Boris Zaltzman *February 1, 2018*

CURRICULUM VITAE and LIST of PUBLICATIONS

- **Personal Details**

  Name: Boris Zaltzman

  Date and Place of Birth: September 12, 1964, Amursk, Russia, USSR

  Date of Immigration: April 8, 1991

  Address and Telephone Number at Work: Alexandre Yersin Department of Solar Energy and Environmental Physics, Swiss Institute for Dryland Environmental and Energy Research, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev, Sede Boqer Campus 84990; 08-6596928. Department of Mathematics, Ben-Gurion University of the Negev; 08-6461607.

  Address and Telephone Number at Home: Lego 24, Medreshet Ben-Gurion, Sede Boqer Campus, 84990; 08-6532978.

- **Education**

  1981–1984 B.A/B.Sc. degree: Dept. of Mathematics and Mechanics, Novosibirsk State University, Novosibirsk, USSR.

  1984–1986 M.A/M.Sc. degree: Dept. of Mathematics and Mechanics, Novosibirsk State University, Novosibirsk, USSR.

  Title of Thesis: The mathematical models of crystallization of anisotropic layered materials.

  Name of Advisor: Professor A.M. Meirmanov.

  1986–1989 Ph.D. degree: Dept. of Mathematics and Mechanics, Novosibirsk State University, Novosibirsk, USSR.

  Title of thesis: The correctness of exact and approximate models in the two-phase Stefan problem (Approved October 1989)

  Name of Advisor: Professor A.M. Meirmanov.

- **Employment History**

  1989–1991 Researcher, The Institute for Water and Environmental Problems, Siberian Division of USSR Academy of Sciences.

  1991–1993 Postdoctoral fellow, Department of Solar Energy and Environmental Physics, Jacob Blaustein Institutes for Desert Research and Department (BIDR) of Mathematics and Computer Science, Ben-Gurion University of the Negev.

  1993–1996 Researcher, Department of Solar Energy and Environmental Physics, BIDR, Ben-Gurion University of the Negev.

1996–2003 (1996–1999, Igal Alon Fellow, Tenured since 1999) Senior Lecturer, Department of Solar Energy and Environmental Physics, BIDR, Ben-Gurion University of the Negev.

2003–April 2008 Associate Professor, Department of Solar Energy and Environmental Physics, BIDR, Ben-Gurion University of the Negev.

April 2008 – present, Professor, Alexandre Yersin Department of Solar Energy and Environmental Physics, Swiss Institute for Dryland Environmental and Energy Research, BIDR and Department of Mathematics, Ben-Gurion University of the Negev.

October 1st, 2009 – September 30th, 2010, Visiting Professor, Department of Chemical Engineering and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, MA 02139; Experimental Soft Condensed Matter Group, School of Engineering and Applied Science/Department of Physics, Harvard University, Cambridge, MA 02138.

September 1st, 2012 – July 31st, 2014, Director of the Swiss Institute for Dryland Environmental and Energy Research, BIDR, Ben-Gurion University of the Negev.

November 1st, 2013 – July 31st, 2014, Deputy Director of Jacob Blaustein Institutes for Desert Research

August 1st, 2014 – Director (Dean) of Jacob Blaustein Institutes for Desert Research

- **Professional Activities**

(a) Positions in academic administration.

May 2017 – November 2017, Member of the BGU President Search Committee

2014 – present, BGU Senate member

2014 – present, Head of BIDR Promotion Committee.

2009 – 2014, Member of BIDR Promotion Committee.

2005-2009 Member of the BCSC (Blaustein Center for Scientific Cooperation) Steering Committee

(b) Membership in professional/scientific societies

Israel Mathematical Union, Society for Industrial and Applied Mathematics

- **Educational Activities**

(a) Courses Taught

1. Undergraduate Courses Taught: Department of Mathematics: Infinitesimal calculus (1991), Ordinary differential equations 'a' (1992, 1993), Ordinary differential equations 'b' (1992), Calculus 'b1' (1992), Calculus 'b2' (1993), Probability (1994, 1998, 2000), Partial differential equations 'a' (1994–pres.), Partial differential equations 'b' (1994), Calculus 'c' (1995), Applied mathematics (1995, 1996).

