

Prof. Dr. Sci. Elshad Allahyarov



Permanent Address

Heinrich-Heine University,
Theoretical Physics II, Soft Matter,
Univestitaetstrasse 1, 40225 Dusseldorf
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Education

- **Russian Academy of Sciences-** Moscow, Russia

Doctor of Sciences in Physics and Mathematics (2005), (Russian- doktor fiz.-mat. nauk, German- Dr.habil.)

Thesis: The role of Coulomb correlations in colloids and biocolloids.

- **Russian Academy of Sciences-** Moscow, Russia

Doctor of Philosophy in Physics (1995), (Russian- kandidat fiz.-mat. nauk, German- Dr., USA- PhD.)

Thesis: Structure factor and effective interactions in non-ideal plasma and liquid metals

- **Moscow State University-** Moscow, Russia

Diploma of Physics (1988) (US equivalent of Master of Arts in Physics)

Thesis: Injection of relativistic electron beams into dense plasma.

Current Appointments

- Research Professor, Theoretical Department (from 1989), *Joint Institute for High Temperatures, Russian Academy of Sciences, Moscow, Russia*
- Research Professor, Soft Matter Institute (from 2012), *Institute for Theoretical Physics II, Heinrich-Heine University of Düsseldorf, Germany*
- Professor, Macromolecular Science (from-2013), *Case Western Reserve University, Cleveland, Ohio, USA*

Previous Appointments

- Senior Researcher, Physics Department (2006-2012)
Case Western Reserve University, Cleveland, Ohio
- Senior Researcher, Institute of Theoretical Physics II (2003-2006)
Heinrich-Heine University of Düsseldorf, Germany
- Privat Dozent, Institute of Solid State Research (1998-2002)
IFF Theory II, Nuclear Research Center, Julich, Germany
- Postdoctoral Researcher (1995-1997)

Laboratory of complex fluids, Technical University of Eindhoven, The Netherlands

- Postgraduate Student (1992-1994)
Laboratory of complex fluids, Technical University of Eindhoven, The Netherlands

- Postgraduate Student (1989-1992)
Joint Institute for High Temperatures, Russian Academy of Sciences, Moscow, Russia

Publications

- *Dispersion of plasma oscillations in non-ideal Coulomb systems*
E. Allahyarov, S. A. Trigger, Teplofizika Vysokikh Temperatur **30**, 136 (1992).
- *Three-dimensional dispersion of Langmuir oscillations in non-ideal plasma*
E. Allahyarov, S. A. Trigger, Teplofizika Vysokikh Temperatur **30**, 462 (1992).
- *The influence of non-Coulomb interaction on plasma oscillation spectrum in classical two-component plasma*
E. Allahyarov, V. B. Bobrov, S. A. Trigger, Teplofizika Vysokikh Temperatur **30**, 876 (1992).
- *On the temperature dependence of the liquid lithium electric resistance,*

