



Interdisciplinary Center for Dynamics of Complex Systems (DYKOS) of the University of Potsdam

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Homepage of the Center: <http://www.agnld.uni-potsdam.de/>

1 History and Profile of the University of Potsdam

Potsdam - once a city of kings and royal residences, is today the capital of Brandenburg and at the same time a European city of culture. The heart of Prussia is famous for its palaces and parks, its gardens and villas, and its numerous museums. In the past basically a military and garrison town, it is today a city of films and media as well as a university city. And it is traditionally also a city of learning and research, whose worldwide reputation substantially rests upon work in the natural sciences in the fields of astro- and Gravitation Physics and Earth Sciences. The "Einstein Tower" on the Telegrafenberg, one of the most significant expressionist buildings, is an imposing symbol of the link between landscape, architecture and science.

Although the University of Potsdam is only a few years old, it nevertheless has its own history. In 1948 the Brandenburg Landeshochschule (school of higher education of the Land Brandenburg) was founded here in Potsdam. Out of this institution developed later the Karl Liebknecht Pedagogical College, the largest teacher training institution in the GDR. After the social and political changes of the year 1989 the University of Potsdam was founded on the grounds of the previous institutions on July 15, 1991. Today it is the largest university in Brandenburg. The University of Potsdam is conceived as a small university. Its motto is: "Klein aber fein," "Small but excellent." Presently approximately 16,000 students study in the various departments of the University of Potsdam, including about 1,300 foreign students from more than 85 countries.

The University of Potsdam was designed as a classical university. Five faculties form the pillars of the institution. They are the Philosophical Faculty, Humanities, Law, Economics and Social Sciences and the Natural Sciences-Mathematics Faculty. With the establishment of supra-faculty, interdisciplinary areas, the University of Potsdam places special emphasis on areas beyond the teaching and research activities of the individual institutes. These fields include the Geo-Sciences, Educational Science, the Potsdam Model of Teacher

Training, the Cognitive Sciences, Complex Systems, Comparative Cultural Studies, Life Sciences, Soft Matter as well as Economics/Institutions and Administration.

Proof of the quality of the research carried out at Potsdam University is the steadily increasing funding through industry and other third parties and the financing of two research groups and two graduate seminars by the German Research Society (DFG). These have been established in the fields of Linguistics, Psychology and Jewish Studies. The achievements in these fields is indicated by the admission of the university into the German Research Society (DFG) in the summer of 1998. Moreover, the university is responsible for further academic education, for example in the area of in-service teacher training and additional qualification courses.

There are co-operations with external institutions located in the vicinity of the university: Max-Planck-Institute of Molecular Plant Physiology, Max-Planck-Institute of Colloids and Interfaces, Max Planck Institute for Gravitational Physics (Albert-Einstein-Institut), GeoForschungsZentrum Potsdam (GFZ, Germany's National Research Centre for Geosciences), Potsdam Institute for Climate Impact Research (PIK), Alfred Wegener Institute for Polar and Marine Research (AWI), Astrophysical Institute Potsdam (AIP).

2 High-Profile Research

An important criterion in assessing the attractiveness of a university is the practical relevance of the research it carries out. In the future, only those universities which cooperate closely with extramural basic research institutions and high-tech companies will have a competitive advantage. The university of the future must be able to network between various fields - from research to teaching as well as to politics, society and the economy. The University of Potsdam already fulfills these criteria to a large extent.

At the beginning of the new millennium the University of Potsdam set itself the goal to be at the forefront, both nation-wide and internationally, in the competition for students and research funding. Following a recommendation of the Council of Science (Wissenschaftsrat) and a follow-up discussion on university structure, the University of Potsdam now concentrates on eight fields of research, interdisciplinary for the most part and particularly competitive, which make the profile of the university clearly visible. These fields of research comprise:

- Geosciences
- Life Sciences
- Cognitive Science
- Complex Systems
- The Comparison of Cultures
- Soft Matter
- Economy - Institutions - Administration
- Potsdam Model of Teacher Training

3 Interdisciplinary Center for Dynamics of Complex Systems

The Center was established in 1994 by the Senate of the University of Potsdam. It is directly responsible to the Senate of the University of Potsdam. The goal of the Center for Dynamics of Complex Systems is to further interdisciplinary research and teaching in the field of Nonlinear Dynamics and Complex Systems.

