptic equations. With the domain width being much less than its length and special boundary conditions, these solutions can be almost constant over large subdomains. Such domains are called stagnation zones (s-zones). We estimate the size, the location of these s-zones and study behavior of solutions on s-zones.

13. V.M.Miklyukov, *On Harnack Inequality for Almost Solutions of Elliptic Equations*, In sb. Notations of Seminar *Superslow Processes*. N.3. Volgograd: Izd-vo VolGU. 2006. 30-43.

Abstract. An analogy for the Harnack inequality is proved for almost solutions of A-harmonic equations.

14. V.M.Miklyukov, *On Stagnation Zones in Superslow Processes*. Dokl. Acad. Nauk (Russia). V.418, N.3, 2008, 304-307.

Abstract. We bring some results on mathematical description of stagnation zones in superslow processes.

15. V.M.Miklyukov, *Flows in Micro- and Nanocanals: Sliding or Adhesion?* Manuscript.

Abstract. We discuss the problem of boundary conditions on the walls of superfine canals.

16. V.M.Miklyukov, *Some Estimates for Stagnation Zones of Almost Solutions of Parabolic Equations*. Sib.J.Industr. Mathem. V.XI. N.3(35), 2008, 96-101.

Abstract. We discuss estimates for stagnation zones of almost solutions of parabolic differential equations with partial derivatives.

17. Vladimir M. Miklyukov, Antti Rasila, Matti Vuorinen, *Stagnation Zones for A-Harmonic Functions on Canonical Domains*. Helsinki University of Technology, Institute of Mathematics, Research Reports A542, 2008, 23 pp.

Abstract. We study stagnation zones of A-harmonic functions on canonical domains in Euclidean n-dimensional space. Phragmen -Lindelof type theorems are proved.

18. Appendix. Program of the Seminar *"The Differential Forms in Micro- and Nanocanals"*.