2. Graduate Courses Taught:

2a Albert Katz International School for Desert Studies: Partial differential equations in mathematical physics (2001–pres.), Finite Difference Methods for Partial Differential Equations (2005).

2b Department of Mathematics: Advanced Mathematical Physics (2006–present).

2c Math. Dept., University Dini, Florence, Electrodiffusion of Ions (2004).

(b) Research students.

2001–2005, Ph.D. student, Tamara Pundik (summa cum laude), BIDR, BGU (jointly with Isaak Rubinstein).

2001–2005, Ph.D. student, Irina Lerman (summa cum laude), Math. Dept., BGU (jointly with Isaak Rubinstein).

2003–2006, M. Sc. student, Saar Oded Haran, BIDR, BGU (jointly with Isaak Rubinstein).

2005–2006, M. Sc. student, Gor Manukyan, BIDR, BGU (jointly with Isaak Rubinstein).

2006–2008, M. Sc. student, Arkadi Futerman, BIDR, BGU (jointly with Isaak Rubinstein and Vitaly Gitis).

2007-pres., Ph.D. student, Rodica Indoitu, BIDR, BGU (jointly with Lea Orlovsky).

2010-2012, M. Sc. student, Suren Vasilyan, BIDR, BGU (jointly with Isaak Rubinstein).

2010-2012, M. Sc. student, Vahe Chinaryan, BIDR, BGU (jointly with Isaak Rubinstein).

2010-2017, Ph.D. student, Ramadan Abo-Rgela, BIDR, BGU (jointly with Isaak Rubinstein).

2013–2015., M.Sc. student, Vardan Vardanyan, BIDR, BGU (jointly with Isaak Rubinstein).

- **Awards, Citations, Honors, Fellowships**

(a) Honors, Citation Awards

1992 Award of Paula and David Ben-Gurion Foundation.

1998–2001 Mendel Wasserman Career Development Chair in Desert Studies

2005 Toronto prize for distinguished researcher

2014 Honour Certificate of Ministry of Alyah and Integration for Leadership in Science and Research

(b) Fellowships

1991–1992 Postdoctoral Fellowship, Math. Dept., BGU.
1992-1993 Postdoctoral Blaustein Fellowship, BIDR, BGU.
1994–1996 Sally Berg Foundation Fellowship.
1996–1999 Igal Alon Fellowship.

- **Refereed Articles in Scientific Journals**

1. B. Zaltzman, *On the explicit estimates in the Stefan problem with "concentrated capacity"*. In the book: Mathematical problems of hydrodynamics. Lavrent'ev Institute of Hydrodynamics, Novosibirsk, 1988, pp. 42–52. (Dinamika sploshnoy sredy, v. 85). (Russ.)

2. I. Götz, B. Zaltzman, *Non-increase of the measure of mushy region in the Stefan problem.* In the book: Problems with free boundary in hydrodynamics. Lavrent'ev Institute of Hydrodynamics, Novosibirsk, 1989, pp.154–158. (Dinamika sploshnoy sredy, v.89). (Russ.)

3. A. Petrova, B. Zaltzman, *The problem of optimal control in the model of liquid - phase epitaxy of material $A_xB_{1-x}C$ in weightlessness.* - Cosmic Science and Technology, V. 4, pp. 57–62, 1989. (Russ.)

4. I. Götz, B. Zaltzman, *Nonincrease of mushy region in the Stefan problem,* Quarterly of Applied Mathematics, V. XLIX (4), 741–746, 1991.

5. J.F. Rodrigues and B. Zaltzman, *On classical solutions of the two-phase steady-state Stefan problem in strips.* Nonlinear Analysis, Theory, Methods and Applications, Vol. 18, 207–217, 1992.

6. Ch. Charach, B. Zaltzman, *Planar solidification from an undercooled melt: asymptotic solutions to continuum model with interfacial kinetics.* Phys. Rev. E, Vol. 47 (2), 1230–1234, 1993.

