Przemysław Perlikowski, PhD

Technical University of Lodz

Division of Dynamics

Abstract Of Scientific Achievements

Łódź 2011

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Curriculum Vitae

Date of Birth: 27.10.1980, Łódź

Education:

1995 – 1999	42 Secondary School in Lodz
1999 – 2005	Technical University of Lodz, Faculty of Mechanical Engineering, stationary studies specialization: Applied Mechanics - Dynamics

Positions:

2004 – 2005	trainee in Division of Dynamics of TU Lodz
2005 – 2007	assistant in Division of Dynamics of TU Lodz
from 2007	assistant professor in Division of Dynamics of TU Lodz
09.2008-05.2010	post-doc in Humboldt University of Berlin

Qualification

2005 MSc, Technical University of Lodz, Faculty of Mechanical Engineering. Title of thesis: Synchronization in nonlinear dynamical system and its application. Supervisor: prof. Andrzej Stefański

2007 PhD, Technical University of Lodz, Faculty of Mechanical Engineering, specialization – mechanics. Title of thesis: Complete Synchronization in networks of nonlinear oscillators.
Supervisor: prof. Andrzej Stefański.
Reviewers: prof. Andrzej Tylikowski – TU Warsaw,
dr hab. inż. Barbara Błażejczyk-Okolewska – TU Lodz

Trainings

09.2008 - 05.2010 (18 months)	Post-doc in MATHEON Junior Research Group in Applied Mathematics "Dynamics and synchronization of complex systems" under supervision of dr Serhiy Yanchuk, Institute of Mathematics, Humboldt university of Berlin, Germany.
02.2009 (2 weeks)	University of Aberdeen, Centre for Applied Dynamics Research, Aberdeen, UK.

	05.2008 (3 weeks)	Weierstrass Institute for Applied Analysis and Stochastic, Berlin, Germany.
	06–08.2005 (3 months)	Material Centre Leoben, ul. Franz Josef 13, Leoben, Austria.

Awards and Scholarships

2011 and 2010	Two „Start” scholarships from Foundation for Polish Science.
2011	Habilitation scholarship of Rector of Technical University of Lodz.
2010	Award of Rector of Technical University of Lodz for the scientific achievements.
2010	Award of Council of Polish Academy of Science and Rectors of Universities of Lodz in Technical Sciences.
2007-2009	Six Fellowships of Marie Curie Foundation for TC1 - TC6 SICON events..
2008	Award for the best PhD thesis in 2007 at Mechanical Faculty of Technical University of Lodz.
2007	Award of Rector of Technical University of Lodz for the teaching achievements.
2006	III award in nationwide competition of "Professor Jan Szmelter" organized by PTMST (Polish Society of Theoretical and Applied Mechanics).

Personal webpage

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Łódź, 21 December 2011.

Scientific achievement

Series of publications constituting a scientific achievement

1. S. Yanchuk, **P. Perlikowski**: "Delay and Periodicity," Physical Review E 79, (2009). (Impact Factor: 2.352) (18 times cited)
2. **P. Perlikowski**, S. Yanchuk, O. V. Popovych, P. A. Tass: "Periodic patterns in a ring of delay-coupled oscillators," Physical Review E 82 (2010). (Impact Factor: 2.352) (3 times cited at ISI Web of Science, 6 times cited at pre.aps.org)
3. S. Yanchuk, **P. Perlikowski**, O. V. Popovych, P. A. Tass: „Variability of spatio-temporal patterns in non-homogeneous rings of spiking neurons," Chaos: An Interdisciplinary Journal of Nonlinear Science, (2011). (Impact Factor: 2.081) (Accepted for publication, 0 times cited)
4. **P. Perlikowski**, S. Yanchuk, M. Wolfrum, A. Stefanski, P. Mosiłek and T. Kapitaniak: "Routes to complex dynamics in a ring of unidirectionally coupled systems", Chaos: An Interdisciplinary Journal of Nonlinear Science , 20(1), (2010). (Impact Factor: 2.081) (3 times cited at ISI web of Science, 6 times cited at chaos.aip.org)

Description of results from publications constituting a scientific achievement

The aim of research in above-mentioned papers is to describe the dynamics of network of coupled dynamical systems with time delay in the feedback loop or in coupling between oscillators.

