ANNUAL REPORT 2007

Physics of Physiological Processes
Faculty of Physics, University of Vienna

STAFF

Group speaker:	Ao. Univ. Prof. Dr. Karl W. Kratky
Guest scientist:	Univ. Doz. Dr. Karl E. Kürten
Lecturers:	Mag. Werner Gruber, Univ. Doz. Dr. Karl E. Kürten, Mag. Dr. Hans Günter Löw
Volunteer:	Dipl. Phys. Dr. Axel Schäfer
Administration:	Andrea Hnizdo
Diploma student:	Matthias Fukac
PhD students:	Mag. Werner Gruber, Mag. Peter F. Hüttner, Mag. Dr. Said Ibrahim, Mag. Ivan Lucić

RESEARCH

The research group "Physics of Physiological Processes" deals with complex dynamical systems (chaos and systems research) in general and with the physics of the human body in particular. The following topics are considered: nonlinearity and feedback, self-organization and synchronization, chaos and fractals, neural networks and cellular automata. These topics are treated in various ways: from a fundamental point of view, studying computer experimental results and interpreting experimental data.

These topics are interdisciplinary, connecting physics especially with biology, psychiatry/ medicine and ecology. In this context, biophysical theses have been studying the effect of light and sound on biological systems. For instance, the fractal dimension of mushroom mycelium was analyzed, and the change of heart-rate variability of human beings was investigated. The fields of research in some detail:

Physics of physiological processes: inter- and transdisciplinary aspects

With the help of chaos and systems research, bridges to other sciences can be built, in research as well as in teaching. Attention is focused on biology and medicine. Among other things, it is investigated how chaos control is used by organisms to regulate their body functions efficiently. Furthermore, several therapies in complementary medicine are interpreted from the view-point of chaos and systems research.

Neurophysics

The mental processes of the brain are described by physical methods. At the moment the problem of cognitive learning and stammering is in the focus of investigation.

The effect of light and sound on heart-rate variability (HRV)

a) Humans are being exposed to light of different spectral composition and of different and varying intensity. Data of biophysical parameters (e.g. ecg, emg, breath) are acquired and then analyzed by nonlinear time series and other methods. The heart-rate variability (HRV) is a major point.

b) In a further step, three kinds of sound were presented to humans: 'pink noise', 'water' (wellspring), and 'frogs' (croaking). Their influence on HRV was again investigated.

c) Calculating the breathing rate via HRV (utilizing the respiratory sinus arrhythmia) yields another interesting variable that makes new interpretations possible.

In addition to the research, several lectures are offered, e.g., "Complex Dynamical Systems", "Physics of Physiological Processes", "Brain modelling I & II" and "Theory of complex interconnected systems I & II".

REFEREED PROJECTS

K.E. Kürten

- Theory of interconnected systems: from cellular automata to genetic, social, and neural network models (supported by the European Science Foundation ESF and by the Department of Physics, Loughborough University)

We study phase transitions from ordered to chaotic behavior applicable to various real-word networks such as gene regulation networks, social networks, multi-agent networks, majority voter networks, epidemic networks, chemical reaction networks, and neural network models. One focus of this study is the determination of critical parameters, where the network is placed "at the edge of chaos", i.e. at a subtle compromise between stability and flexibility, where biological systems have both, the necessary stability and the potential for evolutionary improvements.

Scale-free network topologies have been found almost everywhere in the real world. Many networks expand through the addition of nodes to an already existing network, and those nodes attach preferentially to nodes which are already well connected. (the rich get richer) When this is the case, a scale-free network naturally arises. In fact, a scale-free network is a very specific kind of network in which the distribution of connectivity is extremely uneven: some nodes act as "very connected" hubs using a power-law distribution, whereas most of the nodes are rather sparsely connected. Examples are computer networks and the world wide web, which react significantly different from randomly connected networks in the presence of perturbations. If nodes fail randomly, scale-free networks behave much better than random connectivity networks, because random failures are unlikely to harm an important hub. However, if the failure of nodes is not random, scale-free networks can fail catastrophically.

