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Србија

Директору МИ САНУ др Зорану Огњановићу  
Председнику Научног већа МИ САНУ академику проф. др Драгошу Цветковићу  
Научном већу МИ САНУ

**Стручни извештај са *IV International Seminar "Nonlinear Phenomenology Advances: Mathematics XXI Century & Natural Science"* одржаног у Санкт Петербургу на Петар Велики –Санкт петербуршком политехничком универзитету, Русија, 03.-06. октобра 2017. године**

**Поштовани,**

Подносим вам стручни извештај са *IV International Seminar "Nonlinear Phenomenology Advances: Mathematics XXI Century & Natural Science"*, одржаног у Санкт Петербургу, Русија, 03.-06. октобра 2017. године на Петар Велики –Санкт петербуршком политехничком универзитету у организацији:

- Peter the Great St. Petersburg Polytechnic University (St. Petersburg, Russia)
- Konstantinov Nuclear Physics Institute of NRC "Kurchatov Institute" (Gatchina, Russia)
- Belarusian State University (Minsk, Belarus)  
Joint Institute of Power and Nuclear Research- SOSNY NASB (Minsk, Belarus)
- Komarov Botanical Institute RAS (St. Petersburg, Russia)  
Institute of Mathematics NASB (Minsk, Belarus)
- University of Belgrade (Belgrade, Serbia)  
P.O. Sukhoi State Technical University of Gomel (Gomel, Belarus)

На семинару сам одржала пленарно предавање по позиву под називом:

**„Relation between centrosome excitation and oscillatory energy of mitotic spindle in metaphase trough biomechanical oscillatory model of mitotic spindle“.**

Предавање је било **прво у секцији, изазвало је интересовање и интересантну дискусију.**

На поменутом семинару било је пленарних предавача из различитих земаља: Руске Федерације, Немачке, Србије, Белорусије.

На семинару су била излагања о нелинеарним феноменима у различитим областима математике, нуклеарне физике и биологије.

Љубазношћу домаћина обишла сам департман за математику, библиотеке у којима уче студенти, као и цео универзитетски кампус са ботаничком баштом.

Поред учешћа у семинару и успостављања контаката са колегама из Белорусије и Русије, искористила сам прилику да посетим департман за физичку електронику на *Петар Велики –Санкт петербуришком политехничком универзитету* као и лабораторије у оквиру овог департмана, и успоставим контакт са проф. Алексејем Филимоновим, шефом катедре.

У прилогу вам достављам:

- Сажетак рада
- Позивно писмо
- Извод из програма
- Пар фотографија са конференције

С Поштовањем,

др Анђелка Хедрих

истраживач на пројекту ОИ 174001  
МИ САНУ  
Кнеза Михаила 36  
11 000 Београд  
Србија

У Београду 11.10.2017.

# Relation between centrosome excitation and oscillatory energy of mitotic spindle in metaphase trough biomechanical oscillatory model of mitotic spindle

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## Abstract

Specific organization of metaphase chromosomes is due to complex molecular system of mitotic spindle. Chromosomes oscillate to align precisely during metaphase [1]. Positioning of centrosome, an organizer of microtubules in mitotic spindle, influence a directionality of cell division [2]. There are some opinions that functional genomic architecture is not only present in interphase but also in metaphase stage of cell division cycle [3]. The aim of this work was to study how different oscillatory behavior of centrosomes affects the energy of pairs of homologue chromosomes in the system of mitotic spindle. The analyses were done through mechanical oscillatory model of mitotic spindle [4]. In this model, mitotic spindle is presented as a system of coupled oscillators where one oscillatory pair consists of a centrosome, a microtubule and a related chromosome and these are interconnected with their homologous pairs. Centrosomes are presented as mass particles that represent two rheonomic centres of oscillations. Each element in the model has its mechanical counterpart: microtubules are standard light visco-elastic elements, homologue chromosomes are mass particles that are interconnected with standard light massless elastic spring.

Analytical expressions for potential and kinetic energy as well as for total mechanical energy of oscillating pair of homologues chromosomes are given. Numerical analysis with some approximation for human cell that carries X chromosome is done. Influence of centrosomes' frequency on oscillatory energy of mitotic spindle is discussed.

Total mechanical energy of oscillating pair of homologue chromosomes has oscillatory character. If rheonomic centres oscillate with different frequencies, energy of parts of mitotic spindle that belongs to two sister cells would differ. We suppose that this difference could be additional level of coding information that is transferred into the next cell generation and could be of interests in the process of cell differentiation.

**Key words:** chromosomes, centrosome, mitotic spindle, oscillations, energy, biomechanical model

## References

1. Li C, Xue C, Yang Q, Low B- C & Liou Y-C. NuSAP governs chromosome oscillation by facilitating the Kid-generated polar ejection force NATURE COMMUNICATIONS 2016, 7:10597. DOI: 10.1038/ncomms10597 pp. 1-14.
2. Maly, V.I. Systems biomechanics of centrosome positioning A conserved complexity. *Communicative & Integrative Biology* 2011, 4, 2:230-235.
3. Weise A., Bhatt S., Piaszinski K., Kosyakova N., Fan X., Altendorf-Hofmann A., et al. *Chromosomes in a genome-wise order: evidence for metaphase architecture*. *Molecular Cytogenetics* 2016, 9(36), 1-11.
4. Hedrih A, (Stevanović) Hedrih K. Resonance as potential mechanism for homolog chromosomes separation trough biomechanical oscillatory model of mitotic spindle. *Proceedings (Elektronski izvor) The 6th International Congress of Serbian Society of Mechanics, Mountain Tara, Serbia, June 19-21, 2017*. Edited by Mihailo P. Lazarevic et al. *Minisimposia-Bioengineering (M3)*, pp. 1-10. Belgrade: Serbian Society of Mechanics: Faculty of Mechanical Engineering, University of Belgrade, 2017 (Arandjelovac: Đurđevdan) -1 USB fleš memorija 9x5 cm (u obliku kartice). ISBN: 978-86-909973-6-7. COBISS.SR-ID 237139468.



