

International Round Table

Mathematical and Computational Modelling in Cardiovascular Problems: Forms of International Collaboration

Working group on mathematical models and numerical methods in biomathematics

Yuri Vassilevski

Institute of Numerical Mathematics RAS

Round Table “Mathematical and Computational Modelling
in Cardiovascular Problems: Forms of International Collaboration”

Brief history of INM RAS



The founder of
INM
academician
Gury Marchuk



- 1980: Dept. of Numerical Mathematics of USSR AS
- 1991: Institute of Numerical Mathematics RAS
- 1997: address of INM becomes Gubkina str.8
- 1980-2000: director Gury Marchuk
- 2000-2010: director Valentin Dymnikov
- 2010-present: director Eugene Tyrtysnikov

Scientific directions

- numerical mathematics, informatics, parallel computations
- mathematical modelling in science and technology



Scientific directions

numerical mathematics, informatics, parallel computations



- numerical methods
 - ▶ discretization methods
 - ▶ matrix and tensor computations
 - ▶ methods of theory of control
- parallel computing and HPC
- computational technologies
 - ▶ all stages (domain-mesh-discretization-solution)
- methods of data transformation, analysis and structuring

Scientific directions

mathematical modelling in science and technology



- atmosphere hydrothermodynamics (meteorology)
- dynamics of ocean and seas and data assimilation
- regional climate processes
- global climate and its changes
- dynamics of aerosols (ecology, fires, smog)
- technical hazards and natural catastrophes (dam breaks, landslides, pollution)
- processes in human organism (immune, infectious, blood circulation), epidemiology

Other facts about INM

- 27 Habil., 24 PhD, 10 graduate students
- courses in MIPT and MSU, 8 PhD defences in 2013
- 6 laboratories in other research centers
- 75% of the budget is formed by grants, contracts etc.
- Contracts with ExxonMobil, Rosneft, Rosatom, Nissan etc.

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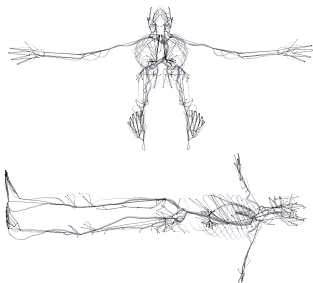
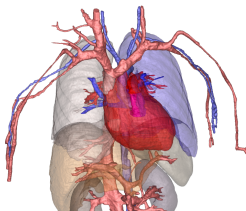
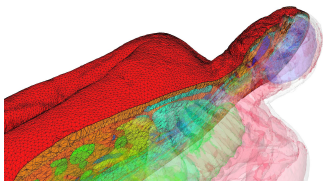
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Informatics technologies in bioimpedance diagnostics and computational haemodynamics

- 3D reconstruction of human body with resolution of organs, tissues, systems
- Mesh generation for human body and its parts (e.g. vascular system)
- Development of mathematical models:
 - ▶ Optimization of bioimpedance diagnostics (lung hydration, body composition)
 - ▶ Virtual blood circulation (surgery, pathologies)



Presentations from INM and affiliates at the workshop

- Alexander Danilov (INM) High resolution human body computational models
- Yuri Ivanov (INM) Patient specific reconstruction of vascular network for haemodynamic modelling
- Sergey Simakov (MIPT) Computational haemodynamics for clinical practice
- Victoria Salamatova (MIPT) Modelling of soft tissue deformation
- Tatyana Dobroserdova (INM) Numerical simulation of blood flow in the vascular network with pathologies or implants
- Timur Gamilov (INM) Modelling of passive blood flow stimulation
- Vasily Kramarenko (MIPT) Natural user interfaces for mathematical models dealing with real human anatomy

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Working group on mathematical models and numerical methods in biomathematics

- Informal society of modelers and mathematicians since 2010
- Activities
 - ▶ Series of workshops
 - ▶ Special issues in international journals
 - ▶ Website *dodo.inm.ras.ru/biomath*

Working group on mathematical models and numerical methods in biomathematics

Series of workshops at INM RAS

- ① 15-16 June 2010: 16 talks, 2 (F)
- ② 11-12 January 2011: 18 talks, 2 (regions), 1 (F), 1 (UK)
- ③ 27-28 October 2011: 21 talks, 4 (regions), 2 (F)
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- In total about 100 talks, more than 100 participants/members
 - 9 groups for cardiovascular modeling in Russia (MSU 2, MIPT 2, Cnt.Hem. 2, INM-MIPT, Ebrg, Nsk, SPb) presented 25 talks
 - 7 talks on cardiovascular modelling from western countries

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The next conference will be in the end of October 2014.