Conclusion: We have shown that the stability of these models depends crucially on the probability distribution of the connectivity structure as well as on the probability distribution of the Boolean interaction weights. The widely discussed scale free distributions clearly outperforms the conventional choices. The mean connectivity of the systems, which was limited to $\langle K \rangle = 2$, in the original models, can be largely shifted to higher values of $\langle K \rangle$ giving rise to more realistic models of biological networks, where the nodes are usually governed my more than two incoming connections on average.

H.G. Löw

- Biophysical investigation of energetic metabolic parameters of muscle tissue during electrostimulation: papillary- and skeletal muscles as examples (cooperation-project with the Institute for Toxicology, University of Vienna)

Based on the physical developments during the refereed project "Continuous fluorescence-optical detection of energetic metabolic parameters of cardiomyocytes during stress induction by electrostimulation" (University of Vienna and Facultas Verlag), further developments are performed. Primary specific aim of this project is to investigate biophysical parameters in vital muscular biomolecules under presence of short pulsed magnetic fields. Modulating the chemical and environmental conditions of the buffer solutions as well as coil-conformations and current pulse shapes studies are focused on influences of dynamic contraction-force-development as well as on autofluorescence, oxygen demand, calcium-fluorescence which represent ionic channel activities under pulsed magnetic stress induction. Force-frequency relations under presence of ionic channel blockers as well as under normoxic and hypoxic conditions are measured. Influences of spectral components of magnetic pulses on penetration depth and biomechanical transduction efficiency are studied using a novel type organ bath. This instrument allows combining fluorescence excitation, optical detection of muscle tissue as well as simultaneous measurement of muscle-tension. All data are recorded and time-stamped within a datastream using LABVIEW-Software packages and a novel developed software protocol which allows minimizing stochastic signal deviations during acquisition. This application oriented project allows specifying the electrodynamic field-parameters influencing muscle contraction and characterizes a novel kind of muscle-stimulation from biophysical and biomedical point of view.

H.G. Löw

- Fluorescence diagnosis, mini-FACS on chip research and development of miniaturized fluorescence diagnostic components using single cellular and single molecular spectroscopy methods (cooperation-project with the Ludwig Boltzmann Institute for Andrology and Urology, KH Lainz, Vienna, and with the Max F. Perutz Laboratories, Campus Vienna Biocenter)

Based on the results of the refereed project 9675 (Austrian National Bank, see above), time-correlated methods for detection of molecular binding properties between biomolecules are applied to develop and construct a miniaturized fluorescence detection device for small liquid samples in context to establish binding assays for medical diagnosis. The aim of this project is focussed to construct an "easy to use+ low-cost" fluorescence device for diagnostic physicians, which allows performing pre-screening-tests on patients blood and liquid samples. Incubation the novel developed tumor-targetting substance Photovidon (Hypericin-PVP-Complex derivative) urinary samples of potential bladder-wall cancer patients are investigated using a "mini-FACS" device as well as an ordinary standard fluorescence cell-sorter (FACS). The correlations between both methods are compared and related to the clinical data supplied by the hospital. The novel device is a contribution to early cancer diagnosis methods in biomedicine and may enhance diagnostic performance at low cost levels.

COOPERATIONS

a. INTERNATIONAL COOPERATIONS

K.W. Kratky

CANADA

- International Institute for Advanced Studies in Systems Research and Cybernetics, Tecumseh, Ontario, Canada (G.E. Lasker)

GERMANY

- Department of Music Education and Music Therapy, Siegen University, Siegen, Germany (C.-L. Zhang)

UK

- Faculty of Computing, Engineering and Mathematical Sciences, University of the West of England, Bristol (Q.M. Zhu)

VARIOUS COUNTRIES:

- Eurasia-Pacific Uninet (Network Office: Salzburg, B. Winklehner)

K.E. Kürten

FRANCE

- Institut Girard Desargues, Université Claude Bernard Lyon-I, France (C. Krattenthaler)

GERMANY

- Institut für Theoretische Physik, Universität Köln, Germany (L. Ristig)

UK

- School of Mathematical and Physical Sciences, Loughborough University, Loughborough, England (F.V. Kusmartsev)

USA

- Department of Physics; Washington University, St. Louis, USA (J.W. Clark)

H.G. Löw

GERMANY

- Ludwig-Maximilians-University of Munich, Laser Research Laboratory Großhadern, Germany (C. Betz, R. Baumgartner et al.)