- E. Allahyarov, V. B. Bobrov, *Teplofizika Vysokikh Temperatur* **31**, 207 (1993)
- *Static structure factor and electric conduction of expanded liquid cesium*,
E. Allahyarov, V. B. Bobrov, S. A. Trigger, *Teplofizika Vysokikh Temperatur* **31**, 44 (1993).
 - *Electrical conductivity of fully ionized plasmas with arbitrary electron degeneracy. 1: Classical plasma*,
V. B. Bobrov, E. Allahyarov, *High temperatures* **31**, 422 (1993).
 - *Electric conductivity of a fully ionized plasma with arbitrary electron degeneration. 2. Liquid-metal plasma*
V. B. Bobrov, E. Allahyarov, *Teplofizika Vysokikh Temperatur* **31**, 352 (1993).
 - *Kramers–Kronig relations for the dielectric constant of a classical plasma and the spectrum of plasma oscillations*.
E. Allahyarov, V.B. Bobrov, *High Temperatures* **31**, 644 (1993)
 - *Structure factor of liquid metals at small wave vectors and a model of a one-component plasma*,
E. Allahyarov, V. B. Bobrov, S. A. Trigger, *High Temperatures* **32**, 341 (1994).
 - *OCP reference theory of dynamic structure factors of expanded liquid metals*
S. A. Trigger, E. Allahyarov, P. P. J. M. Schram, *Physica B* **212**, 97 (1995).
 - *Low-angle structure behavior of expanded liquid metals*,
E. Allahyarov, P. P. J. M. Schram, S. A. Trigger, *Physica B* **212**, 88 (1995).
 - *Overscreening in colloidal systems: the attractive branch of pair macroion interaction*,
E. Allahyarov, L. I. Podlubny, P. P. J. M. Schram, S. A. Trigger, *Physica A* **220**, 349 (1995).
 - *MD simulation of the pair correlation function and static structure of charged colloidal suspensions*,
E. Allahyarov, P. P. J. M. Schram, S. A. Trigger, *Phys. B*, **228**, 136 (1996).
 - *Effective macroion interaction in colloidal systems: Possibility of attraction*,
E. Allahyarov, L. I. Podlubny, P. P. J. M. Schram, S. A. Trigger, *Physica B* **229**, 132 (1996).
 - *Damping of longitudinal waves in charged colloids*,
E. Allahyarov, L. I. Podlubny, P. P. J. M. Schram, S. A. Trigger, *Physica B* **228**, 166 (1996).
 - *Damping of longitudinal waves in colloidal crystals of finite size*
E. Allahyarov, L. I. Podlubny, P. P. J. M. Schram, S. A. Trigger, *Phys. Rev. E* **55**, 592 (1997).
 - *Attraction between like-charged macroions by Coulomb depletion*
E. Allahyarov, I. D'Amico, H. Lowen, *Phys. Rev. Letters* **81**, 1334 (1998).
 - *Possibility of an attraction between highly charged colloids*
E. Allahyarov, P. P. J. M. Schram, S. A. Trigger, *Proc. Int. Conf. Strongly Coupled Coulomb Systems*,
Plenum Press, New-York, 247 (1998).
 - *Role of effective triplet interactions in charged colloidal suspensions*
H. Lowen, E. Allahyarov, *J. Phys. Condensed Matter* **10**, 4147 (1998).
 - *Effective forces between macroions: the cases of asymmetric macroions and added salt*
E. Allahyarov, H. Lowen, S. Trigger, *Phys. Rev. E* **57**, 5818 (1998).
 - *Effect of confinement on the interaction between charged colloidal particles*
E. Allahyarov, I. D'Amico, H. Lowen, *Phys. Rev. E* **60**, 3199 (1999).
 - *The hard physics of soft matter*
H. Lowen, E. Allahyarov, et al, *Advances in Solid State Physics* **40**, 809 (2000).
 - *Effective interaction between helical biomolecules*
E. Allahyarov, H. Lowen, *Phys. Rev. E* **62**, 5542 (2000).
 - *Effective interaction between confined colloids: repulsion or attraction*
H. Lowen, E. Allahyarov, I. D'Amico, *Progr. Colloid Polym. Sci.* **115**, 367 (2000).
 - *Influence of solvent granularity on the effective interaction between charged colloidal suspensions*
E. Allahyarov, H. Lowen, *Phys. Rev. E* **63**, 041403 (2001).
 - *Discrete solvent effects on the effective interaction between charged colloids*
E. Allahyarov, H. Lowen, *J. Phys. Condensed Matter* **13**, L277 (2001).
 - *Interactions and phase transitions of colloidal dispersions in bulk and at interfaces*
H. Lowen, E. Allahyarov, et al, *Phil. Trans. Roy. Soc. Lond. A* **359**, 909 (2001).
 - *Discrete charge patterns, Coulomb correlations and interactions in protein solutions*
E. Allahyarov, H. Lowen, J. P. Hansen, A. A. Louis, *Europhys. Letters.* **57**, 731 (2002).
 - *Effective forces in colloidal mixtures: from depletion attraction to accumulation repulsion*
A. A. Louis, E. Allahyarov, H. Lowen, R. Roth, *Phys. Rev. E* **65**, 061407 (2002).
 - *Adsorption of monovalent and multivalent cations and anions on DNA molecules*
E. Allahyarov, H. Lowen, G. Gompper, *Phys. Rev. E* **68**, 061903 (2003).
 - *Nonmonotonicity of second virial coefficient in strongly correlated systems*