I started this investigations during my stay in Germany, working in the group of DSc. Serhiy Yanchuk in Institutions of Mathematics of Humboldt University of Berlin. In article [1], we described basic properties of oscillators with time delay in the feedback loop. Such systems have a family of periodic solutions, which are repeated infinitely many times with increasing time delay in the feedback loop. We showed the asymptotic properties of the Floquet multipliers spectrum, presenting a stability for large delay. During the further work on the complex dynamics of delayed oscillators, we collaborated with Prof. MD Peter Tass and PD Dr Oleksandr Popovych from the Institute of Neuroscience and Medicine, Neuromodulation from the Research Center Jülich. We published a paper [2] which describes a ring of unidirectionally coupled nonlinear dynamical systems with time delay in the coupling. We showed analytically calculated families of periodic solutions propagating in two directions in the network (in the direction of the coupling and backwards). We also showed changes in dynamics when the coupling is delayed. Particularly noteworthy is the fact that many

interconnected systems and a single oscillator with long time delay in the feedback loop have similar families of periodic solutions and their stability ranges are identical. To illuminate this phenomenon, we used Stuart-Landau and Fitzhugh-Nagumo systems. The propagation of the signal in two directions in the ring is a new phenomenon and may cause a significantly change in the look at determination of the coupling scheme in the experimental neurobiology. The results presented in this publication can be successfully used in the description of the dynamics of lasers, where the one-way coupling is the dominant scheme of connections between nodes. Another paper from this series [3] (just accepted for publication in Chaos) describes the signal propagation and spatio-temporal structures in networks with a heterogeneous distribution of time delay and different values of the coupling coefficient between neurons. This assumption makes our model closer to the real pattern of neurons in brain. We show that any arbitrary spatio-temporal structure can be reached with the properly chosen initial condition and the proper distribution of delay and coupling strengths. Such an arbitrary pattern causes that one can reach an arbitrary scheme of memorizing and transmitting information between neurons.

Another task, which connects to the above described, is a description of the dynamics of unidirectionally coupled oscillators Duffinga [4] without delay. The study of such a system shows the complex dynamics of the network without delay (delay can increase this complexity). A single system has only a single fixed point, but the coupling of at least three circuits causes the destabilization and the emergence of periodic, quasiperiodic, chaotic and hiperchaotic motion. For many coupled oscillators (several hundreds), we find an appearance of the space-time structures and the Eckhaus effect (stabilization of unstable periodic orbits in the vicinity of the stable orbit, this is a first observation of this effect in systems without S1 symmetry). The observed phenomena were confirmed by building a chain of three eclectic coupled Duffing systems.

The above-mentioned series of publications show that I have discovered and described new phenomena which occur in dynamical systems, especially in networks of coupled systems. Those achievements fulfill requirements mentioned in art. 16 „Ustawa o stopniach naukowych i tytule naukowym oraz o stopniach i tytule w zakresie sztuki”.

Professional career

In 1999 I started to study at the Faculty of Mechanical Engineering of the Technical University of Lodz. Since 2000 I followed an individual course of studies under the supervision of Prof. Tomasz Kapitaniak. During my studies, I participated in international student exchange programs (IAESTE). I was working for two months in Yugoslavia (2002) and three months in Austria (2005). In 2005 I graduated with a very good result. I defended a MSc thesis on 08.09.2005, my diploma was entitled: "Synchronization in nonlinear dynamical systems and its applications", the supervisor of my thesis was Prof. Andrzej Stefanski. In the same year, after one-year internship (10.2004-09.2005), I was employed as an assistant in the Division of Dynamics of the TU Lodz.

