

Curriculum Vitae - Michał Matuszewski

Personal data:

Date and place of birth: 7 January 1980, Chorzów, Poland.

Mailing address: Instytut Fizyki PAN, al. Lotników 32/46,
02-668 Warszawa, Poland.

Email address: mmatu@ifpan.edu.pl

Researcher ID: N-3099-2015

Professional Experience:

- 2015- Head of the Quantum Optics Group (ON 2.6) at the Institute of Physics of the Polish Academy of Sciences, Warsaw, Poland.
- 2013- Associate professor (profesor nadzwyczajny) at the Institute of Physics of the Polish Academy of Sciences, Warsaw, Poland.
- 2010-2013 Assistant professor (adiunkt) at the Institute of Physics of the Polish Academy of Sciences, Warsaw, Poland.
- 2009-2010 ARC Australian Postdoctoral Fellow (APD) at the Nonlinear Physics Centre, Research School of Physical Sciences and Engineering, Australian National University, Canberra.
- 2007-2008 Postdoctoral Fellow at the Nonlinear Physics Centre, Research School of Physical Sciences and Engineering, Australian National University, Canberra.

Qualifications:

- 2012 DSc (habilitation) in Theoretical Physics, Institute of Physics of the Polish Academy of Sciences, Warsaw, Poland.
- 2007 PhD in Theoretical Physics, Faculty of Physics, Warsaw University, „Poszukiwanie wielowymiarowych solitonów optycznych przy użyciu metod wariacyjnych”, supervisor: dr hab. Marek Trippenbach.
- 2004-2007 Postgraduate studies at the Warsaw University, Faculty of Physics, Chair for Quantum Optics and Atomic Physics, supervisor: dr hab. Marek Trippenbach.
- 2004 MSc in Theoretical Physics, Faculty of Physics, Warsaw University, „Badanie propagacji impulsów świetlnych w nieliniowych ośrodkach optycznych”, supervisor: dr hab. Marek Trippenbach.

- 1999-2004 Undergraduate studies at the Warsaw University, Individual Inter-faculty Studies in Mathematics and Natural Sciences.
- 2003 BSc in Computer Science at the Faculty of Mathematics, Informatics, and Mechanics, Warsaw University.

Prizes, Awards, and Fellowships:

- Scholarship for outstanding young scientists, Ministry of Science and Higher Education (2012-2015).
- Stefan Pieńkowski award of the Polish Academy of Sciences in the field of Physics and Astronomy (2011).
- “HOMING PLUS” research fellowship, Foundation for Polish Science, 2010-2012.
- Australian Postdoctoral Fellowship (APD) three-year research fellowship funded by the Australian Research Council (ARC), 2009-2011.
- Oliphant Endowment Fund Postdoctoral Fellowship, two-year research fellowship at the Australian National University, 2008-2009.
- Scholarship for the best young scientists (START), Foundation for Polish Science, 2006 and 2007,
- Scholarship of the Minister of Education of Poland, 1999, 2002-2003 and 2003-2004,
- Bronze medal at the 40th International Mathematical Olympiad, Bucharest (1999),
- Four prizes of polish Mathematics and Physics Olympiads, 1998 and 1999,
- Scholarship from the Polish Childrens’ Fund (1998-99),
- Scholarship from the Prime Minister of Poland (1998).

Research areas:

- Bose-Einstein condensates – exciton and polariton condensates, spinor condensates, superfluidity and stability.
- Nonequilibrium phase transitions – universality of dynamics, formation of defects.
- Solitons – existence and stability of solitons in continuous and periodic nonlinear media.
- Nonlinear optics – nonlinear light propagation in colloidal and Kerr media, nonlinear waveguide arrays.

Other activities:

- Member of the Science Dissemination committee of the Minister of Science and Higher Education of Poland (2014-2016).
- Member of the Young Researchers Council, advisory committee of the Minister of Science and Higher Education of Poland (2012-2013).
- Member of the Committee of the Australian National University Mountaineering Club (2008-2010).
- Elector of the Dean of the Faculty of Physics at the University of Warsaw (representative of PhD students, 2005).

Supervision of students:

- Piotr Stepnicki, MSc, “Polarytony w polu magnetycznym”, co-supervisor together with prof. Witold Bardyszewski, University of Warsaw, 2015.
- Michał Kulczykowski, PhD candidate (2013-).
- Paweł Miętki, PhD candidate (2016-).
- Andrzej Opala, PhD candidate (2017-).