- E. Allahyarov, H. Lowen, J.-P. Hansen, A. A. Louis, Phys. Rev. E **67**, 051404 (2003);
Virtual Journal of Biological Physics Research 5,(2003).
- *Charged colloids, polyelectrolytes and biomolecules viewed as strongly coupled Coulomb systems*
H. Lowen, E. Allahyarov, et al., J. Phys. A: Math. Gen. **36**, 5827 (2003).
 - *Mesoscopic solvent simulations: Multi-particle-collision dynamics of three-dimensional flows*
E. Allahyarov, G. Gompper, Phys. Rev. E **66**, 036702 (2003).
 - *Erratum: Mesoscopic solvent simulations: Multiparticle-collision dynamics of three-dimensional flows*
E. Allahyarov, G. Gompper, Phys. Rev. E **67**, 059901 (2003).
 - *Re entrance in DNA condensation*,
E. Allahyarov, N. Gusein-zade, Phys. Reports of Russian Academy of Sciences **6**, 49 (2004).
 - *Crystallization of colloidal plasma: charge renormalization in added salt*
E. Allahyarov, S. Trigger, High Temperature Physics **43**, 315 (2005).
 - *Attraction between DNA molecules mediated by multivalent ions*
E. Allahyarov, G. Gompper, H. Lowen, Phys. Rev. E. **69**, 041904 (2004);
Virtual Journal of Biological Physics Research 7, (2004).
 - *DNA condensation, re dissolution and mesocrystals induced by tetravalent counterions*
E. Allahyarov, H. Lowen, G. Gompper, Euro. Phys. Letters **68**, 894 (2004).
 - *Interaction between overcharged DNA molecules*
E. Allahyarov, G. Gompper, H. Lowen, J. Phys. Cond. Matter **17**, S1827 (2005).
 - *Charged colloids and polyelectrolytes: from statics to electrokinetics*
H. Lowen, E. Allahyarov et al, J. Phys.: Conf. Ser. **11**, 207 (2005).
 - *Interaction between charged colloids in a low dielectric constant solvent*
E. Allahyarov et al, Euro. Phys. Letters 78, 38802 (2007).
 - *Role of electrostatic forces in cluster formation in a dry ionomer*
E. Allahyarov, P. Taylor, J. Chem. Phys. **127**, 154901 (2007).
 - *Charged colloidal particles in a charged wedge: do they go in or out*
H. Lowen, E. Allahyarov et al, J. Phys.: Condens. Matter **20**, 404221 (2008).
 - *Colloids in a low dielectric constant solvent*
E. Allahyarov, E. Zaccarelli, F. Sciortino, H. Lowen, Europhys. Lett. **81**, 59901 (2008).
 - *Predicted electric-field-induced hexatic structure in an ionomer membrane*
E. Allahyarov, P. Taylor, Phys. Rev. E **80**, 020801(R) (2009).
 - *Simulation Study of the Correlation between Structure and Conductivity in Stretched Nafion*
E. Allahyarov, P. Taylor, J. Phys. Chem. B **113**, 610 (2009).
 - *Nonadditivity in the effective interactions of binary charged colloidal suspensions*,
E. Allahyarov, H. Lowen, J. Phys.: Condens. Matter **21**, 424117 (2009).
 - *Simulation Study of Sulfonate Cluster Swelling in Ionomers*
E. Allahyarov, P. Taylor, H. Lowen, Phys. Rev. E **80**, 061802 (2009).
 - *Simulation study of field-induced morphological changes in a proton-conducting ionomer*
E. Allahyarov, P. Taylor, H. Lowen, Phys. Rev. E **81**, 031805 (2010).
 - *Simulation study of the equilibrium morphology in ionomers with different architectures*
E. Allahyarov, P. Taylor, J. Polymer Sci. B: Polymer Physics **49**, 368 (2011).
 - *Simulation study of field-induced proton conduction pathways in dry ionomers*
E. Allahyarov, P. Taylor, H. Lowen, J. Phys.: Condens. Matter **23**, 234105 (2011).
 - *Heterogeneous crystallization of hard-sphere colloids near a wall*
K. Sandomirski, E. Allahyarov, H. Lowen, S. U. Egelhaaf, Soft Matter **7**, 8050 (2011).
 - *Huge broadening of the crystal-fluid interface for sedimenting colloids*
E. Allahyarov, H. Lowen, Euro. Phys. Letters **95**, 38004 (2011).
 - *Simulation study of poled low-water ionomers with different architectures*
E. Allahyarov, P. Taylor, H. Lowen, J. Phys.: Condens. Matter **23**, 455102 (2011).
 - *Double clustering in binary mass hard sphere system*
E. Allahyarov, H. Lowen, J. Chem. Phys. **135**, 134115 (2011).
 - *Heterogeneous crystallization in colloids and complex plasmas: the role of binary mobilities.*
H. Lowen, E. Allahyarov, A. Ivlev, G. E. Morfill, J. Phys.: Condens. Matter **24**, 284125 (2012).
 - *Crystal Orientation and Temperature Effects on Double Hysteresis Loop Behavior in a Poly(vinylidene fluoride-co-trifluoroethylene-co-chlorotrifluoroethylene)-graft-Polystyrene Graft Copolymer,*