Before I defended a PhD thesis [I.1.1] I had co-authored five papers published in refereed scientific journals [I.2.1-I.2.5] and one chapter in monograph [I.3.1]. The first three papers and the chapter in the monograph are devoted to synchronization of Duffing oscillators coupled through an elastic structure [I.2.1, I.2.2, I.3.1] and van der Pol systems with identical couplings [I.2.3]. The last two publications [I.2.4, I.2.5] present results on stability of synchronization in the ring of diffusive coupled Duffing oscillators. Moreover, since 2006 I participated in the research grant (DBN N501 033 31/2490) entitled: “Dynamics and synchronization nonlinear oscillators attached to the elastic beam”, I also received a PhD grant (DBN N501 044 31/2919): “Synchronization in networks of nonlinear oscillators”.

In my doctoral thesis I described existence of synchronization thresholds in an array of nondiagonally coupled oscillators. I showed that a nondiagonal coupling can cause an appearance or a disappearance of desynchronous windows in the coupling parameter space in networks of mechanical and electrical systems. I called this behavior “ragged synchonizability”. Such a phenomenon is independent of the motion character (periodic, quasiperiodic or chaotic) of the isolated node. I analyzed a mechanism governing that phenomenon and showed its influence on the global dynamics of the network. Ragged synchronizability was also observed, for the first time, in real electrical circuits (van der Pol oscillators). The experimental results of my PhD thesis were published after its defense in two papers [II.2.4, II.2.12] and two chapters in monographs [II.3.1, II.3.2]. On the basis of the results of my PhD I was able to comment [II.2.2] on the paper by B. Nana and P. Woafo (Phys. Rev. E 74, 046213 (2006)) showing mistakes in their description of the results.

I defended my PhD thesis: “Complete synchronization in networks of nonlinear oscillators” [I.1.1] on December 10, 2007. Professor Andrzej Stefański was its supervisor. The Council of the Faculty of Mechanical Engineering conferred a PhD degree on me on December 14, 2007. Moreover, my PhD thesis was awarded by the Council of the Faculty of Mechanical Engineering as the best PhD thesis defended at the Faculty of Mechanical Engineering in 2007.

After defense of my PhD I was employed as an assistant professor in the Division of Dynamics of the TU Lodz. I was continuing my previous research and I also undertook some new research topics. In September 2008 I started a post-doc at the Institute of Mathematics of the Humboldt University of Berlin in a group headed by Dr habil. Serhiy Yanchuk. In June 2010 I came back to my position at the TU Lodz.

During the last 20 years, many types of synchronization have been discovered discovered (complete, phase, generalized, lag). In most papers published in scientific journals one can find observations of a given type of synchronization, but quite rarely connections between them are considered. In [II.2.1] I described relations between the complete, phase, generalized synchronization and Lyapunov exponents in the coupled mechanical oscillators driven kinematically with different signals: from periodic to chaotic ones. This paper was awarded in the Prof. Jan Szmelter nationwide competition organized by PTMST (Polish Society of Theoretical and Applied Mechanics) in 2006. Mismatch in system parameters is always present in mechanical systems so I extended my analysis concerning this problem [II.2.3]. The results presented in both papers are robust and can be extended to any networks with external excitation.

Before my PhD I started the investigations on the dynamics of Duffing oscillators coupled through an elastic structure. I was continuously working on this topic, this allowed me to solve the problem of coexistence of different states of phase synchronization and chaotic beating [II.2.5]. The study on this issue let us extend our investigations to synchronization between two pendulum clocks suspended on the common frame. This phenomenon was first described by Christiaan Huygens in 17th century. But so far, nobody had shown interactions between multiple pendulums. We adopted metronomes suspended on an elastic beam as a model. In articles [II.2.8, II.2.9, II.2.16] we show that after some transient time one can observe the following types of synchronization: complete when all pendulums move in the same way, in clusters, when the pendulums compose three or five clusters and, finally for an even number of pendulums, pairs of anti-phase synchronized pendulums.
Then, I participated in the analyzis of the Christiaan Huygens experiment. A careful analyzis showed that the synchronization between the clocks hanged on the common frame required high accuracy and precision performance of suspension clocks [II.2.15]. In [II.2.17] we derived the energy criteria of synchronization of two pendulums with the clock mechanism with different pendulum masses (the problem solved for the mathematical pendulum, where the changes of mass do not affect the period of oscillations). The last article [II.2.19] in this series presents an occurrence of chaos in the system of two coupled pendulums with a clock mechanism. An important part of this study was an illustration of high sensitivity to small changes in parameters of an escapement mechanism. In a narrow range of parameters, we observed an existence of multiple attractors with small basins of attraction.