Teaching experience:

- Member of the Central Committee of the Polish Physics Olympiad, 2005-2007 and 2010-2012.
- Teaching at the Institute of Physics, Polish Academy of Sciences: Lecture “Nonlinear Physics in a nutshell”.
- Teaching at University of Warsaw (210h): Physics I, Foundations of Modern Physics, Computer Laboratory, Programming in C++, Nonlinear Optics.
- Lectures for general public (Festiwal Nauki).

Stays in external institutions:

- July-August 2005, visiting student in the group of prof. Wiesław Królikowski, Laser Physics Centre, Australian National University, Canberra.
- November 2010, visit in the group of prof. Kai Bongs, University of Birmingham, UK.
- January-March 2011, visit in the group of prof. Yuri Kivshar, Australian National University, Canberra.
- June 2011, visit in the group of prof. Alexey Kavokin, University of Southampton, UK.
- October 2011, visit in the group of prof. Kai Bongs, University of Birm-

ingham, UK.

- February 2012, visit in the group of prof. Alexey Kavokin, University of Southampton, UK.
- February 2013, visit in the group of prof. Jacqueline Bloch, CNRS/LPN, France.
- February 2013, visit in the group of prof. Alberto Bramati, Université Pierre et Marie Curie - Paris 6, France.
- February-March 2014, visit in the group of dr Elena Ostrovskaya, Australian National University, Canberra.
- July 2014, visit in the group of dr Fabrice Laussy, Universidad Autónoma de Madrid.
- August 2015, visit in the group of dr Marzena Szymańska, University College London.
- October 2016, visit in the group of prof. Daniele Sanvitto, Lecce, Italy.

Leader of research projects:

- “New quantum states in polaritonic fluids of light”, SONATA BIS scheme grant 2016/22/E/ST3/00045, National Science Center, 2017-2022.
- “Nonequilibrium bosonic gases in semiconductors under the influence of external fields”, OPUS scheme grant 2015/17/B/ST3/02273, National Science Center, 2016-2018.
- “Nonlinear phenomena in polariton and exciton superfluids”, grant for for PhD holders starting a career in research, National Science Center, 2011-2017.
- “Kwantowe stany i przemiany fazowe w kondensatach Bosego-Einsteina ze spinem”, Iuventus Plus, Ministry of Science and Higher Education, 2012-2013.
- “Magnetic interactions in spinor Bose-Einstein condensates”, HOMING PLUS, Foundation for Polish Science, EU funded, 2010-2012.
- Discovery Project „Nonlinear optics in soft matter”, Australian Research Council, 2009-2010.

Participation in research projects:

- European Union project „Nanodesigning of atomic and molecular quantum matter” (NAME-QUAM), 2010-2012.
- Centre of Excellence for Quantum-Atom Optics (ACQAO), Australian Research Council, 2007-2010.
- Grant MNiSW N202 128539 „Dynamiczne zmiany koherencji w gazach

kwantowych” (2010-2012).

- Grant KBN 2P03B 04325 „Nieliniowa Optyka Fotonów i Atomów”, Polish Ministry of Science.
- Grant MNII PBZ MIN-008/P03/2003 „Informatyka i inżynieria kwantowa”, Polish Ministry of Science (2006-2007).
- Grant MNII N202 014 31/0567 „Badania solitonów w nieliniowych ośrodkach optycznych i kondensatach Bosego-Einsteina z periodyczną modulacją” (promotorski), Polish Ministry of Science (2006-2007).

Professional memberships:

- European Physical Society,
- Mediterranean Institute of Fundamental Physics.

Referee of journals:

- Physical Review Letters,
- Physical Review A,
- Physical Review E,
- Optics Letters,
- Journal of Physics B,
- New Journal of Physics,
- Chaos, Solitons, and Fractals,
- Superlattices and Microstructures,
- Acta Physica Polonica A.

Conferences:

- 16 invited lectures, 6 contributed oral presentations, and 17 poster presentations at international conferences and workshops.
- Co-organizer of the “1st Young Researchers Forum”, April 2013.

Foreign languages:

- English – fluent,
- Spanish – intermediate,
- German – basic.