RUSSIA

- Rostov state university, Biophysics department, Rostov-on-Don (A. Uzdensky)

NORWAY

- Institute for Cancer Research, Montebello, Oslo (J. Moan)

USA

- Wellman Laboratories for Photomedicine, Harvard medical school (M. Hamblin et al.)

I. Lucić:

ISRAEL

- Bar Ilan University, department of physics, Ramat-Gan (A. Vishne, S. Havlin)

JAPAN

- Tokai University, school of high-technology for human welfare, Numazu, Shizuoka (S. Matsura).

b. NATIONAL COOPERATIONS

W. Gruber

- Wiener Volkshochschulen, program 'University meets public'

K.W. Kratky

- Atominstitut der Österreichischen Universitäten, Wien (H. Klima)
- Interuniversitäres Kolleg für Gesundheit und Entwicklung, Graz / Schloss Seggau (P.C. Endler)
- Universitätsklinik für Neuropsychiatrie des Kindes- und Jugendalters der Medizinischen Universität Wien (K. Toifl).

H.G. Löw

- Institut für Biomolekulare Strukturchemie der Universität Wien (M. Edetsberger, G. Grabner, G. Köhler)
- Institut für Theoretische Chemie der Universität Wien (E. Gaubitzer)
- Institut für Physiologie der Medizinischen Universität Wien (D. Schmid, C. Plass, P.G. Spieckermann)
- Institut für Medizinische Chemie der Medizinischen Universität Wien (P. Chiba, H. Goldenberg)
- Geriatriezentrum Am Wienerwald, Lainz (H. Löw-Weiser, R. Werni)
- Department für Pharmakologie und Toxikologie der Universität Wien (C. Studenik)
- Ludwig Boltzmann Institut für Andrologie and Urologie, KH Lainz (H. Pflüger)

I. Lucić

- ARC Seibersdorf Research GmbH; Health Technologies (G. Haberhauer)

A. Schäfer

- Fa. ProQuant Systeme, Graz (F. Senekowitsch, F. Tschinder)

PUBLICATIONS

a. ALREADY ISSUED

1. **K.W. Kratky, D. Diepold** and **A. Schäfer**, *The effect of acoustic stimuli on heart-rate variability.* Research in Complementary Medicine (Forsch Komplementärmed) **14 S1** (2007) 51-52.

Introduction. Acoustic stimuli can cause changes in physiological variables, which are reflected in heart-rate variability (HRV). Due to the analysis of HRV, statements concerning the regulatory state of the autonomic nervous system and the circulatory system are possible. We investigated the effect of acoustic stimuli on HRV variables.

Experiments and methods. This work was concerned with the effect of three different acoustic stimuli ("pink noise", "water", "frogs"), coming from a CD with a sound pressure level of 70 dB(A). Twelve healthy volunteers took part in the experiments (6 women and men each). The age of the test persons ranged between 22 and 27 years. The test persons listened to the acoustic stimuli for 15 minutes. The exposition to the stimuli was preceded and followed by 15 minutes of silence. During the periods of acoustic irradiation and silence, HRV was measured two times each for a length of 300 heartbeats. These measurements started 2 and 9.5 minutes after the beginning of the respective periods. The aim of this work was to investigate if significant differences of the HRV variables occur between periods of acoustic irradiation and silence. Evaluation included time- and frequency-domain variables, nonlinear measures and pulse-respiration variables.

Results. "Frogs" caused the most pronounced differences with respect to the HRV variables. Significant results were observed for specific time- and frequency-domain variables and nonlinear measures, as well as for breathing rate and pulse-respiration quotient. The stimulus "water" showed significant differences for specific frequency-domain and for nonlinear measures. "Pink noise" caused significant results only for one variable that is closely connected with the heart rate itself.

Conclusions. The results show that acoustic stimuli can influence HRV within minutes and that the effects of individual stimuli can be distinguished by HRV analysis. It is interesting to note that the artificial "pink noise" has fewer effects than the more natural "frogs" and "water". This may be compared with an analogous result of an anterior study where expositions to full-spectrum and commercial neutral white fluorescent light were compared. The effects on HRV variables were more pronounced for the more natural full-spectrum light.