It will be combined with the International Workshop “Multiscale Modelling and Methods in Biology” (sponsored by French agencies, ~ 15 participants)

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Workshops become more international. You are welcome!

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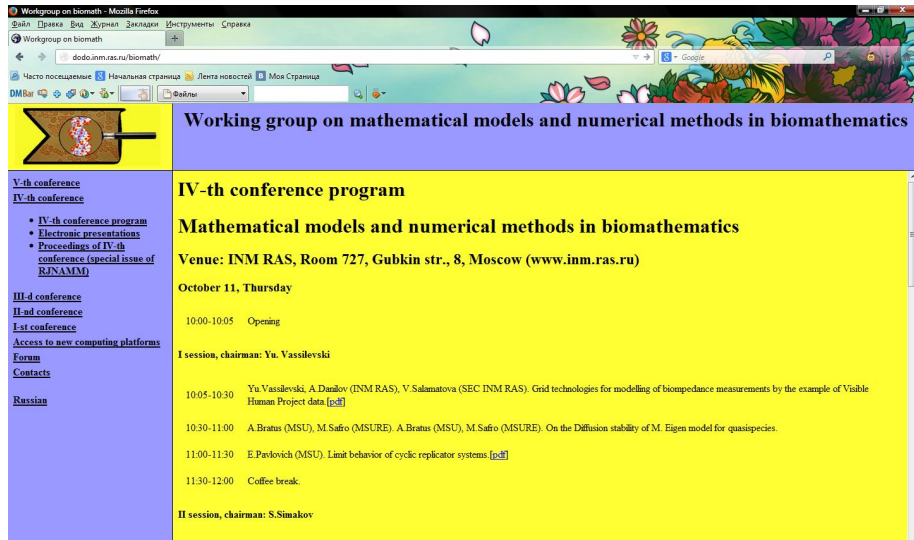
Special issues of journals

Peer-reviewed papers in

- ❶ Math.Modelling of Natural Phenomena 6, No.7, 2011 (EDP Science)
7 papers (2 ♥)
- ❷ Rus. J. Numer.Analysis and Math.Modelling 26, No.6, 2011 (De Gruyter)
7 papers (4 ♥)
- ❸ Rus. J. Numer.Analysis and Math.Modelling 27, No.5, 2012 (De Gruyter)
7 papers (3 ♥)
- ❹ Rus. J. Numer.Analysis and Math.Modelling 28, No.5, 2013 (De Gruyter)
5 papers (3 ♥)
- ❺ Rus. J. Numer.Analysis and Math.Modelling 29, No.5, 2014 (De Gruyter)

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Website dodo.inm.ras.ru/biomath



The screenshot shows a Mozilla Firefox browser window. The address bar displays 'dodo.inm.ras.ru/biomath/'. The page has a decorative header with a floral pattern. The main content area is yellow and contains the following text:

Working group on mathematical models and numerical methods in biomathematics

IV-th conference program

Mathematical models and numerical methods in biomathematics

Venue: INM RAS, Room 727, Gubkin str., 8, Moscow (www.inm.ras.ru)

October 11, Thursday

10:00-10:05 Opening

I session, chairman: Yu. Vassilevski

10:05-10:30 Yu.Vassilevski, A.Danilov (INM RAS), V.Salamatova (SEC INM RAS). Grid technologies for modelling of biimpedance measurements by the example of Visible Human Project data. [[pdf](#)]

10:30-11:00 A.Bratus (MSU), M.Safro (MSURE). A.Bratus (MSU), M.Safro (MSURE). On the Diffusion stability of M. Eigen model for quasiespecies.

11:00-11:30 E.Pavlovich (MSU). Limit behavior of cyclic replicator systems. [[pdf](#)]

11:30-12:00 Coffee break.