Refereed research papers:

1. M. Matuszewski, W. Wasilewski, M. Trippenbach, Y. B. Band, "Self-consistent treatment of the full vectorial nonlinear optical pulse propagation equation in an isotropic medium", *Opt. Commun.* **221**, 337-351 (2003). *Impact Factor: 1.58*.
2. M. Trippenbach, M. Matuszewski, E. Infeld, Cao Long Van, R. S. Tasgal, Y. B. Band, "Enhancement of third harmonic generation by wave vector mismatch to counter phase-modulation", *Opt. Commun.* **229**, 391-395 (2004). *Impact Factor: 1.58*.
3. R. S. Tasgal, M. Trippenbach, M. Matuszewski, Y. B. Band, "Highly nonlinear dynamics of third-harmonic generation by focused beams", *Phys. Rev. A* **69**, 013809 (2004). *Impact Factor: 2.9*.
4. M. Matuszewski, M. Trippenbach, B. A. Malomed, E. Infeld, A. A. Skorupski, "Two-dimensional dispersion-managed light bullets in Kerr media", *Phys. Rev. E* **70**, 016603 (2004). *Impact Factor: 2.35*.
5. M. Trippenbach, M. Matuszewski, B. A. Malomed, "Stabilization of three-dimensional matter-waves solitons in an optical lattice", *Europhys. Lett.* **70**, 8-14 (2005). *Impact Factor: 2.12*.
6. M. Matuszewski, E. Infeld, B. A. Malomed, M. Trippenbach, "Fully three dimensional breather solitons can be created using Feshbach resonance", *Phys. Rev. Lett.* **95**, 050403 (2005). *Impact Factor: 7.4*.
7. M. Matuszewski, E. Infeld, M. Trippenbach, "Stability analysis of three dimensional breather solitons in a Bose Einstein Condensate", *Proc. R. Soc. A* **461**, 3561-3574 (2005). *Impact Factor: 1.4*.
8. M. Matuszewski, C. R. Rosberg, D. N. Neshev, A. A. Sukhorukov, A. Mitchell, M. Trippenbach, M. W. Austin, W. Królikowski, Y. S. Kivshar, "Crossover from self-defocusing to discrete trapping in nonlinear waveguide arrays", *Opt. Express* **14**, 254 - 259 (2006). *Impact Factor: 3.8*.
9. M. Matuszewski, E. Infeld, B. A. Malomed, M. Trippenbach, "Stabilization of three-dimensional light bullets by a transverse lattice in a Kerr medium with dispersion management", *Opt. Commun.* **259**, 49-54 (2006). *Impact Factor: 1.58*.
10. P. Ziń, E. Infeld, M. Matuszewski, G. Rowlands, M. Trippenbach, "Method for obtaining exact solutions of the nonlinear Schrödinger equation for a double-square-well potential", *Phys. Rev. A* **73**, 022105 (2006). *Impact Factor: 2.9*.
11. E. Infeld, M. Matuszewski, M. Trippenbach, "A hybrid variational method of describing pulse splitting by dispersion management", *J. Phys. B* **39**, L113-L118 (2006). *Impact Factor: 1.76*.
12. M. Matuszewski, W. Królikowski, M. Trippenbach, Y. S. Kivshar, "Simple and efficient generation of gap solitons in Bose-Einstein condensates", *Phys. Rev. A* **73**, 063621 (2006). *Impact Factor: 2.9*.