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Dear Professor Dr. Andjelka Hedrih:

On behalf of the Organizing Committee of IV International Seminar "Nonlinear Phenomenology Advances" we take great pleasure in inviting to attend the International Seminar and present your plenary lecture is titled to be "Relation between centrosome excitation and oscillatory energy of mitotic spindle in metaphase trough biomechanical oscillatory model of mitotic spindle". The Seminar and Round Tables will be held from October 3 to October 6, 2017 at Peter the Great St. Petersburg Polytechnic University, 29 Polytechnicheskaya 15251 Saint Petersburg, RUSSIA.

We are taking this opportunity to assure you of our sincere esteem with unchanged our reverence.

We are looking forward You at Saint Petersburg.

Chairman  
Vice-rector



Dmitry W. Serow  
Vitaly V. Sergeev

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## Извод из програма

Tuesday October 3, 2017

9.00-11.00 Registration (124 Department of Mathematics)

11.00-11.20 Opening (411 — Conference Academic Council Hall, Hydro Corpus)

11.20-12.00 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Vyacheslav Kuvshinov)

11.20-12.00 **Andjelka N. Hedrih & Katica (Stevanović) Hedrih (MI SANU, Beograd, SERBIA)**

### **Relation between Centrosome Excitation and Oscillatory Energy of Mitotic Spindle in Metaphase trough Biomechanical Oscillatory Model of Mitotic Spindle**

12.00-12.40 Maria V. Makarova, Ivan A. Kovalew & Dmitry W. Serow  
(SUAI, SPbPU & Saint-Petersburg, RUSSIA)

Onset of Wada Basins From the Cycles

12.40-13.10 Coffe & Tea Break (House of Scientists in Lesnoye)

13.10-14.30 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Alexander Bugay)

13.10-13.50 Alexander A. Tulub (St. Petersburg State University, Saint-Petersburg, RUSSIA)

Quantum Chemical Computations of Topological Phases in  
DNA Molecule and the Triplet Nature of the Genetic Code

13.50-14.30 Slobodan Zdravković (Univerzitet u Beogradu, Beograd, SERBIA)

DNA-RNA Transcription — Resonance Mode and  
Demodulated Standing Solitary Wave

14.30-16.30 Lunch

16.30-17.10 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Alexander A. Tulub)

16.30-17.10 Sergey M. Khryashchev (SPbPU, St.Petersburg, RUSSIA)

Invariant Measures of Dynamical Polysystems and Estimates of Rate of  
Convergence of Control Times in Discrete Time

17.50-18.50 Coffe & Tea Break & Poster Session (House of Scientists in Lesnoye)  
(Chairman Dmitry W. Serow)

V. I. Lashkevich, A. V. Sidorov and O. P. Solovtsova (GSTU, Gomel, BELARUS)

The Inverse Mellin Transform Method and  
the Asymptotic Contour of Stationary Phase

A. Bouhous, K. Kemih and M. Ghanes (Jijel University, ALGERIA)

A New Cryptosystem Based on Fractional Order  
Time-Delay Chaotic Systems and Wavelet

M. Messadi, K. Kemih, F. Zouad and M. Ghanes (Jijel University, ALGERIA)

Wednesday October 4, 2017

11.00-11.40 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Anatoly Zherelo)

11.00-11.40 V. Kuvshinov, A.Kuzmin, E. Bagashov and V. Shaparau  
(JIPNR-Sosny NAS of Belarus, Minsk, BELARUS)

New Nonperturbative Phenomena of Quantum Chromodynamics

11.40-12.20 Vladimir Kudryashov and Alexander Baran  
(IPh NAS of Belarus, Minsk, BELARUS)

Energy Levels of Electron in Circular Quantum Dot in the Presence of  
Spin-Orbit Interactions and Magnetic Field

12.20-12.50 Coffe & Tea Break (House of Scientists in Lesnoye)

12.50-14.10 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Slobodan Zdravković)

12.50-13.30 Anatoly Zherelo (BSU & IM NAS of Belarus, Minsk, BELARUS)

On One Approximation of a Solution of the  
Stochastic Differential Equation with a Drift

13.30-14.10 D. D. Zabrodova, E. V. Kotov and M. R. Petrichenko  
(SPbPU, Saint-Petersburg, RUSSIA)

Estimates for Solution of the Crocco Typical Boundary Problem

14.10-16.10 Lunch

16.10-17.30 Plenary Session (411 — Conference Academic Council Hall, Hydro Corpus)  
(Chairman Alexander Baran)

16.10-16.50 V. Antonov, R. Davidov & N. Kalinin (SPbPU, Saint-Petersburg, RUSSIA)

Mathematical Modeling of Processes with High Energy Density

16.50-17.30 R. Driben, V. V. Konotop, T. Meier and A. V. Yulin  
(University of Paderborn, Paderborn, GERMANY)

Can Nonlinearity be Beneficial for Supporting Bloch  
Oscillations and Dynamic Localization?

17.30-18.30 Coffe & Tea Break & Poster Session (House of Scientists in Lesnoye)  
(Chairman Dmitry W. Serow)

Alefina Sidorenko (BSU, Minsk, BELARUS)

Encription of Images Applying Chaotic Maps and Parallel Computing

Thursday October 5, 2017

09.00-18.00 Bus tour "in Pushkin places in the Gatchina district"

18.00-22.00 Banquet

Friday October 6, 2017