The results presented in [II.2.19] were a consequence of my previous investigations related to the rare attractor problem (solutions sensitive to small changes in parameters with small basins of attraction). From the viewpoint of mechanical and electrical engineering, an occurrence of rare attractors within a change in the parameters of a dynamical system can have dangerous consequences. Therefore, the knowledge of a probability of such a phenomenon is important. In [II.2.14] we define and show a probability of occurrence of rare attractors in the Duffing - Van der Pol system.

Another project which I participated in was a description of coin tossing, using methods of classical mechanics (Euler parameters, quaternions) [II.2.6, II.2.11]. In the equations obtained by our group, we include an unequal distribution of mass, the effect of air resistance during free-fall and a collision of the coin with different types of surfaces. We showed that during the free-fall, the coin does not show sensitivity to initial conditions – the result is predictable. The greatest influence on the final result (heads or tails) has bouncing coins on the ground. Nerveless, our calculations showed that the lines bounding basins of attractions (the set of all initial conditions leads to the same solution) of the given solution are smooth, so still the outcome is predictable. In fact, it is very difficult to determine exactly initial conditions (vibrations of hands) and the shape and surface properties. When there is a sufficiently large number of reflections of the coin from the surface, is nearly impossible to predict the final result. During the further work, we described (in monograph [II.1.1]) the dynamics of throwing of the die and the motion of the ball on the roulette. The conclusions are similar as for the coin toss. This work was also presented as a chapter in monograph [II.3.3].

Since defending my PhD thesis, I have been a co-author (19) or the author (1) of 20 articles in scientific journals from the so-called 'Philadelphia List', one monograph, and 3 chapters in books and 10 conference papers. The results have been also presented by me or other co-authors at many international and national scientific conferences. Most of them have been documented by reviewed publications in conference proceedings (a summary is attached separately in the list of research achievements).

The overall impact factor (IF 2010) of these publications is **50.3**. For all my publication (25 articles in scientific journals), this ratio is: **56,11** (IF 2010). Total number of citations of my articles (November 2011) is **87** including **66** with omitting self-citation (according to the database ISI Web of Science). My Hirsch index is **5** (according to the database ISI Web of Science).

In addition to the above-mentioned achievements, numerous national and international scholarships and awards are measurable effects of significance of my investigations.

Since 2011 I am a post-doc in the project TEAM of the Foundation for Polish Science, implemented under Measure 1.2 "Improvement of human potential science" of the Innovative Economy Operational Programme 2007-2013.

Many of my scientific investigations have been performed within the framework of the following projects: four national research projects funded by the Ministry for Scientific Research and Higher Education (own projects and a PhD project) and two international grants (Royal Society, DAAD) and Polish (Department of International Cooperation). Currently, I am participating in the project: “New methods for estimation of Lyapunov exponents in dynamical systems” financed by the National Science Centre. A full list of titles and numbers of projects has been included in Section III of the statement of research achievements.

I also conduct my research within **international cooperation** with German centers: the Weierstrass Institute for Applied Analysis and Stochastics, the Humboldt University of Berlin, the Institute of Neuroscience and Medicine, Neuromodulation, Research Center Jülich, Jülich and the University Hospital of Cologne.

I have reviewed five articles in the following scientific journals: Communications in Nonlinear Science and Numerical Simulations, International Journal of Bifurcation and Chaos, Journal of Theoretical Biology, Journal of Sound & Vibration, and Philosophical Transactions of the Royal Society A. In November 2011 Minster of Science and High Education appoint me for a member of Interdisciplinary Group for evaluation of projects submitted in program „Iuventus Plus”.

In addition to scientific work, I teach students as well. I have had lectures, calculus and laboratory classes in: Mechanics, Mechanical Vibration, Fundamentals of Computer Science, Dynamics, and Theory of Mechanisms. In the TEAM project, I take care of MSc and PhD students. In 2006 I took part in the modernization of the laboratory of Dynamics and Control.