13. E. Infeld, M. Matuszewski, C. Shino, M. Trippenbach, "Can a variational approach describe pulse splitting in a dispersion managed system?", *Optica Applicata* **36**, 575 (2006). *Impact Factor: 0.46*.
14. M. Matuszewski, B. A. Malomed, M. Trippenbach, "Spontaneous symmetry breaking of solitons trapped in a double-channel potential", *Phys. Rev. A* **75**, 063621 (2007). *Impact Factor: 2.9*.
15. M. Matuszewski, B. A. Malomed, M. Trippenbach, "Competition between attractive and repulsive interactions in two-component Bose-Einstein condensates trapped in an optical lattice", *Phys. Rev. A* **76**, 043826 (2007). *Impact Factor: 2.9*.
16. M. Matuszewski, W. Królikowski, Y. S. Kivshar, "Spatial solitons and light-induced instabilities in colloidal media", *Opt. Express* **16**, 1371 (2008). *Impact Factor: 3.8*.
17. M. Trippenbach, E. Infeld, J. Gocalek, M. Matuszewski, M. Oberthaler, B. A. Malomed, "Spontaneous symmetry breaking of gap solitons and phase transitions in double-well traps", *Phys. Rev. A* **78**, 013603 (2008). *Impact Factor: 2.9*.
18. M. Matuszewski, T. J. Alexander, Y. S. Kivshar, "Spin-Domain Formation in Antiferromagnetic Condensates" *Phys. Rev. A* **78**, 023632 (2008). *Impact Factor: 2.9*.
19. M. Matuszewski, W. Królikowski, Y. S. Kivshar, "Soliton interactions and transformations in hard-sphere colloids", *Phys. Rev. A* **79**, 023814 (2009). *Impact Factor: 2.9*.
20. M. Matuszewski, W. Królikowski, Y. S. Kivshar, "Bistable solitons in colloidal media", *Photonics Lett. Pol.* **1**, 4 (2009).
21. N. V. Hung, M. Matuszewski, M. Trippenbach, "Matter wave soliton collisions in the quasi one dimensional potential", *Physica D* **238**, 1449-1455 (2009). *Impact Factor: 1.74*.
22. M. Matuszewski, T. J. Alexander, Y. S. Kivshar, "Excited spin states and phase separation in spinor Bose-Einstein condensates", *Phys. Rev. A* **80**, 023602 (2009). *Impact Factor: 2.9*.
23. M. Matuszewski, "Engineering optical soliton bistability in colloidal media", *Phys. Rev. A* **81**, 013820 (2010). *Impact Factor: 2.9*.
24. M. Matuszewski, I. L. Garanovich, A. A. Sukhorukov, "Light bullets in nonlinear periodically curved waveguide arrays", *Phys. Rev. A* **81**, 043833 (2010). *Impact Factor: 2.9*.
25. M. Matuszewski, T. J. Alexander, Y. S. Kivshar, "Magnetic domains in spinor Bose-Einstein condensates", *Fiz. Nizk. Temp.* **36**, 883 (2010). *Impact Factor: 0.78*.
26. M. Matuszewski, "Rotonlike instability and pattern formation in spinor Bose-Einstein condensates", *Phys. Rev. Lett.* **105**, 020405 (2010). *Impact Factor: 7.4*.
27. M. Matuszewski, "Ground states of trapped spin-1 condensates in magnetic field", *Phys. Rev. A* **82**, 053630 (2010). *Impact Factor: 2.9*.
28. T. Świsłocki, M. Matuszewski, "Controlled creation of spin domains in spin-1 Bose-