7. B. Zaltzman, *Multidimensional two-phase quasi-stationary Stefan problem,* Manusc. Math, 78 (3), 287–301, 1993.

8. Ch. Charach, B. Zaltzman, I. Götz, *Thermodynamically consistent generalizations of the Stefan problem: Formulation, Correctness and Asymptotic Behavior.* Journal of Mathematical Models and Methods in Applied Science, 4 (3), 331–354, 1994.

9. Ch. Charach, B. Zaltzman, *An analytic model for planar growth of a solid germ from an undercooled melt,* Phys. Rev. E, 49 (5), 4322–4327, 1994.

10. I. Götz, B. Zaltzman, *Two-phase Stefan problem with supercooling,* SIAM Journal of Mathematical Analysis, 26 (3), 694–714, 1995.

11. I. Götz, B. Zaltzman, *Some criteria for disappearance of mushy region in the Stefan problem.* Quarterly Journal of Applied Mathematics, V. LIII, 4, 657–671, 1995.

12. I. Rubinstein, B. Zaltzman, T. Zaltzman, *Electroconvection in a layer and in a loop.* Physics of Fluids, 7 (6), 1467–1482, 1995.

13. I. Rubinstein, B. Zaltzman, *Electrodiffusional free boundary problem in concentration polarization in electrodialysis.* Journal of Mathematical Models and Methods in Applied Science V. 6, 5, 623–648, 1996.

14. A. Hadberg, E. Meron, I. Rubinstein, B. Zaltzman, *Controlling domain patterns far from equilibrium.* Phys. Rev. Letters 76, 427, 1996.

15. J.F. Rodrigues, B. Zaltzman, *Regular solutions of a Stefan problem in strips.* Annali di Matematica Pura ed Applicata, (IV), Vol. CLXXII, 169–189, 1997.

16. A. Hadberg, E. Meron, I. Rubinstein, B. Zaltzman, *Nonsteady front motion in doubly diffusive reaction diffusion systems.* Physical Review E, 55(4), 4450–4457, 1997.

17. I. Rubinstein, B. Zaltzman, O. Kedem, *Electric fields in and around ion exchange membranes.* Journal of Membrane Science 125, 17–21, 1997.

18. I. Rubinstein, B. Zaltzman, *Morphological instability of similarity solution to the Stefan problem with undercooling and surface tension.* Quarterly Journal of Applied Mathematics, LVI(2), 341–354, 1998.

19. M. Primicerio, I. Rubinstein, B. Zaltzman, *Electrodiffusional free boundary problem in a bipolar membrane (semiconductor diode) at a reverse bias for constant current.* Quarterly Journal of Applied Mathematics, LVII(4), 637–659, 1999.

20. I. Rubinstein, B. Zaltzman, *Diffusional mechanism of strong selection in Ostwald ripening.* Physical Review E, 61(1), 709–717, 2000.

21. I. Rubinstein, B. Zaltzman, *Electro-osmotically induced convection at a permselective membrane.* Physical Review E, 62, 2238–2251, 2000.

22. I. Rubinstein, B. Zaltzman, *Electroosmotic slip of the second kind and instability in concentration polarization.* Mathematical Models and Methods in Applied Sciences, 11(2), 263–300, 2001.

23. L. Prigozhin, B. Zaltzman, *Two continuous models for the dynamics of sandpile surfaces.* Physical Review E, 63, 041505, 2001.

24. I. Rubinstein, B. Zaltzman, J. Pretz and C. Linder, *Experimental verification of the electroosmotic mechanism of overlimiting conductance through a cation exchange electrodialysis membrane,* Russian Electrochemistry, 38, 853–864, 2002.

25. A.M. Meirmanov, B. Zaltzman, *Global in time solution to the Hele-Shaw problem with a change of topology,* European Journal for Applied Mathematics, 13, 431–447, 2002.

26. I. Rubinstein, B. Zaltzman and T. Pundik, *Ion-Exchange Funneling in Thin Film Coating Modification of Heterogeneous Electrodialysis Membrane,* Physical Review E, 65, 041507, 2002.

27. M. Primicerio, B. Zaltzman, *A Free Boundary Problem Arising in Chemotaxis.* Advances in Mathematical Sciences and Applications, 12 (2), 685–708, 2002.