Łódź, 17 November 2011.

Note:
In the square brackets are the numbers from the attached statement of scientific achievements.

LIST OF SCIENTIFIC ACHIEVEMENTS

I. Publication before PhD

I.1. Monographs, studies, thesis

I.1.1. P. Perlikowski: „Synchronizacja kompletna sieci nieliniowych układów dynamicznych”, PhD thesis, TU Lodz, 105 pages, Łódź (2007)

I.2. Publication in refereed journals

I.2.1. K. Czołczyński, A. Stefański, P. Perlikowski, T. Kapitaniak: "Dynamics of an Array of Duffing Oscillators Suspended on Elastic Structure", *Machine Dynamics Problems* 31(2) (2007).

I.2.2. K. Czołczyński, T. Kapitaniak, P. Perlikowski, A. Stefański: „Periodization of Duffing oscillators suspended on elastic structure: mechanical explanation”, *Chaos, Solitons and Fractal* 32, 920-926 (2007). IF2010 – **1,729**

I.2.3. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: „Synchronization of self-excited oscillators suspended on elastic structure”, *Chaos, Solitons and Fractals* 32, 937-943 (2007). IF2010 – **1,729**

I.2.4. A. Stefański, P. Perlikowski, T. Kapitaniak: “Ragged synchronizability of coupled oscillators”, *Physical Review* E 75 (2007). IF2010 – **2,352**

I.2.5. P. Perlikowski, A. Stefański: “Synchronization of coupled mechanical oscillators”, *Mechanics and Mechanical Engineering* 10, 110-116 (2006)

I.3 Chapter in monograph

I.3.1. K. Czołczyński, A. Stefański, P. Perlikowski, T. Kapitaniak: Periodization and synchronization of Duffing oscillators suspended on elastic beam, IUTAM Bookseries, Vol. **2**, part 5, 317-322, Springer (2006).

I.4. Conference publications

I.4.1. K. Czołczynski, P. Perlikowski, A. Stefański, T. Kapitaniak: "Synchronization of self-excited oscillators suspended on elastic structure", Nonlinear Dynamics, Kharkiv, Ukraine (2007).

I.4.2. A. Stefański, P. Perlikowski, T. Kapitaniak: "Ragged synchronizability of coupled oscillators" , The 3rd Shanghai International Symposium on Nonlinear Sciences And Applications, Shanghai, China (2007).

I.4.3. P. Perlikowski, A. Stefański, T. Kapitaniak: "General, phase and complete synchronization in chaotic oscillators", Advanced Problems in Mechanics, Saint Petersburg, Russia (2007).

I.4.4. P. Perlikowski, A. Stefański: "Intermittent synchronizability in arrays of coupled mechanical oscillators", PhD 2006 Conference, Pilzen, Czech (2006)

I.4.5. P. Perlikowski: Synchronization of two coupled mechanical oscillators, III Polish-Ukrainian Conference of Young Scientists, Chmielnicki National University, Ukraine, (2005, Plenary session).

II. Publication after PhD

II.1. Monographs, studies, thesis

II.1.1 J. Strzalko, J. Grabski, P. Perlikowski, A. Stefański, T. Kapitaniak, "Dynamics of Gambling: Origins of Randomness in Mechanical Systems", Series: Lecture Notes in Physics, Vol. 792 , Springer, ISBN: 978-3-642-03959-1 (2010)

II.2. Publication In refereed journals

II.2.1. P. Perlikowski: "Synchronization of mechanical oscillators excited kinematically", *Journal of Theoretical and Applied Mechanics* 48(1) (2008). Impact factor IF2010 – **0,264**.

II.2.2. P. Perlikowski, A. Stefański, T. Kapitaniak: "Comment on „Synchronization in a ring of four mutually coupled van der Pol oscillators: Theory and experiment"", *Physical Review E* 77 (2008). Impact factor IF2010 – **2,352**

II.2.3. P. Perlikowski, A. Stefanski, T. Kapitaniak: "1:1 Mode locking and generalized synchronization in mechanical oscillators", *Journal of Sound and Vibration* 318(1-2) (2008). Impact factor IF2010 – **1,57**.