2. D.M. Forrester, **K.E. Kürten** and F.V. Kusmartsev, *Magnetic cellular automata and the formation of glassy and magnetic structures from a chain of magnetic particles*. Phys. Rev. **B75** (2007) 014416.

We show that magnetic materials made of chains of small magnetic particles display many unusual properties. This is associated mainly with a variety of stable different magnetic structures which can arise there. In particular, there arises a magnetic glass, which may be characterized by a whole set of hysteresis loops and by a large variety of Barkhausen jumps arising in the returned branches of the hysteresis loops. We consider in detail a simple example of such a system – a chain of magnetic nanoparticles. To describe such a single chain first we use numerical micromagnetic simulations. On the basis of these simulations, with the use of a perturbation theory, we derive an analytical model which is an anisotropic Heisenberg model. This is a Heisenberg model with an additional anisotropy term arising due to the shape of the particles. Such a term also arises naturally in some classical magnetic materials such as Mn_2Ni chains. We describe all possible stable states of the system as well as transitions between the states induced by magnetic field. Each of these transitions is arising *a la* the spin flop transition. It may be displayed and detected in experiments as a Barkhausen jump in a hysteresis loop. The series of described spin flop transitions will lead to the formation of different types of returned branches in hysteresis loops. We present exact analytical and numerical results describing the energy spectrum and the magnetization of such systems. The results may be used in the design of nanomaterials as well as for magnetic random access memory and magnetic quantum cellular automata elements.

3. **K.E. Kürten**, *Phase transitions and hysteresis in a system of two coupled magnetic nanoparticles*. In: H. Akai, A. Hosaka, H. Toki, and F.B. Malik (eds.), Condensed Matter Theories. Vol. 21. World Scientific Publishing, Singapore 2007.

We study dynamical and static properties of two interacting magnetic particles subjected to exchange interaction, anisotropy parameter, and an external magnetic field with an arbitrary angle with respect to the easy axis. The well-known Stoner Wohlfahrt model for a single magnetic particle is generalized to model the critical behavior of two anti-ferromagnetically coupled ferromagnets. We further present a complete theoretical study of magnetic phase diagrams as a function of the field for arbitrary strength of the anisotropy. We classify all possible magnetic hysteresis loops and show the dependence of the corresponding magnetic moments on the external field. These studies can give answers to the problem of finding adequate materials for practical applications such as sensor, storing or recording devices.

4. **K.E. Kürten** and C. Krattenthaller, *Multistability and multi 2π-kinks in the Frenkel-Kontorova model: an application to arrays of Josephson junctions*. International Journal of Modern Physics **B Vol. 21 Nos. 13&14** (2007) 2324-2334.

A regular ring of Josephson junctions, connected in parallel, is studied analytically and numerically. We show that, depending on the strength of the r-well cosine potential the energy landscape of the Hamiltonian can have of the order of r^N/N locally stable minimal separated by large barriers specified by unstable saddle points. The counting problem for the degeneracy of the total energy is equivalent to a well-known necklace problem in combinatorial mathematics. We also demonstrate that the distribution of the phase differences as well as the energy spectrum is fractal provided that the strength of the cosine potential is sufficiently strong.

5. D.M. Forrester, **K.E. Kürten** and F.V. Kusmartsev, *Two-particle element for magnetic memory.* Phys. Rev. **B76** (2007) 134404 & Virtual Journal of Nanoscale Science & Technology, October 22, 2007 issue.

We propose to use a stack of two or more isolated disk-shaped particles as an element for magnetic memory. Such an element represents a magnetic tunnel junction which is characterized by a few stable states separated by large energy barriers. The switching between the states may be induced by applying a spin polarized current or a magnetic field. We have described the behavior of the stable states and the associated energies of the stack in magnetic fields. In addition, we have described the magnetizations as well as all possible types of hysteresis loops which such an element may have. We discuss the stability of the information stored in the element and determine a critical magnetic field at which the switching of the element arises.

b. ACCEPTED

1. **A. Schäfer** and **K.W. Kratky**, *Estimation of breathing rate from respiratory sinus arrhythmia: comparison of various methods*. Annals of Biomedical Engineering.

