Curriculum Vitae: Thomas Franosch

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Curriculum Vitae

Personal Data

Name:	PD Dr. rer. nat. Thomas Alexander Franosch
Born:	2nd May, 1968, Berlin (West), Germany
Nationality:	German

Education

July 2007	Privatdozent (*venia legendi*) in Theoretical Physics at Ludwig-Maximilians-Universität München
April 2005	*Habilitation* in Theoretical Physics, Freie Universität Berlin; Habilitation Thesis: 'Light scattering and Transient Grating Experiments in Supercooled Liquids'
July 1996	graduation *Dr. rer. nat.* (*summa cum laude*) at Technische Universität München, Thesis adviser: Prof. Dr. Wolfgang Götze, Doctoral Thesis: 'Langzeitanomalien und Glasbildung' (long-time anomalies and the glass transition)
July 1993	graduation *Dipl. Phys.* (*mit Auszeichnung*, with distinction) at Technische Universität München, Thesis adviser: Prof. Dr. Wolfgang Götze, Diploma Thesis: 'Leiter-Isolator Übergang in Gläsern' (conductor-insulator transition in glasses)
1987-1993	Physics studies (*Allgemeine Physik)* at Technische Universität München
May 1987	Abitur (german university entrance qualification)
1980-1987	Gymnasium (high school), Bad Tölz, Germany
1974-1980	Johannes-Tews Grundschule (elementary school), Berlin-Zehlendorf, Germany

Academic Career

Since 1st June 2006	Akademischer Oberrat (non-permanent senior staff member) at Ludwig-Maximilians-Universität München
03/2008 - 09/2008	Visiting Professor at Johannes-Gutenberg-Universität Mainz
10/2007 - 02/2008	Visiting Professor at Ludwig-Maximilians-Universität München
04/2006 - 07/2006	Visiting Professor at Universität Bayreuth
09/2001 - 02/2006	Senior Research Assistant at Hahn-Meitner-Institut Berlin
10/2005 - 02/2006	Visiting Professor at Ludwig-Maximilians-Universität München
04/2005 - 07/2005	Visiting Professor at Ludwig-Maximilians-Universität München
10/2004 - 02/2005	Visiting Professor at Universität Konstanz
11/2000 - 09/2001	Postdoctoral Assistant at the Institut für Theoretische Physik; Technische Universität München (Prof. W. Götze)
09/1998 - 11/2000	Postdoctoral Research Fellow at Harvard University; Condensed Matter Theory Group (Prof. D.R. Nelson); funded partly by the DFG (German Science Foundation)
08/1996 -08/1998	Postdoctoral Assistant at the Institut für Theoretische Physik, Technische Universität München (Prof. W. Götze)
10/1993 - 07/1996	Research Assistant at the Institut für Theoretische Physik, Technische Universität München (Prof. W. Götze)
07/1992 - 07/1993	Diploma student at the Institut für Theoretische Physik, Technische Universität München (Prof. W. Götze)

Teaching Experience

Lecture: Nonlinear Dynamics and Complex Systems, Universität Mainz, summer term 2008

Lecture: Mathematical Methods for Theoretical Physics, LMU München, winter term 2007

Presentation: Lehrerfortbildung 'Molekularer Strassenverkehr' (advanced training for teachers, molecular traffic), Dillingen, October 2007

Tutorials for Theoretical Physics TII: Electrodynamics, LMU München, summer term 2007

Tutorials for Theoretical Physics TVI: Soft Matter and Biological Physics, LMU München, winter term 2006

Presentation: Lehrerfortbildung 'Molekulardynamik-Simulationen von heterogenen Medien' (advanced training for teachers, molecular dynamics simulations of heterogeneous materials), Weihenstephan, June 2006

Lecture: Statistical Physics, Universität Bayreuth, summer term 2006

Lecture: Theoretische Physik TLIV: Thermodynamik für Lehramtskandidaten (Thermodynamics for Teachers), LMU München, winter term 2005

Presentation: Lehrerfortbildung 'Schmelzen molekularer Kolloidkristalle' (advanced training for teachers, melting of molecular colloidal crystals), Dillingen, October 2005

Lecture: Theoretische Physik TVI: Statistical Physics of Biopolymers, LMU München, summer term 2005 (together with Dr. U. Gerland)

Lecture: Mathematische Methoden der Physik: Dynamische Systeme (Dynamical Systems), Universität Konstanz, winter term 2004