II.2.4. P. Perlikowski, B. Jagiełło, A. Stefański, T. Kapitaniak: "Experimental observation of ragged synchronizability", *Physical Review E* 78 (2008). Impact factor IF2010 – **2,352**.

II.2.5. K. Czołczyński, A. Stefański, P. Perlikowski, T. Kapitaniak: “Multistability and chaotic beating of Duffing oscillators suspended on the elastic structure”, *Journal of Sound and Vibration* 322(3) (2008). Impact factor IF2010 – **1,57**.

II.2.6. J. Grabski, J. Strzałko, A. Stefański, P. Perlikowski, T. Kapitaniak: "The Dynamics of Coin Tossing is Predictable", *Physics Reports* 469(2) (2008). Impact factor IF2010 – **19,438**.

II.2.7. S. Yanchuk, P. Perlikowski: "Delay and Periodicity", *Physical Review* E 79 (2009). Impact factor IF2010 – **2,352.**

II.2.8. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Clustering and synchronization of n Huygens' clocks", *Physica A* 388 (2009). Impact factor IF2010 – **1,467**.

II.2.9. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Clustering of Huygens' clocks", *Progress of Theoretical Physics* 122(4) (2009) Impact factor IF2010 – **2,553**.

II.2.10. P. Perlikowski, S. Yanchuk, M. Wolfrum, A. Stefanski, P. Mosiłek, T. Kapitaniak: "Routes to complex dynamics in a ring of unidirectionally coupled systems", *Chaos: An Interdisciplinary Journal of Nonlinear Science* 20(1) (2010). Impact factor IF2010 – **2,081**.

II.2.11. J. Strzałko, J. Grabski, A. Stefański, P. Perlikowski, T. Kapitaniak: "Understanding coin tossing", *The Mathematical Intelligencer* 32(4) (2010). Impact factor IF2010 – **0,59**.

II.2.12. P. Perlikowski, A. Stefański, T. Kapitaniak: "Discontinuous synchrony in an

array of Van der Pol oscillators", *International Journal of Non-Linear Mechanics* 45(9) (2010). Impact factor IF2010 – **1,388**.

II.2.13. P. Perlikowski, S. Yanchuk, O. V. Popovych, P. A. Tass: "Periodic patterns in a ring of delay-coupled oscillators", *Physical Review* E 82 (2010). Impact factor IF2010 – **2,352**.

II.2.14. A. Chudzik, P. Perlikowski, A. Stefański, T. Kapitaniak: "Multistability and rare attractors in van der Pol - Duffing oscillator", *International Journal Bifurcation and Chaos* 21(7) (2011). Impact factor IF2010 – **0,814**.

II.2.15. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Huygens' odd sympathy experiment revisited", *International Journal Bifurcation and Chaos* 21(7) (2011). Impact factor IF2010 – **0,814**.

II.2.16. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Clustering of non-identical clocks", *Progress of Theoretical Physics* 125(3) (2011). Impact factor IF2010 – **2,553**.

II.2.17. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Why two clocks synchronize: Energy balance of the synchronized clocks", *Chaos: An Interdisciplinary Journal of Nonlinear Science* 21, 023129 (2011). Impact factor IF2010 – **2,081**.

II.2.18. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Synchronization of slowly rotating pendulums", *International Journal Bifurcation and Chaos* (2011). Impact factor IF2010 – **0,814**. (Accepted for publication - IJBC-D-11-00054). In attachment confirmation from Editor.

II.2.19. P. Perlikowski, M. Kapitaniak, K. Czołczyński, A. Stefański, T. Kapitaniak: "Chaos in coupled clocks", *International Journal Bifurcation and Chaos* (2011), Impact factor IF2010 – **0,814**. (Accepted for publication - IJBC-D-11-00339). In attachment confirmation from Editor.

II.2.20. S. Yanchuk, P. Perlikowski, O. V. Popovych, P. A. Tass: „Variability of spatio-temporal patterns in non-homogeneous rings of spiking neurons", *Chaos: An Interdisciplinary Journal of Nonlinear Science*. Impact factor IF2010 – **2,081**. Accepted for publication. In attachment confirmation from Editor.