- L. Yang, E. Allahyarov, F. Guan, L. Zhu, *Macromolecules* **46**, 9698–9711 (2013).
- *Novel polymer ferroelectric behavior via crystal isomorphism and the nanoconfinement effect*, L. Yang, X. Li, E. Allahyarov, P. Taylor, Q.M. Zhang, L. Zhu, *Polymer* **54**, 1709-1728 (2013).
- *Highly asymmetric electrolytes in the primitive model: Hypernetted chain solution in arbitrary spatial dimensions*. M. Heinen, E. Allahyarov, H. Löwen, *J. Comp. Chem.* **35**, 275-289 (2014).
- *Magnetomechanical response of bilayered magnetic elastomers*, E. Allahyarov, A. M. Menzel, L. Zhu, H. Löwen, *Smart Materials and Structures* **23**, 115004 (1-12) (2014).
- *Heterogeneous crystallization of hard and soft spheres near flat and curved walls*, K. Sandomirski, S. Walta, J. Dubbert, E. Allahyarov, A. B. Schofield, H. Löwen, W. Richtering, S. U. Egelhaaf. *Eur. Phys. J* **223**, 439-454 (2014).
- *Analysis of the actuation properties of charged multilayer films*, E. Allahyarov, H. Löwen and L. Zhu, *J. Appl. Phys.* **117**, 034504 (1-14) (2015).
- *Do crystallization seeds seed crystallization? Some time*. E. Allahyarov, K. Sandomirski, H. Löwen, S. U. Egelhaaf. *Nature Communications* (accepted) (2015).
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Referee to Journals

- Physical Review Letters
- Physical Review E
- J.Phys.: Condensed Matter
- J. Chemical Physics
- J. Phys. Chem.
- Langmuir
- High Temperatures
- J. Membrane Science

Membership in professional societies

- American Physical Society
- European SoftComp Network of Excellence

Conferences, Seminars, and Colloquia

- Oral and poster contributions to American Physical Society March Meetings, 2006-2014
- Oral and poster contributions to International Conferences on Liquid Matter, 2002-2014
- Oral and poster contributions to Julich Soft Matter Days Conferences, 2000-2014
- Oral and poster contributions to Computational Physics Conferences, 2000-2014
- Oral and poster contributions to various workshops on Soft Matter Physics subjects organized by Forschungszentrum Julich (2000-2007), University of Dusseldorf (1995-2014), and Technical University of Eindhoven (1992-1998)
- Invited seminar talks in the USA universities (Laboratory of Phys. Struct. Biology of NIH- *V. Parsegian*, Case Western Reserve University- *P. Taylor*, University of Akron- *A. Sokolov*, University of College Park Maryland- *M. Fisher*, Soft Matter Laboratory of Florida International University), European universities (Lund University-*P. Linse*, Göteborg University- *R. Kjellander*, University of Konstanz- *R. Klein*, Humboldt University of Berlin- *W. Ebeling*, University of Mainz- *C. Holm*, University of Wuppertal- *S. Dietrich*, University of Essen-Duisburg- *E. Spohr*, University of Aachen- *G. Gompper*, FOM University of Amsterdam- *D. Frenkel*, Technical University of Eindhoven- *P. Schram*, University of Utrecht- *A. Blaaderen*, University of Cambridge- *J.-P. Hansen*, Moscow State University- *A. Khokhlov*), and in Russian Academy of Sciences (Institute of General Physics- *A. Rukhadze*, Institute for High Temperatures- *V. Fortov*, Institute of Chemical Physics- *O. Vinogradova*) during 1992-2015.