Seminar: Theorie der Phasengleichgewichte und der kritischen Phänomene (theory of phase equilibria and critical phenomena), Freie Universität Berlin, summer term 2004 (together with Dr. K. Kroy)

Lecture: Hydrodynamik und Elastizität mit Anwendungen in der Biologie (hydrodynamics and elasticity and their applications in biology), Freie Universität Berlin, summer term 2003 (together with Dr. K. Kroy)

Lecture: Statistische Mechanik II: Weiche Materie und Biologische Physik (advanced statistical mechanics: soft condensed matter and biological physics), Freie Universität Berlin, winter term 2002 (together with Prof. E. Frey)

Seminar: Stochastische Zugänge zur Thermodynamik (stochastic approach to thermodynamics), Freie Universität Berlin, summer term 2002 (together with Dr. M. Falcke)

Tutorials: Theorie der Wärme – Statistische Mechanik (statistical mechanics), Freie Universität Berlin, summer term 2002

Tutorials: Klassische Mechanik und Elektrodynamik (Classical Mechanics and Electrodynamics), Technische Universtät München, winter term 1995 and 1996

Teaching assistant: Klassische Mechanik, Quantenmechanik II, Statistische Mechanik (classical Mechanics, advanced Quantum Mechanics, Statistical Mechanics), 1991-1993

Student Supervision

PhD Theses

Jonas Kraus on 'Hydrodynamics at Micro- and Nanoscales' (graduation 2010)

Marta Balbás-Gambra on 'Molecular colloidal crystals', (2009)

Tobias Munk on 'Brownian Motion of Needle through a heterogeneous network', (October 2008)

Felix Höfling on 'Dynamics of the Lorentz problem of rod-like objects', (September 2006)

Paolo Pierobon on 'One-dimensional Transport of extended objects as a minimal model for dynamic properties of molecular motors', (May 2006)

Diplomas Theses

Matthias Grimm on 'Theoretical Analysis of Protein-free RNA Replication using Nonequilibrium Conditions' (July 2009)

Karl-Ulrich Bamberg on 'Transport in disordered materials' (July 2009)

Peter Colberg on Parallelization of Molecular Dynamics Simulations on Graphics Processing Units' (October 2008)

Axel Kammerer on 'Anomalous Transport in heterogeneous Media', (March 2008)

Jonas Kraus on 'Hydrodynamics at Micro- and Nanoscales', (October 2007)

Anna Melbinger on 'Classical Spin Transport far from Equilibrium' (October 2007)

Maximilian Schultz on 'Rotational Dynamics and Light-Scattering in Supercooled Molecular Liquids' (Heraeus-Prize, 2004)

Invited Talks at international Conferences and Workshops

'From Solid State to BioPhysics IV', Dubrovnik, Croatia, June 2008, 'Entangled Dynamics of a Stiff Polymer'

'Crystallization and Jamming in Soft Matter under Driving – Colloidal Suspensions, Granular Media, Foams and Complex Plasmas', Leiden, The Netherlands, February 11-22, 2008

PHYSBIO, Non-equilibrium in Physics and Biology, October 2007, St. Etienne de Tinée, 'Suppression of Diffusion by Disorder'

Workshop 'Macromolecular Systems for Nanoscinece', Kloster Irsee, September 6 - 9, 2007, 'Slow transport in complex environment'

ASC Workshop on 'Nonequilibrium Phenomena in Classical and Quantum Systems', Munich, October 9 - 11, 2006, 'Non-equilibrium phase transitions in driven lattice gases'

CeNS Workshop at Venice International University 'Emerging Nanosystems - from quantum manipulation to nanobiomachines', September 25 - 29, 2006, 'Phase Separation in driven Non-equilibrium transport'

'From Solid State to BioPhysics III', Dubrovnik, Croatia, June 24 - July 1, 2006, 'Collective Phenomena in one-dimensional Driven Lattice Gases – Minimal Models for intracellular Transport and Traffic'

Dynamics of Viscous Liquids, Mainz, April 9-12, 2006, 'The Localization Transition of the 3D Lorentz Model and Continuum Percolation'

ASC Workshop on 'Brownian Motion: A Paradigm of Soft Matter and Biological Physics', München, September 25-28, 2005, 'The Localization Transition of the 3D Lorentz Model and Continuum Percolation'

5th International Discussion Meeting on Relaxations in Complex Systems, Lille, July 2005, 'Time-Resolved Spectroscopy in Glass-Formers'