28. Y. Oren, I. Rubinstein, C. Linder, G. Saveliev, B. Zaltzman, E. Mirsky, O. Kedem, *Modified heterogeneous anion-exchange membranes for desalination of brackish and recycled water.* Environmental Engineering Science, 19 (6), 513–529, 2002.

29. L. Prigozhin, B. Zaltzman, *On the Approximation of the Dynamics of Sandpile Surfaces*, Portugaliae Mathematica, 60, 127–137, 2003.

30. I. Rubinstein, B. Zaltzman, *Wave number selection in a nonequilibrium electroosmotic instability,* Physical Review E, 68 (3), 032501, 2003.

31. S. Antoncev, A. Meirmanov, I. Rubinstein and B. Zaltzman, *"Concentrated capacity" model of ion-exchange funneling in a modified (thin film coated) heterogeneous electrodialysis membrane*, Quarterly of Applied Mathematics, 62 (1), 77–95, 2004.

32. I. Götz, I. Rubinstein, E. Zvetkov, B. Zaltzman, *Complexity and hierarchical majority rule,* International Journal of Modern Physics C, 15 (3), 427–433, 2004.

33. I. Rubinstein, Y. Oren, B. Zaltzman B, *Multi-phase model of a sparse ion-exchange spacer*, Journal of Membrane Science 239 (1), 3–8, 2004.

34. I. Lerman, I. Rubinstein, B. Zaltzman, *Absence of bulk electroconvective instability in concentration polarization,* Phys. Rev. E, 71, 011506, 2005.

35. I. Rubinstein, B. Zaltzman, I. Lerman, *Electroconvective instability in concentration polarization and nonequilibrium electro-osmotic slip,* Phys. Rev. E, 72, 011505, 2005.

36. T. Pundik, I. Rubinstein, B. Zaltzman, *Bulk electroconvection in electrolytes,* Phys. Rev. E, 72, 061502, 2005.

37. I. Rubinstein, B. Zaltzman, *Electro-convective versus electro-osmotic instability in concentration polarization,* Adv. Coll. Int. Sc., 134–135, 190–200,2007.

38. B. Zaltzman, I. Rubinstein, *Electroosmotic slip and electroconvective instability,* Journal of Fluid Mechanics, 579 , 173–226, 2007.

39. B.D. Storey, B. Zaltzman, I. Rubinstein, *Bulk electroconvective instability at high Peclet numbers,* Phys. Rev. E, 76, 041501, 2007.

40. S.M. Rubinstein, G. Manukyan, A. Staicu, I. Rubinstein, B. Zaltzman, R.G.H. Lammertink, F. Mugele, M. Wessling, *Direct Observation of Nonequilibrium Electroosmotic Instability*, Phys. Rev. Let., 101, 236101, 2008.

41. I. Rubinstein, B. Zaltzman, A. Futerman, V. Gitis, V. Nikonenko, *Reexamination of electrodiffusion time scales*, Phys. Rev. E, 79, 021506, 2009.

42. I. Rubinstein and B. Zalztman, *Probing the extended space charge by harmonic disturbances*, Phys. Rev. E, E 80, 021505,2009.

43 . I. Rubinstein and B. Zalztman, *Dynamics of extended space charge in concentration polarization* , Phys. Rev. E, 81, 061502.

44. I. Rubinstein and B. Zalztman, *Extended Space Charge in Concentration Polarization*, Adv. Coll. Int. Sc., 159(2),117,–129 2010.

45. A. Fasano, A. Mancini, M. Primicerio, B. Zaltzman, *Waiting time phenomena forced by critical boundary conditions in classical diffusion problems,* Quarterly of Applied Mathematics, 69 (1), 105–122, 2011.

46 E.V. Dydek, B. Zaltzman, I. Rubinstein, D.S. Deng, A. Mani, M.Z. Bazant, *Overlimiting Current in a Microchannel,* Phys. Rev. Let., 107, 118301, 2011.

47 I. Rubinstein and B. Zalztman, *Convective Diffusive Mixing in Concentration Polarization – from Taylor Dispersion to Surface Convection,* J. Fluid Mech., 728, 239, 2013.