Collaborators:

- Philip L. Taylor, Distinguished University Professor
Department of Physics, Case Western Reserve University,
10900 Euclid Ave, Cleveland, OH 44106-7079
taylor@case.edu
- Hartmut Lowen: Professor
Institut für Theoretische Physik II Heinrich-Heine-Universität Dusseldorf,
Universitätsstrasse 1, D-40225, Dusseldorf, Germany
hlowen@thphy.uni-duesseldorf.de
- Alexei Sokolov, Professor
Department of Chemistry, University of Tennessee,
1420 Circle Drive, 563 Buehler Hall, Knoxville, TN 37996-1600
sokolov@utk.edu
- Peter Pintauro, Professor
Department of Chemical Engineering, Vanderbilt University,
VU Station B, Box 351604, Nashville, TN 37235-1304
peter.pintauro@vanderbilt.edu
- Rudolf Podgornik, Professor
Faculty of Mathematics and Physics, University of Ljubljana,
Jamova 39, SI-1000 Ljubljana, Slovenia
rudolf.podgornik@fmf.uni-lj.si
- Gerhard Gompper, Professor
Forschungszentrum Jülich, Institut für Festkörperforschung,
D-52425 Jülich, Germany
g.gompper@fz-juelich.de
- Jean-Pierre Hansen: Professor
Theoretical Sector of the Cambridge University,
Lensfield Road, Cambridge, CB2 1EW, Great Britain
jph32@cam.ac.uk
- Pieter Schram, Professor
Laboratory for Fluid Mechanics, Eindhoven University of Technology,
Building Cascade, NL - 5600 MB, Eindhoven, The Netherlands
p.p.j.m.schram@tue.nl

Scientific Activity within last 5 years

Grants.

1) 2006-2012

Title: *Theory, Modeling, and Simulation of Ion Transport in Ionomer Membranes*

Funding body: Department of Energy, USA, DOE Grant DE-FG02-05ER46244

2) 2013-2014

Title: *Design & Development for Energy Storage Capacitors Using Novel Dielectric Materials*

Funding body: National Science Foundation (DMR-0907580), USA.

3) 2011-2013

Title: *Physics of Colloidal Dispersions in External Fields*

Funding Body: Transregional Collaborative Research [SFB-TR6](#), DFG (Deutsche Forschungsgemeinschaft)

4) 2014-2016

Title: *Nucleation and Front Propagation Problems in Dusty Plasma*

Funding Body: European Research Council, INTERCOCOS-[P7-IDEAS-ERC](#), Interdisciplinary research:

Connecting complex plasmas with colloidal dispersions

5) 2015-2020

Title: *Long Range Interactions for Biomolecular and Inorganic Mesoscale Assembly and Function*

Funding Body: DOE/Office of Science Program Office: Basic Energy Sciences, DE-FOA-0001204

Conferences

2010

1. *American Physical Society, 2010 APS March Meeting, Portland, Oregon, USA.*

Oral Presentation: *Simulation study of proton transport in a cylindrically confined ionomer channel*

Authors: [E. Allahyarov](#), P. Taylor, H. Lowen

2. *American Physical Society, 2010 APS March Meeting, Portland, Oregon, USA.*

Oral Presentation: *Theoretical and simulation study of charge distribution and transport in ionomers.*

Authors: [E. Allahyarov](#), P. Taylor, K. Brinker, Z. Tobin

3. *International Workshop "Theory and Computer Simulation of Polymers: New Developments", 2010, MSU, Moscow, Russia*

