Директору Математичког института САНУ
Проф. др Зорану Огњановићу
Научном већу Математичког института САНУ
Академику Драгошу Цветковићу, председнику

Стручни извештај
о учешћу у европској научној конференцији

10ᵗʰ European Solids Mechanics Conference (ESMC 2018) will be held in Bologna, Italy,\
http://www.esmc2018.org/drupal8/
6.1 Nonlinear Dynamics in Mechanical and Structural Systems

У периоду 2 ДО 6 јула боравила сам у Болоњи, по позиву организатора минисимпозијума Нелинеарна динамика у механичким и структурним системима, који је био део програма европске конференције из механике чврстог тела:

10ᵗʰ European Solids Mechanics Conference (ESMC 2018) will be held in Bologna, Italy,\
http://www.esmc2018.org/drupal8/
6.1 Nonlinear Dynamics in Mechanical and Structural Systems

у организацији Европског друштва за механику, Универзитета у Болоњи и Универзитета у Тренту. Ја см члан овог Европског друштва за механику (EuroMech Society) од његовог оснивања.

Организатопри минисимпозијума

6.1 Nonlinear Dynamics in Mechanical and Structural Systems
су били истакнути научниции

Sergey Sorokin   Jon Juel Thomsen   Giuseppe Rega
Aalborg University   TU Denmark, Lyngby   Sapienza University, Rome
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У раду ове интернационалне европске конференције и минисимпозиијума учествовала сам са саопштењем под називом:

Hedrih (Stevanovic) K. R. Trigger of coupled three singular points in dynamics of different mechanical systems each with one degree of freedom, 6.1 Nonlinear Dynamics in Mechanical and Structural Systems, Abstract 227 , USB -ESMC 2018.

које сам сапштила првог дана конференције у првој сесдници Минисимпозијума
6.1 Nonlinear Dynamics in Mechanical and Structural Systems.

Била сам и **један од два председв**ајућа једном сесијом са професоро **Хари Данковиз-ем (Harry Dankowicz, University of Illinois at Urbana-Champaign**), који је и главни и одговорни уредник, водећег у свету, реферативног часописа **Applied Mechanics Reviews**, који публикује **Internationa American Society of Mechanical Engineers**, чији сам члан више од 20 година.

Излагање на овом научном скупу реализовано је у склопу активности истраживања на пројекту ОИ 174001 Динамика хибридних система сложених структзура.

Ова конференција ESMC, је једна од четири главне Европске конференције Европског друштва за механику и одржава се сваке треће године као велика конференције, са по правилу више од 1.000 учесника. Ја сам учествовала у већем броју поједних конференција ове серије, а 2009 **године** сам и била **организатор једног минисимпозијума из Виброреологије** у оквиру програма ESMC Lisanon 2009. Када је ова конференција била одржана у Грацу, ESMC Graz 2012 године, једна већа група младих истраживача и доктораната са Пројекта ОН174001, којим руководим је учествовала успешно са својим саопштењима, и били смо веома запажени. Ја сам и тада председавала једном секцијом.

Ове године, у раду ESMC 2018, укупно је било једно опште предавање, 5 пленарних предавања, 55 минисимпозијума, 9 општих секција, 20 паралелних сесија, 136 организатора минисимпозијума, прихваћено је 1136 апстраката од 1353 пријављених, 1111 усмених излагања, 25 постера. Највећи број учесника био је из Кине, Француске, Немачке и Италије. Биле су заступљене све европске земље, као и Индија, Либан, Ирак, Мароко, Аустралија, Јапан, САД, Канда, Чиле, Аргентина , Бразил и друге.

Имајући у виду да сам учествовала у дискосијама по већем броју секцијских саопштења, као и давала коментаре и научне информације и инструкције, моје учешће је било веома активно у раду ове Конфренције.

У прилогу су инсерти докзумената из којих се може добити увид у рад ове Конференције, као и мој научни прилог овој конференцији, као и позивно писмо..

С поштовањем,

У Београду, 3 август 2018.   Katica R. (Stevanović) Hedrih
                                                                         Руководилац пројекта ОМ174001

UNIVERSITY OF TRENTO - Italy   ALMA MATER STUDIORUM
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SOCIETY

ESMC 2018
10th European Solid Mechanics Conference
Bologna, July 2-6, 2018

September 15, 2017

Prof. Katica Hedrih
Mathematical Institute SANU
Belgrade, Serbia

Invitation to contribute to the ESMC 2018 Mini-Symposium
6.1 Nonlinear Dynamics in Mechanical and Structural Systems

Dear Professor Hedrih,

the **10th European Solids Mechanics Conference** (ESMC 2018) will be held in Bologna, Italy, on July 2-6, 2018. The first edition of this conference series, organized under the auspices of the European Mechanics Society (EUROMECH), was held in Munich in 1991 and subsequent conferences took place every three years in Genoa, Stockholm, Metz, Thessaloniki, Budapest, Lisbon, Graz, and Madrid. The next conference of the series is co-organized by the Universities of Trento and Bologna. Information on the ESMC 2018 is available at the website http://www.esmc2018.org/drupal8/.