We study in interdisciplinary collaboration the behavior of complex systems using methods of nonlinear dynamics and statistical physics. Beyond the development of new methods, we focus on applications of the theoretical results in a variety of different areas of physics and life. Now the center has become one of the top centers on nonlinear and complex systems in Europa and in the world. The main directions of the center are

- A) **Complex systems theory**
- B) **Nonlinear processes in geosciences and astrophysics**
- C) **Computational neuroscience**
- D) **Bioinformatics and systems biology**

The Center puts its emphasis on organization of scientific cooperation in interdisciplinary research. Its activity also includes distribution of funds and creation of new projects. The Interdisciplinary Center for Dynamics of Complex Systems uses the resources of these departments to achieve synergy effects.

a) Interdisciplinary Research Projects

- Innovationskolleg “ Formale Modelle kognitiver Komplexität” (DFG)
- DFG-Forschergruppe: “Konfligierende Regeln und Strategien zur Resolution von Konflikten in der Kognitionswissenschaft”
- SFB 555 “Komplexe nichtlineare Prozesse - Analyse, Simulation, Steuerung und Optimierung” (DFG)
- EU Research Training Network “Control and Synchronization of Spatially Extended Nonlinear Systems”
- DFG - Priority Programme 1114 “Mathematische Methoden der Zeitreihenanalyse und digitalen Bildverarbeitung”
- COST Action Advanced Methods for the Estimation of Human Brain Activity and Connectivity (NEUROMATH) (EU)
- BMBF-Project zur Systembiologie FORSYS
- EU-Network of Excellence BIOSIM: Biosimulation - A New Tool in Drug Development
- Graduate training programme Shaping Earth’s Surface in a Variable Environment Interactions between tectonics, climate and biosphere in the African-Asian monsoonal region

b) **International Graduate Schools:**

- International Graduate School for Computational Neuroscience of Behavioral and Cognitive Dynamics (Helmholtz Center for Mind and Brain Dynamics, <http://www.helmholtz-center.agnld.uni-potsdam.de>)
- International Max-Planck-Research-School on Biomimetic Systems (<http://www.imprs.org/courses.html>)
- Annual summer-schools of the Helmholtz Institute for Supercomputational Physics (part of the center)
 - * 2001: **Tools to Simulate Turbulence on Supercomputers**
 - * 2002: **Scientific Supercomputing in Climate Research**
 - * 2003: **Chaos and Stability in Planetary Systems** (5 applicants for every position)
 - * 2004: **Computational Fluid Mechanics**
 - * 2005: **Complex Networks in Brain Dynamics**
 - * 2006: **Supercomputational Cosmology**

The researchers of center have access to high level software tools like Matlab, IDL and Mathematica. The scientific library holds the main journals in the relevant fields. The electronic versions of these journals are available online. The center frequently hosts highly qualified researchers from worldwide coming for a short visit to give lectures and to exchange expertise.

Currently the Center for Dynamics of Complex Systems has almost 50 members from different university departments (biology, chemistry, general linguistics, geosciences, informatics, mathematics, physics, psychology) and research institutes located in Potsdam (Max-Planck-Institute of Molecular Plant Physiology, Max-Planck-Institute of Colloids and Interfaces, Max Planck Institute for Gravitational Physics (Albert-Einstein-Institut), GeoForschungsZentrum Potsdam (GFZ, Germany's National Research Centre for Geosciences), Potsdam Institute for Climate Impact Research (PIK), Alfred Wegener Institute for Polar and Marine Research (AWI), Astrophysical Institute Potsdam (AIP).

Advisory Board of the Center

Prof. Dr. H. Abarbanel, Department of Physics & Institute for Nonlinear Science, University of California, San Diego, USA

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Prof. Dr. V. Anishchenko, Department of Physics, Laboratory of Nonlinear Dynamics, Saratov State University, Russia

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Prof. Dr. S. Havlin, Department of Physics, Bar-Ilan University, Ramat-Gan, Israel

Prof. Dr. G. Hooper, Information Technology and Electrical Engineering, University of

Queensland, Brisbane, Australia

Prof. Dr. G. E. Morfill, Max-Planck-Institut für extraterrestrische Physik, Garching, Germany

Prof. Dr. John B. Rundle, Interdisciplinary Professor of Physics, Civil Engineering and Geology

Director, Center for Computational Science and Engineering, University of California, USA

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Prof. Dr. J. Uriagereka, Linguistics, University of Maryland, College Park, Maryland, USA

Publications, Guests and Seminar Schedule

To get an impression of the research activities of our center please visit

http://www.agnld.uni-potsdam.de/~publman/Publikationen_agnld.html (publications)

and <http://www.agnld.uni-potsdam.de/~shw/Koll.html> (seminar schedule).

