Curriculum Vitae of Prof Sergey Zelik

Education and degrees:

1989-1994 - Student at the Department of Mathematics and Mechanics, Moscow State University, Russia.
1994-1998 - PhD student at Moscow State University, supervisor Prof Mark Vishik.
June 1994 - MSc in Mathematics.
April 1998 - PhD in Mathematics.
December 2004 - Doctor of Science (Doktor nauk) in Physics and Mathematics (Habilitation)

Employment:

2015- Professor, University of Surrey
2012 - 2014 - Reader, University of Surrey
2011 - 2012 - Senior Lecturer, University of Surrey
2006 - 2011 - Lecturer, University of Surrey
2005 - 2006 - Weierstrass Fellow, Weierstrass Institute, Berlin, Germany
2003 - 2005 - Alexander von Humboldt Fellow, University of Stuttgart, Germany
2001 - 2003 - PostDoc position at the University of Poitiers, France
1998 – 2001 - Doctor of Science fellowship at the Institute of Information Transmission Problems, Moscow, Russia;

Grants and awards:

1993 - Euler Stipendium from German Mathematical Society
1995-1997 - Soros PhD Student grant from G. Soros Foundation
2003-2005 - Alexander von Humboldt Fellowship
2012-2013 - International research grant "Asymptotical and numerical investigation of infinite dimensional dynamical systems with dissipation and dispersion" from Russian Government (principle investigator)

Grants in UK:

2010-2012 - Royal Society International Collaboration Grant UK-France
2010 - ICMS grant for organising the workshop "Dissipative PDEs" in Edinburgh
2011 - OxPDEs grant for organising Summer School in Surrey
2017 - 2020 - EPSRC grant on "Inertial Manifolds and finite-dimensional reduction

Supervising PhD students:

1. **Peter Antony**: (Gov't scholarship from Nigeria) started January 2009 -completed February 2013.
2. **Kavita Patni**: (self funding) started January 2009 - completed December 2014;
3. **Jon Pennant**: (EPSRC funded) started October 2010, completed June 2015
4. **Anton Savostianov**: (ORS + URS funded) started January 2012 - was awarded the prize as the best PhD student of FEPS in 2014; also was awarded the prize for the best PhD student work from the American Institute of Mathematics Conference in Madrid in July 2014; completed August 2015
5. **Tasos Rossides**: (self funded) started October 2010 (co-supervisor), completed November 2014;
6. **Anna Kostianko**: (ORS+URS funded) started October 2013 (co-supervisor), completed May 2017.

Teaching:

1999-2001: Reading group "Attractors of dissipative PDEs" at Moscow State University
2007 (Spring) Level 2: "Linear PDEs" at University of Surrey
2007 and 2009 (Autumn) Level M: "Functional analysis and PDEs"
2008--2013 (Autumn) Level 3: “Introduction to Function Spaces"
2008 (Spring) Level 2: “Theory of Finance"
2010 (Autumn-Spring) Reading group “Theory of PDEs" for PhD students
2011(Spring) and 2012(Spring) Level 1: “Vector Calculus"
2013(Autumn) Level M: “Linear operators and Spectral Theory”
2015(Spring) Level 3: "Introduction to Function Spaces"
2016(Autumn) Level M: "Functional Analysis and PDEs"
2017(Spring) Level 3: "Introduction to Function Spaces"

Administration:

Informal seminar organiser, Final year projects coordinator, Departmental seminar organiser, Level 3 coordinator, DsPDE research seminar organizer.

Leadership:

Organiser of the ICMS workshop on PDEs (Edinburgh, 2010);
Organiser of the Summer School on PDEs in Surrey (Surrey, 2011);
Organiser of 2 mini-symposia on PDEs at the SIAM conference (San-Diego, 2011);
Invited lecturer (17 hours, 50 participants) at the International Summer School on PDEs for PhD students and PostDocs, Istanbul, 2011;
Invited lecturer at a crash course (5 lectures) on Nonlinear PDEs, Centre for Analysis and Nonlinear PDEs at the Maxwell Institute in Edinburgh, November 2012.
Member of the Editorial Board of 4 scientific journals: Dynamics of PDEs, Evolution Equations and Control Theory, Asymptotic Analysis, and Abstract and Applied Analysis.

Recent invited talks at conferences and scientific seminars:

1. *"Recent progress in Inertial manifolds", research seminar, Bath, December 2016, UK.*
2. *"Finite-dimensional reduction in dissipative PDEs",* University of San Paulo, September 2016, Brasil.
3. "*Counterexamples in the theory of Inertial Manifolds",* International workshop on Dynamics of PDEs, IMA, Minneapolis, USA, July 2016.
4. "*Multi-pulse evolution in dissipative systems", I*nternational workshop on dynamical systems, March 2015, Bremen, Germany.
5. *“Attractors for the Cahn-Hilliard-Oono equations”,* research seminar, Koch University, Istanbul, August 2014, Turkey.
6. *“Inertial manifolds for 1D reaction-diffusion-advection problems,* International conference on Dynamical Systems, Moscow, January 2014, Russia.
7. *“Attractors of quantic wave equations in bounded domains”,* research seminar, Nice, December 2013, France.
8. Infinite Energy Solutions for Damped Navier-Stokes equations in R^2, Leipzig, research seminar, November 2013, Germany.