II. 3 Chapters in monograph

II.3.1. P. Perlikowski, A. Stefański, T. Kapitaniak, "Ragged Synchronizability of Coupled van der Pols Oscillators", Nonlinear Dyanamics, Narosa Publishing House, New Delhi, India, ISBN 978-81-7319-941-7 (2009).

II.3.2. P. Perlikowski, A. Stefański, T. Kapitaniak: “Ragged Synchronizability and Clustering in a Network of Coupled Oscillators”, Recent Advances in Nonlinear Dynamics and Synchronization (NDS-1) - Theory and Applications, Springer, ISBN: 978-3-642-04226-3 (2009).

II.3.3. J. Strzałko, J. Grabski, A. Stefański, P. Perlikowski, T. Kapitaniak: “Dynamics of coin tossing, Topics on Chaotic Systems”, Selected Papers from CHAOS 2008 International Conference, World Scientific (2009).

II. 4. Conference publications

II.4.1. Stefański, P. Perlikowski: "Coexistence of synchronous states in chaotically driven mechanical oscillators", The International Congress of Theoretical and Applied Mechanics (ICTAM), Adelaide, Australia (2008)

II.4.2. P. Perlikowski, A. Stefański, T. Kapitaniak: "Ragged Synchronizability and Clustering in a Network of Coupled Oscillators", FIRST International Workshop On Nonlinear Dynamics And Synchronization (INDS08), Klagenfurt, Austria (2008).

II.4.3. A. Stefański, P. Perlikowski: "Dynamics of Coupled Mechanical Oscillators with Common Driving", Euromech Colloquium 498, Kazimierz Dolny, Poland (2008).

II.4.4. J. Strzałko, J. Grabski J., A. Stefański, P. Perlikowski, T. Kapitaniak: "The Dynamics of Coin Tossing is Predictable", Euromech Colloquium 498, Kazimierz Dolny, Poland (2008).

II.4.5. K. Czołczynski, A. Stefański, P. Perlikowski, T. Kapitaniak: "Synchronization types of oscillators suspended on elastic structure", 5-th International Conference on Nonlinear Mechanics, Shanghai, China (2008).

II.4.6. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Clustering of clocks", Euromech Colloquium 503, Frascati (Rzym), Italy (2009).

II.4.7. J. Grabski, J. Strzałko, P. Perlikowski, A. Stefanski, B. Jagiello, T. Kapitaniak: "Coin Tossing Dynamics - Experiments and Simulations", GAMM 2009 Gdansk University of Technology, Poland, Gdansk (2009).

II.4.8. K. Czołczyński, P. Perlikowski, A. Stefanski, T. Kapitaniak: "Clustering of Huygens' clocks", International Conference on Vibration Problems (ICoVP), IIT Kharagpur - 721 302, India (2009).

II.4.9. P. Perlikowski: "*Routes to complex dynamics*", Exploring Complex Dynamics in High-Dimensional Chaotic Systems: From Weather Forecasting to Oceanic Flows Workshop, MPIPKS Dresden, Germany (2010).

II.4.10. P. Perlikowski, K. Czołczyński, A. Stefański, T. Kapitaniak: „Synchronization and rare attractors in coupled non-identical clocks", 2nd International Symposium RA'11 on "Rare Attractors and Rare Phenomena in Nonlinear Dynamics", Rīga – Jūrmala, Lithuania (2011).

II. 5. Conference communication

II.5.1. K. Czołczyński, P. Perlikowski, A. Stefański, T. Kapitaniak: "Why two clocks synchronize: Energy balance of the synchronized clocks", Dynamics Days Europe, Oldenburg, Niemcy (2011).

III. Scientific projects

III.1. 2006 – 2007: N501 044 31/2919 -- "Synchronization of network of nonlinear oscillators," (co-investigator with Prof. A. Stefański as principal investigator)..

III.2. 2006-2009: 2490/T02/2006/31 -- "Dynamics and synchronization nonlinear mechanical oscillators suspected on elastic beam," (co-investigator with Professor T. Kapitniak as principal investigator).