A Current Projects & Funds (2003-2006)

Project	Budget
EU-Network of Excellence BIOSIM “A New Tool in Drug Development”	300.000
EU-Project “Extreme Events: Causes and Consequences”	90.880 €
EU-Project “Brain Respiration and Cardiac Causalities in Anaesthesia”	221.200 €
SFB 555 “Komplexe nichtlineare Prozesse” (Potsdamer Anteil)	341.500 €
HGF: “Virtual Institute Pole Equator Pole”	53.000 €
DFG-Project “Erweitertes Monitoring nach Herzoperationen”	122.000 €
DFG-Project “Kardiovaskuläre Regulation während des humanen Schlafes”	36.400 €
DFG-Project “Raum-zeitliche Seismizitätsmodelle”	20.400 €
DFG-Project “Extrapolation solarer Vektormagnetogramme”	27.400 €
DFG-Research Unit “Konfligierende Regeln”	317.300 €
INTAS: “Synchronization of biological oscillators”	41.600 €
DFG-Priority Programmes	
SPP 1114 “Mathematische Methoden”	117.500 €
SPP 384 “Kinetics of cosmic Granular Gases”	92.600 €
SPP 384 “Dynamics of perturbed dense Planetary Rings”	60.000 €
SPP 384 “Martian dust tori Continuation SPP 1115”	92.800 €
SPP 1115 “Staubtori um Mars”	20.650 €
DLR-Project “CASSINI-CDA Experiment 2 & 3”	271.600 €
Junior Research Group of the VW-Foundation	376.900 €
Landesmittel EFRE: Toolbox für die Analyse physiologischer Daten	30.830 €
Landesmittel HWP: Nichtlineare Datenanalyse	30.830 €
Zielvereinbarung: Internationales Promotionskolleg	184.400 €
VW-Projects	
“Nichtlinear-dynamische Effekte in produktionstechnischen Systemen”	90.000 €
“Stochastic modeling of the proteasome and its application in Cancer therapy”	127.000 €
ESA-Project “Bone-Project”	192.650 €
BMBF-Project “Multimedia in der Mathematik”	189.500 €
DAAD-Projects (foundationers, exchange programme)	9.000 €
Alexander von Humboldt-Foundation (foundationers, exchange programme)	40.340 €
Helmholtz-School “Supercomputational Physics”	342.000 €
Funds for the University of Potsdam (2003-2006)	4.065.280 €