Although respiratory sinus arrhythmia (RSA) is a well-known and often studied phenomenon, methods to estimate (average) respiratory rate from heart rate variability via RSA have been investigated and published only sparsely. We reinvestigate three published techniques and contrast them to our own approaches. All methods were also evaluated for respiration signals to yield approximations of the true breathing rate for comparison. Our analyses are based on physiological recordings available at PhysioNet, an online database. Results show that the RSA of young supine subjects yields good approximations of mean respiratory rate in the case of time series longer than 1 min, while the estimations become noticeably less accurate for elderly persons. Our own "advanced counting method" produced the best results, and in addition principally permits even the definition of instantaneous respiratory rates. Consequently, it is recommended for further investigations.

2. C.M. Kacher, H. Klima and **K.W. Kratky**, *Suppressive Influence Of Periodic And Chaotic Laser Light On Cancer Cells*. International Journal on Modelling, Identification and Control (IJMIC), Special Issue on Modelling and Characterisation of Dynamic Processes of Physiotherapy.

HeLa-cells have been irradiated with a HeNe-laser of 633 nm in the lag-phase at initial cell densities of 10^4 cells per ml. It is shown that cancer cells react differently to the 633 nm laser light (100 J/m^2 or 200 J/m^2). Energy densities of 100 and 200 J/m^2 and different kinds of radiation (constant, periodic and pseudo-chaotic radiation) have been applied. The relative cell densities have been measured immediately, 24 hours and 48 hours after the radiation. We could show that all three kinds of radiation show different effects. Soon after the exposure constant radiation is very effective. Periodic radiation is least effective and pseudo-chaotic radiation is little effective soon after the radiation but gets more effective with time.

3. H. Klima, **I. Lucić** and **K.W. Kratky**, *Ultraweak photon emission of Psilocybe cubensis mycelium tissue: Comparison of tissue treated with acoustic waves and non-treated tissue.* International Journal on Modelling, Identification and Control (IJMIC), Special Issue on Modelling and Characterisation of Dynamic Processes of Physiotherapy.

Every kind of living matter (cells, organ tissue or organism) emits certain amount of light quantum that can be measured as ultraweak photon emission, also called biophoton emission [1,2]. In this research we investigate the photon emission of mycelium cultures of *Psilocybe cubensis* that were treated with acoustic waves of 194.71 Hz for 13 days compared with non-treated control samples.

4. **K.E. Kürten** and C. Krattenthaler, *Multistability and multi 2π-kinks in the Frenkel-Kontorova model: an application to arrays of Josephson junctions.* In: G. Röpke, H. Reinholz, and P. Fulde (eds.), Condensed Matter Theories, Vol. 22. World Scientific Publishing, Singapore.

A regular ring of Josephson junctions, connected in parallel, is studied analytically and numerically. We show that, depending on the strength of the r-well cosine potential, the energy landscape of the Hamiltonian can have of the order of r^N/N stable minimal separated by large barriers specified by unstable saddle points. The counting problem for the degeneracy of the total energy is equivalent to a wellknown necklace problem in combinatorial mathematics. We also demonstrate that the distribution of the phase differences as well as the energy spectrum is fractal provided that the strength of the cosine potential is sufficiently strong.

c. SUBMITTED

1. **K.E. Kürten** and J.W. Clark, *Critical dynamics of randomly assembled and diluted threshold networks*. Phys. Rev. **E**.
2. F.V. Kusmartsev and **K.E. Kürten**, *Physics of the mind: Opinion dynamics and decision making processes based on a binary network model*. International Journal of Modern Physics **B.**
3. **K.E. Kürten**, *Dynamical phase transitions in opinion networks: Coexistence of opportunists and contrarians.* International Journal of Modern Physics **B.**
4. A. Kubin, **H.G. Löw** et al., *Water-soluble hypericin*. International Journal of Photochemistry and Photobiology.
5. D. Schmid, D. Staudacher, C. Plass, **H.G. Löw** et al., *Mediated proportional limiting of mechanical power output in rat and guinea pig left ventricular papillary muscles prone to hypoxic core*. American Journal of Physiology.
6. C. Plass, **H.G. Löw**, G.M. Wiesenthaler et al., *Photorelaxation of human vascular smooth muscle: mechanisms and clinical implications*. International Journal of Circulation Research.

d. CONFERENCE PROCEEDINGS

1. **A. Schäfer** and **K.W. Kratky,** *Heart rate variability, respiratory sinus arrhythmia and breathing rate: new approaches to investigate the relation of respiratory activity and cardiovascular dynamics.* In: Österreichische Physikalische Gesellschaft (Hrsg.), 57. Jahrestagung der ÖPG, Krems 2007 (S.63).