The European Solid Mechanics Conference is the major event for the solids mechanics community in Europe and provides a unique forum for scientists and engineers to exchange ideas on the current state-of-the-art in the mechanics of solids, on new concepts and ideas, and to identify new research directions.

In view of your expertise in the area of nonlinear dynamics, it is our pleasure *to invite you* to participate in the 10th European Solids Mechanics Conference and *to contribute to the Mini-Symposium*

6.1 Nonlinear Dynamics in Mechanical and Structural Systems
The mini-symposium will be focused on recent developments in nonlinear dynamics of mechanical and structural systems and related subjects. Topics to be covered include, but are not limited to:

– Nonlinear vibrations and acoustics of structural and machine elements
– Nonlinear vibrations and acoustics in engineering design: smart nonlinear structures/devices
– Nonlinear wave propagation in mechanical systems

- Micro/nano-electro-mechanical nonlinear systems
- Slow-fast nonlinear systems and phenomena
- Energy harvesting using nonlinearity
- Fluid-structure interaction
- Reduced-order modelling of nonlinear systems
- Time- or/and space-periodic nonlinear systems
- Nonlinear modeling of friction and damping
- Vibro-impact processes and analysis
- Experimental methods in nonlinear dynamics
- System identification of structural nonlinearity
- Systems with time delay

You are kindly invited to submit an ***Abstract*** of your proposed presentation before ***November 15, 2017***. Online submission with the relevant instructions is open.

We do hope that you will accept our invitation to contribute to the Mini-Symposium on ***Nonlinear Dynamics in Mechanical and Structural Systems*** at the ESMC 2018.
Please, do not hesitate to contact us in case anything is unclear or if you need additional information.

We look forward to receiving soon your positive response.

With kindest regards,

Yours sincerely

Sergey Sorokin   Jon Juel Thomsen   Giuseppe Rega
Aalborg University   TU Denmark, Lyngby   Sapienza University, Rome
svs@make.aau.dk   jjt@mek.dtu.dk   giuseppe.rega@uniroma1.it

Chairs of ESMC 2018 Mini-Symposium
6.1 Nonlinear Dynamics in Mechanical and Structural Systems

ESMC
2018 BOLOGNA

UNIVERSITÀ DI TRENTO

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10th
European
Solid
Mechanics
Conference

EUROPEAN
MECHANICS
SOCIETY

BOLOGNA July 2-6, 2018 | Palazzo dei Congressi

P R O G R A M   B O O K

Trigger of coupled three singular points in dynamics of different mechanical systems each with one degree of freedom

Katica (Stevanović) Hedrih[1,2]

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Keywords: trigger of coupled singular points, bifurcation, phase portrait, coupled rotations, vector rotators, mass moment vectors, kinetic pressure, heavy mass particle motion along rough curvilinear trace wit Amontons-Coulomb friction.

A review of different examples with trigger of coupled three singular points in dynamics of different mechanical systems each with one degree of freedom is presented and analyzed. Trigger of coupled three singular points appear in the phase portrait of dynamics of mechanical system with one degree of freedom: 1* and with coupled rotations and mass deviation with respect to the axes of rotations; 2* in the form of a heavy mass particle moving along rough curvilinear line with Amontons-Coulomb type friction; 2* as it is generalized rolling pendulum along curvilinear trace with minimum and maximums in vertical plane. Phase portrait and constant total mechanical energy curves for each of the previous listed models of dynamics are mathematically described and graphically presented and analyzed. A theorem of existence of a trigger of coupled three singular points and a homoclinic phase trajectory in the form of number "eight" is presented.

Kinetic pressures on bearing of rotors with simple as well as coupled rotations are presented by deviational components of mass moment vectors and kinematical vector rotators coupled for corresponding bearing and axis of rotation.

References

[1] Hedrih (Stevanović) K., (2004), *A Trigger of Coupled Singularities, MECCANICA,* Vol.39, No. 3, 2004., pp. 295-314. , DOI: 10.1023/B:MECC.0000022994.81090.5f, \

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[4] Hedrih (Stevanović) K., (2005), *Nonlinear Dynamics of a Heavy Material Particle Along Circle which Rotates and Optimal Control, Chaotic Dynamics and Control of Systems and Processes in Mechanics (Eds: G. Rega, and F. Vestroni), p. 37-45. IUTAM Book, in Series Solid Mechanics and Its Applications,* Editerd by G.M.L. Gladwell, Springer,. 2005, XXVI, 504 p., Hardcover ISBN: 1-4020-3267-6.