'Unifying Concepts in Glass Physics', Bangalore, June – July 2004, 'The Role of Rotation-Translation coupling in the Theory of Light Scattering and Transient Grating Experiment'

'Dynamics of Viscous Liquids', München, March 14–17, 2004, 'Recent progress on the theory of light-scattering and transient grating experiments'

ROMA2002 'Unifying Concepts in Glass Physics', Roma, February 27 – March 2, 2002, 'Structural relaxation of a dumbell solute'

Dynamical Properties of Solids (DyProSo XXVIII) September, 16 – 20, 2001, Congrescentrum Rolduc, Kerkrade, Netherlands, 'New developments in mode coupling theory'

List of Publications

Publications in peer-reviewed Journals

1. Domain wall delocalization, dynamics and fluctuations in an exclusion process with two internal states; T. Reichenbach, E. Frey, and T. Franosch, Eur. J. Phys. E *in press*

2. Anisotropic Memory Effects in Confined Colloidal Diffusion S. Jeney, B. Lukić, J.A. Kraus, T. Franosch, and László Forró, Phys. Rev. Lett. **100**, 240604 (2008) (see also cover page)

3. Entangled Dynamics of a Stiff Polymer, F. Höfling, T. Munk, E. Frey, and T. Franosch Phys. Rev. E **77**, 060904(R) (2008)

4. Microscale Fluid Flow Induced by Thermoviscous Expansion Along a Travelling Wave, F.M. Weinert, J.A. Kraus, T. Franosch, and D. Braun Phys. Rev. Lett. **100**, 164501 (2008)

5. Critical Properties of the Lorentzgas close the Localization Threshold; F. Höfling, T. Munk, E. Frey, and T. Franosch, J. Chem. Phys. **128**, 164517 (2008)

6. Traffic jams induced by rare switching events in two-lane transport, T. Reichenbach, E. Frey, and T. Franosch, New Journal of Physics **9**, 159 (2007)

7. Crossover in the Slow Decay of Dynamic Correlations in the Lorentz Model, F. Höfling and T. Franosch, Phys. Rev. Lett. **98**, 140601 (2007)

8. Spin models for orientational ordering of colloidal molecular crystals, A. Šarlah, E. Frey, and T. Franosch, Phys. Rev. E **75**, 021402 (2007)

9. Driven lattice gas of dimers coupled to a bulk reservoir, P. Pierobon, E. Frey, and T. Franosch, Phys. Rev. E **74**, 031920 (2006)

10. Exclusion Processes with Internal States, T. Reichenbach, T. Franosch, and E. Frey, Phys. Rev. Lett. **97**, 050603 (2006)

11. Localization Transition of the 3D Lorentz Model and Continuum Percolation, F. Höfling, T. Franosch, and E. Frey,
Phys. Rev. Lett. **96**, 165901 (2006) (see also cover page)

12. Melting of Colloidal Molecular Crystals on Triangular Lattices,
A. Šarlah, T. Franosch, and E. Frey, Phys. Rev. Lett. **95**, 088302 (2005)

13. Transient grating experiments on supercooled molecular liquids II: microscopic derivation of the phenomenological equations, T. Franosch and R. M. Pick, Eur. Phys. J. B **47**, 341 (2005)

14. Renewal process and fluctuation analysis of molecular motor stepping, J. E. Santos, A. Parmeggiani, T. Franosch, and E. Frey, Physical Biology 2 (2005) 207

15. The Totally Asymmetric Simple Exclusion Process with Langmuir Kinetics, A. Parmeggiani, T. Franosch, and E. Frey, Phys. Rev. E **70**, 046101 (2004)

16. Heterodyne detected transient gratings in supercooled molecular liquids; A phenomenological theory, R. M. Pick, C. Dreyfus, A. Azzimani, R. Gupta, R. Torre, A. Taschin, T. Franosch, Eur. Phys. J. B **39**, 169 (2004)

17. Collective Phenomena in Intracellular Processes, E. Frey, A. Parmeggiani, T. Franosch, Genome Informatics **15**, No. 1, 46-55 (2004)

18. Phase Coexistence in Driven One-Dimensional Transport, A. Parmeggiani, T. Franosch, and E. Frey, Phys. Rev. Lett. **90**, 086601 (2003)

19. Frequency and time resolved light scattering on longitudinal phonons in molecular supercooled liquids, R. M. Pick, C. Dreyfus, A. Azzimani, A. Taschin, M. Ricci, R. Torre and T. Franosch, J. Phys.: Condens. Matter **15**, S825-S834 (2003)