Oral presentation: *Nanocomposite membranes with directed proton conductivity.*

Authors: [E. Allahyarov](#)

2011

4. *8th Liquid Matter Conference, September 6-10, 2011, Wien, Austria*

Oral Presentation: *Huge broadening of the crystal-fluid interface for sedimenting colloids*

Authors: [E. Allahyarov](#)

5. *8th Liquid Matter Conference, September 6-10, 2011, Wien, Austria*

Oral Presentation: *Heterogeneous crystallization of hard-sphere colloids near flat and curved walls*

Authors: [E. Allahyarov](#), K. Sandomirski, S. Egelhaaf, H. Lowen

6. *American Physical Society, 2011 APS March Meeting, Dallas, Texas, USA*

Oral Presentation: *Molecular-dynamics study of proton transport near an ionomer-electrode interface.*

Authors: P. Taylor, [E. Allahyarov](#)

7. *American Physical Society, 2011 APS March Meeting, Dallas, Texas, USA*

Oral presentation: *Simulation study of charge distribution near an ionomer-electrode interface*

Authors: [E. Allahyarov](#), [P. Taylor](#)

8. *American Physical Society, 2011 APS March Meeting, Dallas, Texas, USA*

Oral Presentation: *Heterogeneous crystallization of Yukawa particles near interfaces*

Authors: [K. Sandomirski](#), [E. Allahyarov](#), [H. Lowen](#), [S. Egelhaaf](#)

2012

9. *American Physical Society March Meeting 2012, Boston, Massachusetts, USA*

Oral Presentation: *Theoretically guided design of efficient polymer dielectrics*

Authors: [P. Taylor](#), [E. Allahyarov](#)

10. *International Conference "Colloidal Dispersions in External Fields", CODEF III March 20 - 23, 2012, Bonn, Germany.*

Oral Presentation: *Freezing line for polydisperse colloids.*

Authors: [H. Löwen](#), [E. Allahyarov](#)

2013

11. *American Physical Society March Meeting, March 18–22, 2013; Baltimore, Maryland, USA*

Oral Presentation: *Theoretical considerations in the design of polymer dielectrics*

Authors: [P. Taylor](#), [G. Brown](#), [J. Miao](#), [E. Allahyarov](#)

12. *Soft Matter Composites Annual meeting, Rimini, Italy, 27-30 May 2013.*

Oral Presentation: *Template controlled crystal growth in colloidal systems.*

Authors: [E. Allahyarov](#)

13. *4th International Conference, Dusty Plasmas in Applications, Odessa, Ukraine, 25-29 August, 2013*

Oral Presentation: *Standing waves in Dusty Plasma colloids.*

Authors: [E. Allahyarov](#)

14. *International Symposium: Plasma Crystals in Space. A Russian-German Program. Moscow, Russia, October 7-8, 2013.*

Oral Presentation: *Latent heat generation in nucleation processes*

Authors: [E. Allahyarov](#), [A. Ivlev](#), [H. Lowen](#)

15. *International Soft Matter Conference, September 15-19, 2013, Rome, Italy.*

Oral Presentation: *Template controlled crystal growth in colloidal systems.*

Authors: [E. Allahyarov](#), [A. Ivlev](#), [H. Lowen](#)

2014

16. *Strongly Coupled Coulomb Plasma, SCCS 2014 Conference, Santa Fe, NM, USA,*

Oral Presentation: *Template controlled crystal growth in strongly coupled plasma.*

Authors: [E. Allahyarov](#), [H. Lowen](#), [A. Ivlev](#)

2015

17. *Workshop: Theory and Computer Simulation of Polymers: New Developments, June 28 - July 1, 2015, Martin-Luther-University Halle-Wittenberg, Germany*

Oral Presentation: *Composite polymer activation under applied fields.*

Authors: [E. Allahyarov](#)

18. *Fourth International Conference Frontiers in Polymer Science 2015, 20 - 22 May 2015, Riva del Garda, Italy*

Oral Presentation: *Bilayer composites with charged interfaces: Actuation issues.*

Authors: [E. Allahyarov](#)