B Key Publications

- Spahn, F. and Schmidt, J. Saturn's bared mini-moons NATURE 440, 614-615 (2006)
- Spahn, F., Schmidt, J., Albers, N., Hoerning, M., Makuch, M., Seiss, M., Kempf, S., Srama, R., Dikarev, V., Helfert, S., Moragas-Klostermeyer, G., Krivov, A., Sremcevic, M., Tuzzolino, A., Economou, T., and Gruen, E. Cassini Dust Measurements at Enceladus: Implications for the Origin of the E Ring SCIENCE 311, 1416-1418 (2006)
- Steuer, R., Gross, T., Selbig, J. & Blasius, B. Structural kinetic modeling of metabolic networks, Proc. Natl. Acad. Sci. USA 103, 11868-11873 (2006)
- Maraun, D. and Kurths, J. Epochs of phase coherence between El Nino/ Southern Oscillation and Indian monsoon. Geophys. Res. Lett., 32:L15709 (2005)
- Marwan, N. and Kurths, J. Line structures in recurrence plots. Physics Letters A, 336(4-5):349-357(2005)
- Belykh, V., Osipov, G., Kuckländer, N., Blasius, B., and Kurths, J. Automatic control of phase synchronization in coupled complex oscillators. Physica D, 200:81-104 (2005)
- Brilliantov, N. V., Saluena, C., Schwager, T., and Pöschel, T. Transient structures in a granular gas. Phys. Rev. Lett., 93:134301 (2004)
- Karolyi, G., Tel, T., de Moura, A., and Grebogi, C. Reactive particles in random flows. Phys. Rev. Lett., 92:174101 (2004)
- Romano, M. C., Thiel, M., Kurths, J., and von Bloh, W. Multivariate Recurrence Plots. Physics Letters A, 330(3-4):214-223 (2004)
- Rosenblum, M. G. and Pikovsky, A. S. Controlling synchrony in ensemble of globally coupled oscillators. Phys. Rev. Lett., 92:114102 (2004)
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- Narteau, C., Shebalin, P., Hainzl, S., Zöller, G., and Holschneider, M. Emergence of a band-limited power law in the aftershock decay rate of a slider-block model. Geophys. Res. Lett., 30:10.1029/2003GL017110 (2003)
- Neufeld, Z., Kiss, I., Zhou, C., and Kurths, J. Synchronization and oscillator death in oscillatory media with stirring. Phys. Rev. Lett., 91:084101 (2003)
- Osipov, G., Hu, B., Zhou, C., Ivanchenko, M., and Kurths, J. Three types of transitions to phase synchronization in chaotic oscillators. Phys. Rev. Lett., 91:024101 (2003)
- Schmidt, J. and Salo, H. Weakly nonlinear model for oscillatory instability in Saturn's rings. Phys. Rev. Lett., 90:061102 (2003)
- Ullner, E., Zaikin, A., Garcia-Ojalvo, J., Bascones, R., and Kurths, J. Vibrational resonance and vibrational propagation in excitable systems. Phys. Lett. A, 312:348-354 (2003)
- Ullner, E., Zaikin, A., Garcia-Ojalvo, J., and Kurths, J. Noise-induced excitability in oscillatory media. Phys. Rev. Lett., 91(18):180601-1-180601-4 (2003)
- Wessel, N., Schirdewan, A., and Kurths, J. Intermittently decreased beat-to-beat variability in congestive heart failure. Phys. Rev. Lett., 91:119801 (2003)
- Zaikin, A., Garcia-Ojalvo, J., Bscoces, R., Ullner, E., and Kurths, J. Doubly stochastic coherence via noise-induced symmetry in bistable neural models. Phys. Rev. Lett., 90:030601 (2003)
- Zhou, C., Kurths, J., Neufeld, Z., and Kiss, I. Noise-sustained coherent oscillation of ex-

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Schäfer, C., Rosenblum, M., Kurths, J., and Abel, H.-H. Heartbeat synchronized with ventilation. *Nature*, 392(6673):239-240 (1998)

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http://www.agnld.uni-potsdam.de/~publman/Publikationen_agnld.html

C Workshops

- 2004: 29.-30.3. INTAS-Meeting on Synchronization of Biological Oscillators
- 2004: 7.5. RTN workshop: Network Meeting COSYC of SENS
- 2004: 4.-6.11. First Promotionskolleg Workshop: Computational Neuroscience of Behavioral and Cognitive Dynamics
- 2004: 18.-20.11. TransCoop workshop: Multilingual Acquisition and Processing
- 2005: 13.-14.1. Dynamical systems in climate processes
- 2005: 16.2. Spatio-temporal Synchronization in Ecological Systems a Link from Local Dynamics to Global Structure
- 2005: 4.-11.3. March 4th - 11th, 2005 Real, Mental and Virtual Space
- 2005: 10.-11.3. Data Analysis in Geophysics: Theoretical and Practical Seminars
- 2005: 14.-17.3. Tandem Workshop on Advanced Methods of Electrophysiological Signal Analysis (Part A) and Symbol Grounding? Dynamical Systems Approaches to Language (Part B)
- 2005: 9.-11.5. 346. WE-Heraeus-Seminar: Cardiovascular Physics - Model Based Data Analysis of Heart Rhythm
- 2005: 30.-31.5. PEP - Jahres-Treffen
- 2005: 11.-23.9. Wilhelm und Else Heraeus Summer School: Turbulent Flows in the Focus of Technology and Physics
- 2005: 18.-23. 13th International IEEE Workshop on Nonlinear Dynamics of Electronic Systems
- 2005: 22.-24.9. Recurrence Plot Workshop
- 2005: 28.-29.10. Second Workshop Promotionskolleg
- 2005: 28.-29.11. 8th MHD-Days
- 2006: 24.-25.4. BioSim workshop: Biosimulation “ A New Tool in Drug Development”
- 2006: 13.-14.7. Biosignalverarbeitung: Impulsgeber in der biomedizinischen Technik
- 2006: 14.-15.7. Third Workshop Promotionskolleg

- 2007: 3.-7.9. 3rd INTERNATIONAL CONFERENCE “PHYSICS AND CONTROL” (PhysCon 2007)
- 2007: 10.-14.10. 3rd BioSim Conference