9. “Weak interaction of solitons and center manifold reduction”, Berlin, International workshop on nonlinear optics, WIAS, November 2013, Germany.
10. “Infinite energy solutions for Cahn-Hilliard type equations in unbounded domains“, International conference DIMO-2013, Levico Terme, Italy, 10-13 September, 2013.
11. Counterexamples to the regularity of Mane projections and global attractors, International Conference on Dynamics, Bifurcations and Strange Attractors, Nizhnij Novgorod, Russia, July 1—5, 2013;
12. Infinite Energy Solutions for Damped Navier-Stokes equations in R^2, International conference on differential equations dedicated to 90th anniversary of M. Vishik, Moscow, June 4-7, 2012.
13. Infinite-dimensionality in the “finite-dimensional” dissipative dynamics, ICMS workshop “Dynamics in infinite-dimensions: ergodic theory and PDEs”, Edinburgh, May 21-25, 2012.
14. *Counterexamples in the attractors' theory*, Equadiff (Loughborough, August 1-5, 2011).
15. *Attractors without Log-Lipshitz Mane projections*, Petrovskij conference (Moscow, June 1-5, 2011);
16. *Attractors for non-autonomous dissipative systems*, scientific seminar at Koch University (Istanbul, April, 2011).

Major research achievements:

1. *Infinite-energy solutions for dissipative PDEs in unbounded domains*: While energy estimates play a crucial role in the study of dissipative dynamics in bounded domains, they are not readily available in the case where the underlying domain is unbounded, since the energy integral is typically infinite. In collaboration with M.Vishik, A.Miranville and M.Efendiev, I have developed new and powerful techniques which allowed us to establish the dissipativity, as well as further regularity of solutions and the existence of the global attractor, for various classes of PDE’s in unbounded domains, which were beyond the reach of the classical approach. A singular achievement in this direction was a solution of the classical open problem of well-posedness of infinite-energy solutions for the Navier-Stokes equations in cylindrical domains (Poiseuille flows, etc.).

2. *Entropy theory for dissipative PDEs in unbounded domains:* Once the existence of global attractors is established for a class of PDE’s, the question of how to characterise and study the dynamics on the attractor arises. In the case of bounded domains, the attractor dimension is usually finite and, therefore, despite the infinite-dimensionality of the initial phase space, the limit dynamics is finite-dimensional, so ideas and methods from the classical theory of dynamical systems have to be applicable (Lyapunov exponents, topological and metric entropies, bifurcation scenarios, etc.). In contrast to that, the dynamics in unbounded domains may have a higher level of complexity, which is normally not observable in classical dynamics (e.g., topological entropy can be infinite). A new, truly infinite-dimensional theory must be built for an adequate description of such kind of dynamics. The basic concepts and tools of this theory were proposed in a sequence of papers. It was shown that the “size” of the infinite-dimensional attractor can be naturally described in terms of the Kolmogorov epsilon-entropy, and universal asymptotics for that quantity were obtained. A number of topological and smooth invariants (replacing the topological entropy which is now infinite) were introduced and investigated. An effective general algorithm of constructing the high complexity spatio-temporal patterns (e.g., with infinite topological entropy) is suggested based on the newly developed theory of essentially unstable manifolds and classical tools of the information theory (Shannon-Kotelnikov formula).

A theory of infinite-dimensional hyperbolic sets was built, invariant manifold theorem for infinite multi-pulse configurations was proven, and methods of reduction of PDE’s in unbounded domains to lattice dynamical systems were developed (in collaboration with Mielke).

3. *Exponential attractors:* Being an effective tool of investigating the dissipative dynamics, the concept of a global attractor has at least two essential drawbacks. Firstly, the rate of attraction to it may be arbitrary slow and, in general, cannot be explicitly found or expressed in terms of the physical parameters of the system under consideration; secondly, the global attractor may be very sensitive to perturbations. In order to overcome these drawbacks, the concept of the exponential attractor (inertial set) has been suggested by Eden, Foiash, Nikolaenko and Temam. However, their construction was extremely implicit (with the Axiom of Choice in the core of it) and worked only in Hilbert spaces. In collaboration with A. Miranville and M. Efendiev, I suggested an alternative, explicit construction of an exponential attractor which has now become standard in the subject (to date, MathSciNet cites 131 references). In the subsequent papers, we have developed the perturbation theory of exponential attractors, extended the approach to non-autonomous systems, to dissipative systems in unbounded domains, etc.

4. *Localised dissipative structures and Sinai-Bunimovich space-time chaos*: Homoclinic solutions are known to be crucial for the understanding of complicated dynamics and deterministic chaos in ODE’s. Indeed, if the existence of a single non-degenerate (transverse) homoclinic orbit is verified, the Shilnikov-Smale theorem allows for a build-up of the whole family of complicated orbits parameterised by a Bernoulli shift with positive topological entropy. What is the analogue of such elementary building blocks of chaos for the case of spatially extended systems? It was shown (in collaboration with D.Turaev) that the existence of a single spatially localised solution with chaotic temporal dynamics implies the existence of a family of space-time chaotic solutions parameterised by a subset of a multi-dimensional Bernoulli shift with positive space-time entropy and, in particular, the so-called Sinai-Bunimovich space-time chaos. In turn, using the center manifold reduction theorem for the multi-soliton structures proved earlier, one can reduce the problem of finding the temporally chaotic soliton in a given PDE to the analysis of a system of ODEs describing the weak interaction of several stationary solitons. Following this strategy, we gave an analytic proof of the existence of Sinai-Bunimovich space-time chaos for the one-dimensional Ginzburg-Landau equation. To date, this is the only example of a basic equation of mathematical physics where the space-time chaos is rigorously established.