20. Light scattering by longitudinal acoustic modes in molecular supercooled liquids I: phenomenological approach, R.M. Pick, T. Franosch, A. Latz, and C. Dreyfus, Eur. Phys. J. B **31**, 217 (2003)

21. Light scattering by longitudinal acoustic modes in supercooled molecular liquids II: Microscopic Derivation of the Phenomenological Equations, T. Franosch, A. Latz, and R.M. Pick, Eur. Phys. J. B **31**, 229 (2003)

22. Completely monotone solutions of the mode-coupling theory for multi-component mixtures, T. Franosch and Th. Voigtmann, J. Stat. Phys. **109**, 237-259 (2002)

23. Light scattering spectra of supercooled molecular liquids, T. Franosch, M. Fuchs, and A. Latz, Phys. Rev E **63**, 061208 (2001)

24. Shear response of a smectic film stabilized by an external field,
T. Franosch and David R. Nelson, Phys. Rev E **63**, 061706 (2001)

25. Channel flow of smectic films, T. Franosch, Shilpa Jain, and
David R. Nelson, Phys. Rev. E **61**, 3942 (2000)

26. Population Dynamics near an Oasis with time-dependent Convection, T. Franosch and David R. Nelson, J. Stat. Phys. **99**, 1021 (2000)

27. Relaxation rate distribution for supercooled liquids, T. Franosch and W. Götze, J. Phys. Chem. B **103**, 4011 (1999)

28. Comparison of Monte Carlo data and Percus-Yevick calculations of molecular pair correlation functions of a solute molecule in a simple liquid, T. Franosch and A.P. Singh, J. Chem. Phys. **110**, 5831 (1999)

29. Mode-coupling theory for the shear viscosity in supercooled liquids, T. Franosch and W. Götze Phys. Rev. E **57**, 5833 (1998)

30. Phase diagram for a linear solute molecule in a supercooled liquid, T. Franosch and A.P. Singh, J. Non-Cryst. Solids **235-237**, 153 (1998)

31. Structure and structure relaxation, T. Franosch, W. Götze, M.R. Mayr and A.P. Singh, J. Non-Cryst. Solids **235-237**, 71 (1998)

32. Structural relaxation in orthoterphenyl: a schematic-mode-coupling-theory-model analysis, A.P. Singh, G. Li, W. Götze, M. Fuchs, T. Franosch and H.Z. Cummins, J. Non-Cryst. Solids **235-237**, 66 (1998)

33. Solution of the Percus-Yevick equation for the molecular pair correlation function of a linear solute molecule in a simple liquid, T. Franosch and A.P. Singh, J. Chem. Phys. **107**, 5524 (1997)

34. Theory for the reorientational dynamics in glass-forming liquids, T. Franosch, M. Fuchs, W. Götze, M.R. Mayr, and A.P. Singh, Phys. Rev. E **56**, 5659 (1997)

35. Asymptotic laws and preasymptotic correction formulas for the relaxation near glass-transition singularities, T. Franosch, M. Fuchs, W. Götze, M.R. Mayr, and A.P. Singh, Phys. Rev. E **55**, 7153 (1997)

36. Evolution of structural relaxation spectra of glycerol within the gigahertz band, T. Franosch, W. Götze, M.R. Mayr, and A.P. Singh, Phys. Rev. E **55**, 3183 (1997)

37. A theory for a certain cross over in relaxation phenomena in glasses, T. Franosch and W. Götze, J. Phys.: Condensed Matter **6**, 4807 (1994)

38. The influence of the nuclear shape and of the muonic vacuum polarization on strongly bound electrons, Thomas Franosch and Gerhard Soff, Z. Phys. D **18**, 219 (1991)

Manuscripts in preparation

1. Enhanced diffusion of a needle in a planar course of point obstacles, F. Höfling, E. Frey, and T. Franosch, submitted to *Physical Review Letters* (June 2008)

2. Cluster-resolved scaling and universal corrections for percolating systems, A. Kammerer, F. Höfling, and T. Franosch

3. Giant Anisotropic Diffusion of a Rod in Disordered Environments, T. Munk, F. Höfling, E. Frey, and T. Franosch

4. Hydrodynamic memory in harmonically trapped single colloids, S. Jeney, B. Lukić, J.A. Kraus, T. Franosch, and L. Forró

5. Persistent correlations of single particle diffusion close to a wall, J.A. Kraus, S. Jeney, B. Lukić, L. Forró, and T. Franosch