[5] Hedrih (Stevanović) K., (2009), *Vibrations of a Heavy Mass Particle Moving along a Rough Line with Friction of Coulomb Type, ©Freund Publishing House Ltd., International Journal of Nonlinear Sciences & Numerical Simulation 10(11): 1705-1712, 2009.*

**6-1 -Nonlinear Dynamics in
Mechanical and Structural Systems**

Evening Session

DAY: Monday

ROOM: Magenta A

TIME 17.15-19.15

CHAIR: Giuseppe Rega, Alois Steindl

KEYNOTE	1180	**Derivation of Nonlinear Damping from Linear Viscoelasticity by a Fractional Standard Solid Model and Application to Nonlinear Vibrations** Author: Marco Amabili Presenting Author: Marco Amabili
	223	**Auto-parametric response of a non-holonomic system under kinematic excitation** Authors: Jiri Naprstek, Cyril Fischer Presenting Author: Jiri Naprstek
	880	**Random bouncing ball dynamics under correlated excitation** Authors: Chaïma Zouabi, Joël Perret-Liaudet, Julien Scheibert Presenting Author: Joël Perret-Liaudet
	1016	**Analysis of explosive aspect ratio in the blast wave: From flat to spherical case** Authors: J.A. Artero-Guerrero, J. Pernas-Sánchez, F. Teixeira-Dias, D. Varas, J. López-Puente Presenting Author: J.A. Artero-Guerrero
	227	**Trigger of coupled three singular points in dynamics of different mechanical systems each with one degree of freedom** Author: Katica R. (Stevanovic) Hedrih Presenting Author: Katica R. (Stevanovic) Hedrih

Welcome Reception 19.15 - 1st floor

Dear ESMC participant,

On behalf of the organizers of the ESMC minisymposium *6-1 -Nonlinear Dynamics in Mechanical and Structural Systems* I would ask you to **kindly confirm** (by replying to this mail) your availability to co-chair one of the seven sessions at the time detailed in the below table:

#	Time	Room	Chairs [ok?]
1	Monday 17.15-19.15	Magenta A	Rega [ok] & Steindl [??]
2	Tuesday 14.30-16.30	Magenta A	Thomsen [ok] & Thomas [??]
3	Tuesday 17.00-19.00	Magenta A	Sorokin [ok] & Lenci [??]
4	Wednesday 10.15-12.15	Magenta A	Gottlieb [??] & Pellicano [??]
5	Thursday 10.15-12.15	Magenta A	Dankowicz [??] & Hedrih [ok]
6	Thursday 14.30-16.30	Magenta A	Savi [??] & Indeitsev [??]
7	Thursday 17.00-19.00	Magenta A	Amabili [ok] & Mazzilli [??]

Due to time constraints we took the liberty to report suggested chair names and times to the main organizers, without asking first for your availability; we hope you will forgive us this. In case you are not available we will find a substitute, though by now it is too late to change names in the technical programme, where your name is already listed in accordance with the above table.

With the best regards,
Jon Juel Thomsen, Technical Univ. of Denmark
- on behalf also of co-organizers Giuseppe Rega and Sergey Sorokin

Jon Juel Thomsen
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MS: 6-1 -Nonlinear Dynamics in Mechanical and Structural Systems		
DAY: Thursday		
ROOM: Magenta A		
TIME 10.15-12.15		
CHAIR: Harry Dankowicz, Katica Hedrih		

KEYNOTE	1166	*Identification of nonlinear modes based on normal form and experimental continuation. Application to the acoustics of chinese gongs*
		Authors: Olivier THOMAS , Vivien DENIS , Marguerite JOSSIC , Christophe GIRAUD-AUE , Baptiste CHOMETTE , Adrien
		Presenting Author: Olivier THOMAS
	213	*Non-linear vibration modes of beams and cables on elastic media subjected to linearly varying normal forces*
		Authors: Carlos Mazzilli , Eduardo Ribeiro , Stefano Lenci , Lucio Demeio
		Presenting Author: Carlos Mazzilli
	1218	*Fast computation of forced response in multi-degree-of-freedom nonlinear mechanical systems using integral equations*
		Authors: Shobhit Jain , Thomas Breunung , George Haller
		Presenting Author: Shobhit Jain/Thomas Breunung
	205	*On the coupling between axial and transversal vibration in a rectilinear Euler-Bernoulli beam*
		Authors: Stefano Lenci , Francesco Clementi
		Presenting Author: Stefano Lenci
	528	*Motion Control of a Flexible Underactuated Manipulator by Utilizing of Resonance of a Flexible Arm*
		Authors: Satoshi Kobayashi , Hiroshi Yabuno
		Presenting Author: Satoshi Kobayashi

