Curriculum Vitae

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Wykształcenie

2000 – doktorat z matematyki teoretycznej (za prace pt. ,,Macierzowy problem momentów").

1997–1998 – grant IM PAN dla doktorantów.

1996–2000 – studia doktoranckie w IM PAN (Warszawa).

1996 – tytuł magistra z matematyki teoretycznej, UWroc..

1995–1996 – stypendium MEN.

1995 – nagroda im. J. Marcinkiewicza za prace pt. ,,Some counterexamples to the subexponential growth of othogonal polynomials".

1989–1996 – studia magisterskie na kierunku matematyka teoretyczna, Uniw. Wrocławski.

Przebieg zatrudnienia

2013– *do dziś* – adiunkt na Wydziale Matematyki Stosowanej, AGH im. S.Staszica, Kraków.

2012–2013 – własna działalność gospodarcza (ubezpieczenia, działalność edukacyjna), Katowice.

2011–2012 – Towarzystwo Ubezpieczeń na Życie ,,Warta", Katowice.

2005–2011 – adiunkt na Wydziale Matematyki Stosowanej, AGH im. S.Staszica, Kraków.

2003–2004 – adiunkt na Wydziale Podstawowych Problemów Techniki, Politechnika Wrocławska, Wrocław.

2001–2003 – adiunkt na Wydziale Matematyki, Uniwersytet Wrocławski, Wrocław.

2000–2001 – adiunkt w Instytucie Matematycznym PAN, Warszawa, Kraków.

Zainteresowania naukowe

Wielomiany ortogonalne i problem momentów;

Równania funkcyjne i równania rekurencyjne;

Analiza funkcjonalna i teoria operatorów;

Spacer losowy na grafach;

Probabilistyka kwantowa i wolna;

Teoria gier;

Rachunek prawdopodobieństwa i statystyka matematyczna;

Modele matematyczne:

Matematyka aktuarialna;

zastosowania matematyki w: krystalografii, agrofizyce, fizyce ciała stałego, medycynie, itp.

Staże naukowe (visiting professor)

2010, Ruhr-Uniwersität Bochum, Niemcy, (prof. H. Dette).

temat badań: matrix orthogonal polynomials.

2004, Ernst-Moritz-Arndt-Universität Greifswald, Niemcy, (prof. M. Schürmann).

temat badań: operator theory, quantum probability and q-calculus

2003, Ruhr-Uniwersität Bochum, Niemcy, (prof. H. Dette).

temat badań: matrix-valued measures on $[0,1]$ and matrix orthogonal polynomials.

2002–03, Ruhr-Uniwersität Bochum, Niemcyy, *Krupp Fund grant*, (prof. H. Dette).

temat badań: matrix-valued measures on $[0,1]$.

Doświadczenie dydaktyczne

Prowadzone wykłady i seminaria

Wstep do Logiki i Teorii Mnogości;

Podstawy Probabilistyki i Procesów Stochastycznych;

Funkcje Specjalne i Wielomiany Ortogonalne

Analiza Matematyczna I i II*;

Analiza Zespolona;

Algebry Banacha i analiza spektralna;

Teoria operatorów przestrzeni Hilberta;

Teoria gier;

C^***-algebry**;

Modele matematyczne w przyrodzie i technice*;

Programowanie w pakietach matematycznych: *Mathematica* i *MATLAB*;

*) wykłady prowadzone również w jezyku angielskim

Résumé

Growth of orthogonal polynomials

In 1995 I found an example of orthogonal polynomials with the property that the set $\{x \mid \liminf_{n\to\infty} |p_n(x)|^{1/n} > 1\}$ is dense in the support of the orthogonality measure. This holds for $a_n = \frac{1}{2}$ and $b_n \in \{0, r\}$ chosen in a special way. Moreover I obtained by a little change of the recurrence coefficients b_n another example of polynomials p_n orthogonal with respect to the measure supported on $[-1,1] \cup [r-1, r+1]$, where $|p_n|$ has an exponential growth on a dense subset of $[-1,1]$ and $\liminf_{n\to\infty} |p_n(x)|^{1/n} = 1$ uniformly on $[r-1, r+1]$. Both examples are contained in [1].

Orthogonal polynomials in two variables

I [2] investigated also systems of orthogonal polynomials in two variables. In the case of the rotation invariant measure I found a very simple recurrence formula for polynomials $p_{n,k}$ orthogonal with respect to it. This case contains the so-called disk polynomials. The formula is as follows:

$$zp_{n,k}(z) = a_{n,k}p_{n+1,k}(z) + b_{n,k}p_{n,k-1}(z)$$

$$p_{0,0}(z) = 1, \qquad p_{n,-1}(z) = 0, \qquad \overline{p_{n,k}(z)} = p_{k,n}(z)$$

where $z = x + iy$. The coefficients $a_{n,k}$, $b_{n,k}$ are positive, moreover they can be computed easily from the recurrence coefficients of polynomials of one variable, orthogonal with respect to the radial part of the measure.