III.3. 2007-2009: "Multi-scale modelling of dry friction" Royal Society International Joint Projects 2007/R1 (RSIJP/W11/2008), United Kingdom. (co-investigator with Professor T. Kapitniak as principal investigator).

III.4. 2008-2009: International supporting grant for grant RSIJP/W11/2008, DWM/AD/2704/2008, "Multi-scale modelling of dry friction". Funded from Ministry of Science and Higher Education of Poland. (co-investigator with Professor T. Kapitniak as principal investigator).

III.5. 2008-2010: DWM/N97/DAAD/2008 – "Dynamic complexity in systems with delay" DAAD (German Academic Exchange Service) -- Ministry of Science and Higher Education of Poland Joint Project, Germany and Poland. (co-investigator with Professor T. Kapitniak as principal investigator).

III.6. 2008-2009: International supporting grant for grant DWM/N97/DAAD/2008 – “Dynamic complexity in systems with delay". Funded from Ministry of Science and Higher Education of Poland. (co-investigator with Professor T. Kapitniak as principal investigator).

III.7. 2011 - 2014 participation as a post-doc in TEAM project from Fundation for Polish Science: “Synchronization of Mechanical Systems Coupled through Elastic Structure”. Head of project Prof. Tomasz Kapitaniak. Programme operated within the Innovative Economy Operational Programme 2007-2013, Measure 1.2 "Improvement of human potential science".

III.8. 2011 – 2014 participation In grant: „New methods for estimation of Lyapunov exponents in dynamical systems,” financed by National Science Centre. (co-investigator with DSc J. Wojewoda as principal investigator)

IV. Reviewing of scientific projects and papers

IV.1 Review of journal papers

Journal	Number of Reviews
Communications in Nonlinear Science and Numerical Simulations	1
International Journal Bifurcation and Chaos	1
Journal of Theoretical Biology	1
Journal of Sound & Vibration	1
Philosophical Transactions of Royal Society A	1

IV.2 Review of scientific projects

In November 2011 Minster of Science and High Education appoint me for a member of Interdisciplinary Group for evaluation of projects submitted in program „Iuventus Plus”.

V. Impact Factor, Hirsch Index, Citation

Impact Factor (IF2010): **56,11** (**50,3** after PhD)

Hirscha Index: **5** (ISI Web of Science), **5** (Publish or Perish)

Citation: **87** where **66** without self-citation (ISI Web of Science), **118** (Publish or Perish)

Summary of scientific achievements

	Total		After PhD	
	polish	international	polish	international
Monographs, thesis	1	1		1
Chapters in monographs		4		3
Publication published in refereed journals	3	19	1	16
Publication accepted for publication in refereed journals		3		3
Publication published in conference proceedings		19	1	9
Conference communications		1		1
Review of publication		5		5
Grants from Ministry of Science and Higher Education and National Science Center	2		2	
International Grants		2		2
Grants supporting international grants	2		2	
Grants for PhD	1			

VI. TEACHING ACHIEVEMENTS

VI.1. Teaching

1) *Mechanical Vibrations (Physics III)*
    - lecture, calculus and laboratory (non-stationary studies), III semester, Mechanics and Construction of Machines
    - lecture, calculus and laboratory (stationary studies), V semester, Mechanics and Construction of Machines.
2) *Dynamics of Machines*
    - calculus and laboratory (stationary studies), V semester, Mechanics and Construction of Machines, Automatics and Robotics, Applied Mechanics

- lecture, calculus and laboratory (non-stationary studies), VII semester, Mechanics and Construction of Machines, Automatics and Robotics.

3) *Dynamics and Control*

- laboratories in English, V semester, Mechatronics (International Faculty of Engineering).

4) *Theory of Machines*

- lecture, calculus and laboratory (stationary studies), III semester, Mechanics and Construction of Machines.

5) *Mechanics*

- calculus and laboratory (stationary studies), I semester, Enginery of production.
- calculus and laboratory (non-stationary studies), I and III semesters, Mechanics and Construction of Machines.

VI.2 Supervision of PhD students

From October 2011 I am auxiliary supervisor of PhD of mgr. Anna Karmazyn (supervisor prof. Andrzej Stefański).