6-1 -Nonlinear Dynamics in Mechanical and Structural Systems

Morning Session

DAY: Thursday

ROOM: Magenta A

TIME 10.15-12.15

CHAIR: Harry Dankowicz, Katica Hedrih

KEYNOTE	1166	**Identification of nonlinear modes based on normal form and experimental continuation. Application to the acoustics of chinese gongs**

Authors: Olivier Thomas, Vivien Denis, Marguerite Jossic, Christophe Giraud-Audine, Baptiste Chomette, Adrien Mamou-Mani

Presenting Author: Olivier Thomas

213 Non-linear vibration modes of beams and cables on elastic media subjected to linearly varying normal forces

Authors: Carlos Mazzilli, Eduardo Ribeiro, Stefano Lenci, Lucio Demeio

Presenting Author: Carlos Mazzilli

1389 Nonlinear parametric modeling of compression roller batteries and experimental validation

Authors: Andrea Arena, Biagio Carboni, Walter Lacarbonara

Presenting Author: Andrea Arena

205 On the coupling between axial and transversal vibration in a rectilinear Euler-Bernoulli beam

Authors: Stefano Lenci, Francesco Clementi

Presenting Author: Stefano Lenci

528 Motion Control of a Flexible Underactuated Manipulator by Utilizing of Resonance of a Flexible Arm

Authors: Satoshi Kobayashi, Hiroshi Yabuno

Presenting Author: Satoshi Kobayashi

Lunch 12.15 - 13.45 - 1st floor

Poster Session 12.15 - 13.45 Ground floor

GS-1 Biomechanics

Morning Session

DAY: Monday

ROOM: Magenta A

TIME 11.15-13.15

CHAIR: Gabriele Greco, Sarah Johnson

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226 **Resonant frequencies of mouse chromosomes trough mechanical oscillatory model of mitotic spindle**

Authors: Andjelka Hedrih, Katica (Stevanovic) Hedrih

Presenting Author: Andjelka Hedrih

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354 **Stag beetle elytra sustains the external loads better using multi-layered structure**

Authors: Lakshminath Kundanati, Stefano Signetti, Himadri S. Gupta, Michele Menegon and Nicola M. Pugno

Presenting Author: Lakshminath Kundanati

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784 **In silico simulation of growth and remodeling in biological tissues**

Authors: M. M. A. Peyroteo, J. Belinha, J.A.C.F. Leite Moreira, R. N. Jorge

Presenting Author: M. M. A. Peyroteo

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914 **Modelling of cross-linking dynamics in actomyosin networks**

Authors: João Pedro Ferreira, Marco Parente, Renato Natal

Presenting Author: João Pedro Ferreira

1081 **Biomechanical Characterization of Thrombus Material through Experimental and Computational Analysis**

Authors: Sarah Johnson, Michael Gilvarry, Patrick McGarry, Peter McHugh

Presenting Author: Sarah Johnson

1352 **Patient-specific isogeometric analysis of thoracic aortic aneurysm**

Authors: Margherita Coda, Elena Faggiano, Michele Conti, Simone Morganti, Santi Trimarchi, Ferdinando Auricchio, Robert Leroy Taylor, Alessandro Reali

Presenting Author: Margherita Coda

Lunch 13.15 - 14.45 - 1st floor

Resonant frequencies of mouse chromosomes trough mechanical oscillatory model of mitotic spindle

Andjelka N. Hedrih[1], Katica (Stevanović) Hedrih[1,2]

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Keywords: resonant frequencies, mitotic spindle, oscillatory model.

Recently, scientists pointed out that the way chromosomes move within the cell during the cell division process could carry additional epigenetic information [1]. Using biomechanical oscillatory model of mitotic spindle [2] we recently suggest resonance as a potential mechanism for homolog chromosomes separation. According to this mechanical oscillatory model, mitotic spindle is presented as a system of coupled oscillators: 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 centers of oscillations. We assume that rheonomic centers oscillate under single external forced frequency. Each element in the model has its mechanical counterpart. Using the biomechanical oscillatory model of mitotic spindle [2,3,4] and relevant numerical data from the literature, the numerical analysis of resonant frequencies of mouse chromosomes is presented. For each homolog chromosome pair we obtained non-linear frequency curves and identified two eigen resonant frequencies which behave differently. First resonant frequency is almost the same for all pairs of homolog chromosomes, while the second resonant frequency increases as mass of homolog chromosome decreases. The first resonant frequency is impact by the chromosome masses which are very similar to each other, while the second resonant frequency is impact both by the chromosome mass and its position in the mitotic spindle. The findings are important for understanding the process of cell division.

References
 [1] 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 9(36), 1-11, (2016).
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