6. Optically driven fluid flow in confined systems, J.A. Kraus, F.M. Weinert, D. Braun, and T. Franosch

Research Interests

My research interests are devoted to the physical properties of soft condensed matter and, in particular, biological physics. This area has been established now as one of the most promising and expanding fields within condensed matter physics. Its success is founded from the experimental point of view on the possibility to directly visualize and manipulate mesoscopic objects and from the prospect of theoretical physics by the rapidly increasing computer power allowing to validate and support theoretical models by the means of simulations. This paves the way to provide understanding for the emergence of complex structures and dynamics on mesoscopic length- and time scales. My own research activities cover a variety of methods including analysis of experimental data, phenomenological modeling, computer simulation as well as aspects of mathematical physics. The common theme of all efforts is the emergence of new structures and properties due to collective behavior. Typically, I try to combine analytic approaches in combination with approximate theories corroborated by computational physics.

Complex Dynamics in disordered Media – Molecular Crowding Anomalous transport in crowded environments is a topic well-suited for computer simulations. Examples range from porous media to the cell which comprises obstacles to diffusion of various sizes due to the lipids, sugars, and membranes, floating in the cytoskeleton. Within the framework of continuum percolation a series of detailed predictions for the critical behavior is known, which can now be scrutinized by high-precision simulations. The scaling behavior is blurred by the appearance of corrections to scaling which explains the generic mechanisms leading to apparent density-dependent exponents for anomalous transport seen in experimental systems.

Entangled Dynamics of Stiff Biopolymers The transport of rather rigid rod-like objects, like stiff actin filaments, in a network is slowed down drastically due to entanglement effect. Corroborated by large-scale computer simulation, we elaborate the tube concept for needles in a two-dimensional parcours of point-like obstacles. In particular, we have observed the decrease of the rotational diffusion as the density of obstacles increasing according to a power-law resulting from a theory based on the tube concept of Doi and Edwards. Our simulation data provide insight into the complex dynamics of constrained translation-rotation coupling and we have built an analytic theory in the highly entangled regime explaining an intermediate power-law in the scattering functions.

Non-equilibrium phase transitions and driven intracellular transport Novel collective properties emerge by coupling the driven transport of molecular motors along

mesoscopic tracks with Langmiur kinetics. In a mesoscopic limit, phase separation characterized by a sharp pinned domain wall, generically occurs in an extended regime of parameters. Preliminary experimental studies on *kinesin* motors on *microtubuli* corroborate the scenario of self-organized traffic jams. Extension of such models may play a rôle also for other driven one-dimensional systems, such as classical spin transport in a *spintronics* device.

Hydrodynamics at Micro- and Nanoscales Applications in microfluidics as well as biophysical tools require a detailed understanding of fluid transport on small length scales and its control in confined environment and external fields. Since the Reynolds number is typically small, viscous process dominate all other forces. However, in non-stationary systems or at small time scales, inertia plays an important role opening the possibility to build a sensor for the viscoelastic properties of complex/confined material operating at high frequencies.

Self-Assembly of colloidal and macromolecular systems Colloids are an ideal model system to study fundamental topics of statistical mechanics and they constitute a paradigm of soft condensed matter systems. Furthermore they can be easily manipulated by optical trapping and, in particular, one can stimulate them to build novel phases and induce phase transitions. Theoretical approaches, for example mean-field theory or computer simulation, allow to make predictions for future experiments and open the way for new physics. Recently, similar ordering phenomena have been observed for macromolecular systems at surfaces. We are currently investigating the possibility to explain such a behavior in terms of 'self-assembly'.

Further Expertise: Light-scattering and transient grating experiments in supercooled liquids Light-scattering is an important tool to study the structural relaxation in supercooled liquids. The theoretical description requires to consider the translation-rotation coupling, which generates novel effects in combination with generalized frequency-dependent susceptibilities. Experimental investigations, in particular *transient grating experiments*, reveal a complex interplay of the intrinsic structural relaxation and the hydrodynamic modes, such sound waves and heat diffusion.

Further Expertise: Mode-Coupling Theory of the glass transitions Dense systems are dominated by the *excluded volume effect* and often avoid crystallization and enter a glassy state. There a complex structural relaxation emerges as a result of the *cage effect*. The most successful theoretical approach is the *mode-coupling theory of the glass transition* that gives a series of non-trivial predictions for dynamic correlation functions in a mesoscopic time window. Recently, this theory has attracted significant attention, since it also explains quantitatively phenomena closely related to gelation.