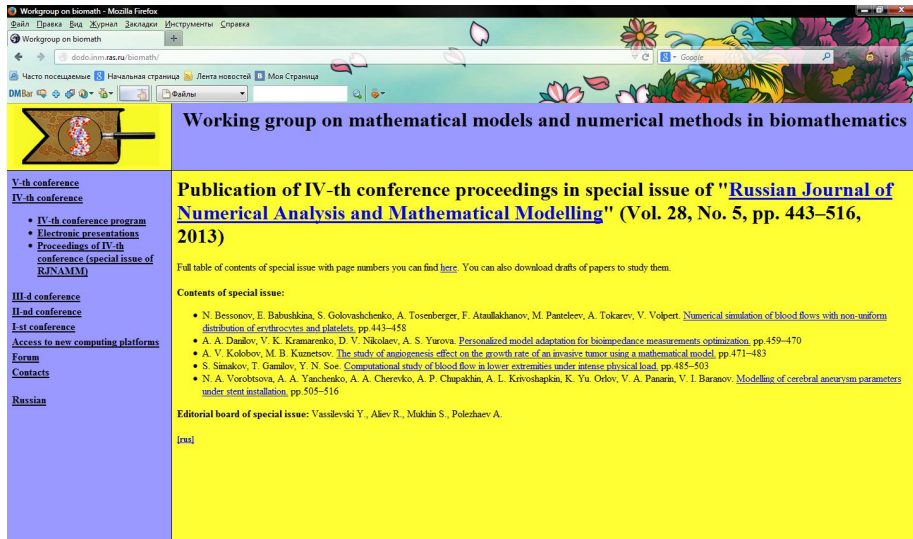
II session, chairman: S.Simakov

The left sidebar of the browser window contains a navigation menu with the following links:

- [V-th conference](#)
- [IV-th conference](#)
- [IV-th conference program](#)
- [Electronic presentations](#)
- [Proceedings of IV-th conference \(special issue of RJNAMM\)](#)
- [III-d conference](#)
- [II-nd conference](#)
- [I-st conference](#)
- [Access to new computing platform](#)
- [Forum](#)
- [Contacts](#)
- [Russian](#)

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Working group on mathematical models and numerical methods in biomathematics

Publication of IV-th conference proceedings in special issue of "[Russian Journal of Numerical Analysis and Mathematical Modelling](#)" (Vol. 28, No. 5, pp. 443–516, 2013)

Full table of contents of special issue with page numbers you can find [here](#). You can also download drafts of papers to study them.

Contents of special issue:

- N. Bessonov, E. Babushkina, S. Golovashchenko, A. Tosenberger, F. Atanllakhanov, M. Pantelev, A. Tokarev, V. Volpert. [Numerical simulation of blood flows with non-uniform distribution of erythrocytes and platelets](#), pp.443–458
- A. A. Danilov, V. K. Kramarenko, D. V. Nikolaev, A. S. Yurova. [Personalized model adaptation for bioimpedance measurements optimization](#), pp.459–470
- A. V. Kolobov, M. B. Kuznetsov. [The study of angiogenesis effect on the growth rate of an invasive tumor using a mathematical model](#), pp.471–483
- S. Simakov, T. Gamilov, Y. N. Soe. [Computational study of blood flow in lower extremities under intense physical load](#), pp.485–503
- N. A. Vorobtsova, A. A. Yanchenko, A. A. Cherevko, A. P. Chupakhin, A. L. Krivoschapkin, K. Yu. Orlov, V. A. Panarin, V. I. Baranov. [Modelling of cerebral aneurysm parameters under stent installation](#), pp.505–516

Editorial board of special issue: Vassilevski Y., Aïev R., Mukhin S., Polezhaev A.