48 D.S. Deng, Dydek, E.V. Dydek, J.H. Han, S. Schlumpberger, A. Mani, B. Zaltzman, M.Z. Bazant, *Overlimiting Current and Shock Electrodialysis in Porous Media*, Langmuir, 29, 16167, 2013.

49 R. abu-Rjal, V. Chinaryan, Bazant, M.Z. Bazant, I. Rubinstein, B. Zaltzman, *Effect of concentration polarization on permselectivity*, Phys. Rev. E., 89, 012302, 2014.

50 I. Rubinstein and B. Zaltzman, *Equilibrium Electroconvective Instability*, Phys. Rev. Lett., 114, 114502, 2015.

51 R. abu-Rjal, L. Prigozhin, I. Rubinstein, and B. Zaltzman, *Teorell instability in concentration polarization* , Phys. Rev. E, 92, 022305, 2015.

52 R. abu-Rjal, I. Rubinstein, and B. Zaltzman, *Driving factors of electroconvective instability in concentration polarization*, Phys. Rev. Fluids, 1, 023601, 2016.

53 R. abu-Rjal, L. Prigozhin, I. Rubinstein, and B. Zaltzman, *Equilibrium electro-convective instability in concentration polarization: The effect of non-equal ionic diffusivities and longitudinal flow*, Russ. J. of Electrochemistry, Vol. 53 (9), 903, 2017.

54 I. Rubinstein and B. Zaltzman, *Equilibrium Electro-Osmotic Instability in Concentration Polarization at a Perfectly Charge-Selective Interface*, Phys. Rev. Fluids, 2, 093702, 2017.

- **Research Grants**

1992–1995 Mathematical Model in Separation, Israel Atomic Energy Commission. Total amount 165,000 NIS.

2007-2011, Nonequilibrium Electroosmotic Instability and Electroconvection in Electrolytes, Israel Science Foundation, Total amount 170,000$.

2011-2015, Overlimiting Conductance in Confined Systems, BSF, Total Amount 144,000$.

- **Dominant research areas**

Physico-Chemical Hydrodynamics: 1. Theory of electrodiffusion of ions in aqueous systems, 2. Membrane transport, 3. Electroconvection and theory of nonequilibrium electrokinetics, 4. Ionic transport in microstructures and microfluidics, 5. Novel physics of desalination.

- **Research profile**

In the last 20 years most of my research, joint with Isaak Rubinstein, concerned electric conduction from an electrolyte solution into a charge selective solid, such as ion exchange membrane, electrode or micro-nano-channels array. Our main finding is that this conduction becomes unstable when the electrolyte concentration near the interface approaches zero due to diffusion limitation. The sequence of events leading to instability is as follows: upon the decrease of the interface concentration, the electric double layer (EDL) at the interface transforms from its common quasi-equilibrium structure to a different, non-equilibrium one. The key feature of this new structure is an extended space charge added to the usual one of the quasi-equilibrium EDL. The non-equilibrium electro-osmosis related to this extended space charge renders the quiescent conductance unstable. The resulting vortical flow destroys the diffusion layer and, thus, greatly hastens the ion supply towards the interface. This finding, besides its fundamental importance due to the central role of EDL in interface phenomena and significance of conductive instabilities in Newtonian fluids (compare with Benard-Rayleigh and Marangoni instabilities in thermal conduction), is of a potential applicative value. The major potential applications are in the areas of electrochemistry and micro-fluidics, including intensification of ionic mass transport near the electrodes and design electro-kinetic micro-pumps. The original motivation for our study came from the search for explanation of the phenomenon of over-limiting conductance through charge-selective membranes (employed in fuel cells, electrodialysis, microfluidic preconcentration devices) which remained a challenge for many decades. Our found explanation of this phenomenon may be helpful for development of efficient desalination process based on 'over-limiting' high current electrodialysis. The applied benefits of our research also root in the possibility to use the obtained know-how on non-equilibrium electro-kinetic phenomena for efficient operation and control of ion-exchange membrane and electrode devices operating in the regime of high concentration polarization as well as their micro-fluidic nano-channel counterparts.