In some special cases the recurrence coefficients are explicitly computed (it covers also the case of disk polynomials).

Together with P. Śniady we showed in [4] using those recurrence formulas that in the $U(1)$-field theories the corresponding connection coefficients are $Cq^n(1-q^k)/(1-q)$ for some constants $C, q > 0$. This corresponds to q-Laguerre polynomials and it seems to be very important in quantum physics.

Matrix measures and matrix-valued orthogonal polynomials

At the same time I started to investigate matrix orthogonal polynomials, i.e. matrix-valued polynomials P_n which satisfy the relation

$$\int_{\mathbb{R}} P_n(x)d\Sigma(x)P_m(x)^* = I\delta_{n,m}$$

where Σ is a given matrix of measures (called orthogonal matrix measure). In [6] I investigated properties of such measures using matrix continued fractions. In the case of constant recurrence coefficients I show the explicit formula for spectrum of orthogonality measures. In the case of hermitian and constant recurrence coefficients the orthogonality measure is absolutely continuous with respect to the Lebesgue measure multiplied by the identity matrix, and its density can be explicitly computed.

In [7] I extended these results to the function valued in some C^*-algebra. This allowed me to investigate the properties of a discrete Schrödinger operator on a Hilbert space containing the C^*-algebra module.

Random walk on infinite graphs

The methods from the theory of matrix-valued orthogonal polynomials leaded to analysis and to description of properties of random walk on some infinite graphs. The main achievements are contained in [9]. The special cases of ladder graphs are considered in [10].

Methane diffusion–reaction processes in the soil

Since 1996 I have also collaborated with W. Stepniewski from Agrophysical Institute of Polish Academy of Sciences. We elaborated a theoretical model of diffusion–reaction system in the soil and give approximate numerical solutions in [3] and [5].

Present research interests

Orthogonal Polynomials, Special Functions, Difference Equations and related fields, q-Calculus

My main interest are matrix-valued orthogonal polynomials which are extension of classical orthogonal polynomials of one variable. Especially I am looking for recurrence equations and other related formulas (cf. [8]) and explicit forms of matrix measures which orthogonalize such polynomials (cf. [11]).

My other interests are pointed to the q-calculus and quantum physics, where orthogonal polynomials and recurrence formulas appear, and to the wide spectrum of applications like for instance in the agrophysics or medicine.

Publications

[11] M. J. Zygmunt, *Matrix orthogonal polynomials with respect to a non-symmetric matrix of measures* , Opuscula Math., 36 (3), 2016, 409–423.

[10] M. J. Zygmunt, *Non symmetric random walk on infinite graph*, Opuscula Math., 31 (4), 2011, 669–674.

[9] H. Dette, B. Reuther, W. J. Studden, M. J. Zygmunt, *Matrices measures and random walks with a block tridiagonal transition matrix*, SIAM J. Matrix Anal. Appl., 29 (1), 2006, 117–142.

[8] M. J. Zygmunt, *Jacobi Block Matrices with Constant Matrix Terms*, Oper. Th.: Adv. & Appl., 154, 2004, 233–238.

[7] M. J. Zygmunt, *Matrix orthogonal polynomials and continued fractions*, Linear Alg. Appl., 340 (1-3), 2002, 155–168.

[6] M. J. Zygmunt, *General Chebyshev polynomials and discrete Schrödinger operators*, J. Phys. A: Math. Gen., (34) 48, 2001, 10613–10616.

[5] W. Stepniewski and M. J. Zygmunt, *Methane oxidation in homogenous soil covers of landfill: a finite-element analysis of the influence of gas diffusion coefficient*, Int. Agrophysics, 14 (4), 2000, 449–456.

[4] W. Stepniewski and M. J. Zygmunt, *Mitigation of methane emission from landfills*, in *Sustainable development – an European view*, Zeszyty Naukowe PAN ,,Człowiek i środowisko", 27, 2000, 79–93.

[3] P. Śniady and M. J. Zygmunt, *The* $U(1)$*-invariance of field theories*, J. Math. Phys. 41, 2000, 4604–4606.

[2] M. J. Zygmunt, *Recurrence formula for polynomials in two variables, orthogonal with respect to the rotation invariant measures*, Constr. Approx., 15, 1999, 301–309.

[1] M. J. Zygmunt, *Some counterexamples to subexponential growth of orthogonal polynomials*, St. Math., 116 (2), 1995, 197–206.