- Einstein condensates by phase separation”, Phys. Rev. A **85**, 023601 (2012). *Impact Factor: 2.9.*
29. M. Matuszewski, T. Taylor, A. V. Kavokin, “Exciton supersolidity in hybrid Bose-Fermi mixtures”, Phys. Rev. Lett. **108**, 060401 (2012). *Impact Factor: 7.4.*
 30. M. Matuszewski, K. Bongs, J. Kronjäger, “Patterns and excitations in antiferromagnetic spinor condensates”, Phys. Rev. A **85**, 023635 (2012). *Impact Factor: 2.9.*
 31. M. Matuszewski, T. C. H. Liew, Y. G. Rubo, and A. V. Kavokin, “Spin-orbital coupling and topology of spin-degenerate cold exciton gases”, Phys. Rev. B **86**, 115321 (2012). *Impact Factor: 3.7.*
 32. T. Świsłocki, E. Witkowska, J. Dziarmaga, M. Matuszewski, “Double universality of a quantum phase transition in spinor condensates: Modification of the Kibble-Zurek mechanism by a conservation law”, Phys. Rev. Lett. **110**, 045303 (2013). *Impact Factor: 7.4.*
 33. E. Witkowska, J. Dziarmaga, T. Świsłocki, M. Matuszewski, “Dynamics of the modified Kibble-Zurek mechanism in antiferromagnetic spin-1 condensates”, Phys. Rev. B **88**, 054508 (2013). *Impact Factor: 3.7.*
 34. P. Stepnicki, M. Matuszewski, “Tight-binding model for exciton-polariton condensates in external potentials”, Phys. Rev. A **88**, 033626 (2013). *Impact Factor: 2.9.*
 35. M. Matuszewski, E. Witkowska, “Universality in nonequilibrium condensation of exciton-polaritons”, Phys. Rev. B **89**, 155318 (2014). *Impact Factor: 3.7.*
 36. Y. Xue, M. Matuszewski, “Creation and Abrupt Decay of a Quasistationary Dark Soliton in a Polariton Condensate”, Phys. Rev. Lett. **112**, 216401 (2014). *Impact Factor: 7.4.*
 37. Emilia Witkowska, Tomasz Świsłocki, Michał Matuszewski, “Thermal fluctuations and quantum phase transition in antiferromagnetic Bose-Einstein condensates”, Phys. Rev. A **90**, 033604 (2014). *Impact Factor: 2.9.*
 38. N. Bobrovska, E. A. Ostrovskaya, M. Matuszewski, “Stability and spatial coherence of nonresonantly pumped exciton-polariton condensates”, Phys. Rev. B **90**, 205304 (2014). *Impact Factor: 3.7.*
 39. T. C. H. Liew, O. A. Egorov, M. Matuszewski, O. Kyriienko, X. Ma, E. A. Ostrovskaya, “Instability-induced formation and nonequilibrium dynamics of phase defects in polariton condensates”, Phys. Rev. B **91**, 085413 (2015). *Impact Factor: 3.7.*
 40. B. Piętka, D. Zygmont, M. Król, M. R. Molas, A. A. L. Nicolet, F. Morier-Genoud, J. Szczytko, J. Łusakowski, P. Zięba, I. Tralle, P. Stepnicki, M. Matuszewski, M. Potemski, B. Deveaud, “Magnetic field tuning of exciton-polaritons in a semiconductor microcavity”, Phys. Rev. B **91**, 075309 (2015). *Impact Factor: 3.7.*
 41. P. Stepnicki, B. Piętka, F. Morier-Genoud, B. Deveaud, M. Matuszewski, “Analytical

- method for determining quantum well exciton properties in a magnetic field”, Phys. Rev. B **91**, 195302 (2015). *Impact Factor*: 3.7.
42. M. Kulczykowski, N. Bobrovska, M. Matuszewski, “Bright sink-type localized states in exciton-polariton condensates”, Phys. Rev. B **91**, 245310 (2015). *Impact Factor*: 3.7.
43. N. Bobrovska, M. Matuszewski, “Adiabatic approximation and fluctuations in exciton-polariton condensates”, Phys. Rev. B **92**, 035311 (2015). *Impact Factor*: 3.7.
44. L. Dominici, M. Petrov, M. Matuszewski, D. Ballarini, M. De Giorgi, D. Colas, E. Cancellieri, B. Silva Fernández, A. Bramati, G. Gigli, A. Kavokin, F. Laussy, D. Sanvitto, “Real-space collapse of a polariton condensate”, Nature Commun. **6**, 8993 (2015). *Impact Factor*: 11.47.
45. O. Voronych, A. Buraczewski, M. Matuszewski, and M. Stobińska, “Exciton-polariton localized wave packets in a microcavity”, Phys. Rev. B **93**, 245310 (2016). *Impact Factor*: 3.7.
46. Tomasz Świsłocki, Emilia Witkowska, Michał Matuszewski, “Nonadiabatic quantum phase transition in a trapped spinor condensate”, Phys. Rev. A **94**, 043635 (2016). *Impact Factor*: 2.9.
47. M. Kulczykowski, M. Matuszewski, “Phase ordering kinetics of a nonequilibrium exciton-polariton condensate”, Phys. Rev. B **95**, 075306 (2017). *Impact Factor*: 3.7.
48. N. Bobrovska, M. Matuszewski, T. C. H. Liew, and O. Kyriienko, “Interactive optomechanical coupling with nonlinear polaritonic systems”, Phys. Rev. B **95**, 085309 (2017). *Impact Factor*: 3.7.
49. R. Mirek, M. Król, K. Lekenta, J.-G. Rousset, M. Nawrocki, M. Kulczykowski, M. Matuszewski, J. Szczytko, W. Pacuski, and B. Piętka, “Angular dependence of giant Zeeman effect for semimagnetic cavity polaritons”, Phys. Rev. B **95**, 085429 (2017) *Impact Factor*: 3.7.
50. O. Voronych, A. Buraczewski, M. Matuszewski, M. Stobińska, “Numerical modeling of exciton-polariton Bose-Einstein condensate in a microcavity”, Computer Phys. Commun. **215**, 246–258 (2017). *Impact Factor*: 3.6.
51. B. Piętka, M. R. Molas, N. Bobrovska, M. Król, R. Mirek, K. Lekenta, P. Stepnicki, F. Morier-Genoud, J. Szczytko, B. Deveaud, M. Matuszewski, and M. Potemski, “2s exciton-polariton revealed in an external magnetic field”, Phys. Rev. B **96**, 081402(R) (2017). *Impact Factor*: 3.7.
52. B. Piętka, N. Bobrovska, D. Stephan, M. Teich, M. Król, S. Winnerl, A. Pashkin, R. Mirek, K. Lekenta, F. Morier-Genoud, H. Schneider, B. Deveaud, M. Helm, M. Matuszewski, and J. Szczytko, “Doubly Dressed Bosons: Exciton Polaritons in a Strong Terahertz Field”, Phys. Rev. Lett. **119**, 077403 (2017). *Impact Factor*: 8.5.
53. P. Miętki and M. Matuszewski, “Magnetic polarons in a nonequilibrium polariton condensate”, Phys. Rev. B **96**, 115310 (2017). *Impact Factor*: 3.7.
54. A. Gianfrate, L. Dominici, O. Voronych, M. Matuszewski, M. Stobińska, D.