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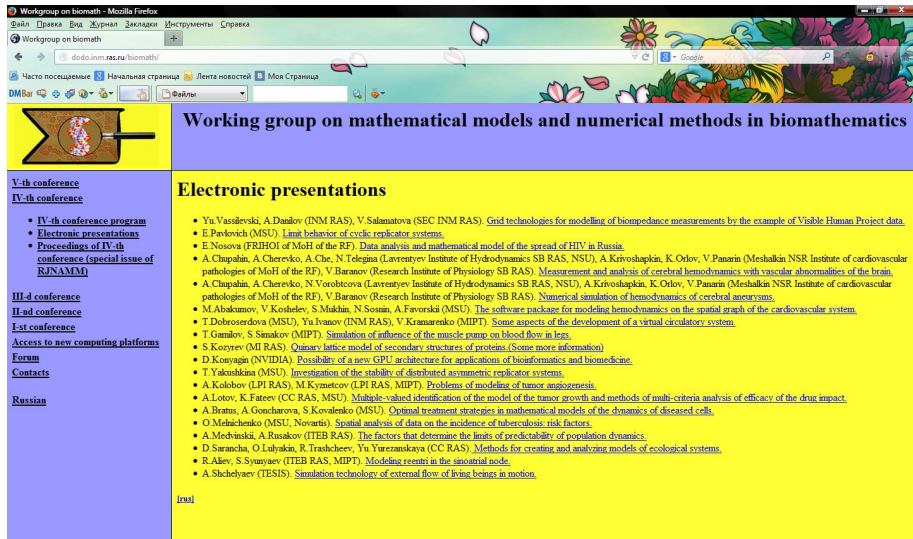
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- Yu Vassilevski, A Danilov (INM RAS), V. Salamatova (SEC INM RAS). [Grid technologies for modelling of biopedance measurements by the example of Visible Human Project data.](#)
- E Pavlovich (MSU). [Limit behavior of cyclic replicator systems.](#)
- E Nosova (FRIHOI of MoH of the RF). [Data analysis and mathematical model of the spread of HIV in Russia.](#)
- A Chupahin, A Cherevko, A Che, N Tselina (Lavrentyev Institute of Hydrodynamics SB RAS, NSU), A Krivoschapkin, K. Orlov, V Panarin (Meshalkin NSR Institute of cardiovascular pathologies of MoH of the RF), V Baranov (Research Institute of Physiology SB RAS). [Measurement and analysis of cerebral hemodynamics with vascular abnormalities of the brain.](#)
- A Chupahin, A Cherevko, N Vorobtsova (Lavrentyev Institute of Hydrodynamics SB RAS, NSU), A Krivoschapkin, K. Orlov, V Panarin (Meshalkin NSR Institute of cardiovascular pathologies of MoH of the RF), V Baranov (Research Institute of Physiology SB RAS). [Numerical simulation of hemodynamics of cerebral aneurysms.](#)
- M Abakumov, V Koshlev, S Mukhin, N Sosnin, A Favorskii (MSU). [The software package for modeling hemodynamics on the spatial graph of the cardiovascular system.](#)
- T Dobrosheva (MSU), Yu Ivanov (INM RAS), V Kramarenko (MIPT). [Some aspects of the development of a virtual circulatory system.](#)
- T Gamulov, S Simakov (MIPT). [Simulation of influence of the muscle pump on blood flow in legs.](#)
- S Kozuyev (MI RAS). [Quinary lattice model of secondary structures of proteins \(Some more information\)](#)
- D Konyagin (NVIDIA). [Possibility of a new GPU architecture for applications of bioinformatics and biomedicine.](#)
- T Yakushkina (MSU). [Investigation of the stability of distributed asymmetric replicator systems.](#)
- A Kolobov (LPI RAS), M Kymetov (LPI RAS, MIPT). [Problems of modeling of tumor angiogenesis.](#)
- A Lotov, K Fateev (CC RAS, MSU). [Multiple-valued identification of the model of the tumor growth and methods of multi-criteria analysis of efficacy of the drug impact.](#)
- A Bratus, A Goncharova, S Kovalenko (MSU). [Optimal treatment strategies in mathematical models of the dynamics of diseased cells.](#)
- O Melnichenko (MSU, Novartis). [Spatial analysis of data on the incidence of tuberculosis: risk factors.](#)
- A Medvinskii, A Rusakov (ITEB RAS). [The factors that determine the limits of predictability of population dynamics.](#)
- D Sarancha, O Lulyakin, R Trushcheev, Yu Yurevskaya (CC RAS). [Methods for creating and analyzing models of ecological systems.](#)
- R Aliev, S Syumayev (ITEB RAS, MIPT). [Modeling reentry in the sinoatrial node.](#)
- A Shchelyaev (TESIS). [Simulation technology of external flow of living beings in motion.](#)

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THANK YOU FOR YOUR
ATTENTION!