- Ballarini, M. De Giorgi, G. Gigli, D. Sanvitto, “Superluminal X-waves in a polariton quantum fluid”, *Light: Science & Applications* **7**, 17119 (2018). *Impact Factor: 14.6*.
55. N. Bobrovska, M. Matuszewski, K. S. Daskalakis, S. A. Maier, S. Kéna-Cohen, “Dynamical Instability of a Nonequilibrium Exciton-Polariton Condensate”, *ACS Photonics*, **5**, 111 (2018). *Impact Factor: 6.8*.

Citation count (ISI Web of Science, 25.01.2018): 753

h-index: 16

Conference Papers:

1. P. Wasylczyk, W. Wasilewski, M. Matuszewski, M. Trippenbach, Czesław Radzewicz, “Nonlinear propagation of femtosecond laser pulses in dielectrics”, *Proceedings of SPIE Vol. 5258*, 20-24 (2003).
2. Michał Matuszewski, Eryk Infeld, Boris A. Malomed, A. A. Skorupski, Marek Trippenbach, “Two- and three-dimensional light bullets in a Kerr medium with dispersion management”, *Proceedings of SPIE Vol. 5949*, 24-34 (2005).
3. C. Rosberg, M. Matuszewski, D. Neshev, A. Sukhorukov, A. Mitchell, M. Trippenbach, M. Austin, W. Krolikowski, Y. Kivshar, “Discrete Self-Trapping vs Defocusing in Nonlinear Waveguide Arrays”, *Proceedings of Conference on Lasers and Electro-Optics Quantum Electronics and Laser Science/Conference on Photonic Applications Systems and Technologies (CLEO/QELS)* (2006).
4. M. Matuszewski, W. Krolikowski, Y. Kivshar, “Soliton interactions and transformations in hard-sphere colloids”, *Proceedings of European Conference on Lasers and Electro-Optics and the European Quantum Electronics Conference (CLEO/EQEC)* (2009).
5. M. Matuszewski, A. Sukhorukov, I. Garanovich, “Mobile light bullets in curved waveguide arrays”, *Proceedings of European Conference on Lasers and Electro-Optics and the European Quantum Electronics Conference (CLEO/EQEC)* (2009).
6. M. Matuszewski, I. Garanovich, A. Sukhorukov, “Light Bullets in Nonlinear Curved Waveguide Arrays”, *Proceedings of Australasian Conference on Optics Lasers and Spectroscopy and the Australian Conference on Optical Fibre Technology in association with the International Workshop on Dissipative Solitons (ACOLS ACOFT)* (2009).

Other:

1. P. Bajor, J. Fichna, M. Grabowski, B. Lis, M. Matuszewski, P. Oprocha “Jak napisać

wniosek o finansowanie badań naukowych – poradnik Rady Młodych Naukowców”,
(2013).