Respiratory sinus arrhythmia (RSA) is a prominent component of heart rate variability (HRV) and a well-known and often studied phenomenon. However, methods to estimate (average) respiratory rate from RSA have been documented only sparsely. Our group recently investigated several techniques including approaches of our own. Our analyses were based on physiological recordings available at PhysioNet, an online database.

Results show that the RSA of young subjects yields good approximations of mean respiratory rates in the case of time series longer than 1 min, while the estimations become noticeably less accurate for elderly persons. Our own 'advanced counting method' produced the best results; consequently, it is recommended for further investigations. In addition, our method principally permits even the definition of instantaneous respiratory rates, which opens up new perspectives. As an example, one could complement HRV analysis by investigating the time series of individual breath cycle lengths. This possibility will be called 'breathing rate variability' and discussed in brief. We complement our presentation by checking the applicability of our breathing rate estimations from RSA with a real-life example: Analysis of HRV recordings from healthy volunteers made under various conditions of illumination by colored fluorescent light, which yields significant results for the influence of colored illumination on respiratory rate and its relation to heart rate.

LECTURES, POSTERS

a. LECTURES

K.W. Kratky

- Die Herzfrequenz-Variabilität als Indikator des autonomen Nervensystems (Workshop 25 der MedSuccess 2007 der Österreichischen Medizinerunion; Wien), 21.4.07.
- Ganzheitlichkeit in der Medizin (Vorlesung beim Studiengang Altorientalische Musiktherapie; Wien), 15.&16.6.07.
- Systeme der Heilung (Vorlesung beim Studiengang Altorientalische Musiktherapie, Wien), 19.&20.10.07
- Komplementäre Medizinsysteme (Weiterbildung "Energetische Modelle und Methoden – Therapeutische Berührung", Zentrum – Lebensenergie, Wien), 9.11.07.
- Weltbilder komplementärmedizinischer Richtungen (Ringvorlesung "Komplementärmedizinische Methoden" an der Medizinischen Universität Wien), 12.11.07.

b. CONFERENCE CONTRIBUTIONS

- **W. Gruber**: Das Gelbe vom Ei – über die Physik des Frühstücks (invited talk, DPG-Tagung, Regensburg, Germany), 27.3.07.
- **K.E. Kürten:** Critical phenomena in binary opinion dynamical network models: an analytical study (invited talk at the Symposium "Decision Models with Social Interactions. Integrating Economic and Psychological Insights", June 13-14, 2007 in Wroclaw, Poland), June 13, 2007.
- **K.W. Kratky**: Die Herzraten-Variabilität (HRV) als Indikator des vegetativen Nervensystems – ein westliches Gegenstück zur östlichen Pulsdiagnose? (2. Internationales Johannes Bischko-Symposium: Psychosomatik in Ost und West – Mensch, Psyche, Maschine; Wien), 30.6.07.

- **A. Schäfer** and **K.W. Kratky:** Heart rate variability, respiratory sinus arrhythmia and breathing rate: new approaches to investigate the relation of respiratory activity and cardiovascular dynamics (Fachtagung für Medizinische Physik, Biophysik und Umweltphysik an der 57. Jahrestagung der Österreichischen Physikalischen Gesellschaft; Krems, Austria), 25.9.07.
- **K.E. Kürten:** Multistability and fractal energy spectra in the Frenkel-Kontorova model (invited talk at the XXXI International Workshop on Condensed Matter Theories, December 3-8, 2007 in Bangkok, Thailand), December 7, 2007.

c. POSTERS

- **K.E. Kürten**; Genetic regulatory networks at the borderline between order and chaos (invited poster at the 393rd WE-Heraeus Seminar "Trends in Molecular Biophysical Spectroscopy – Electronic Structure, Function, and Dynamics of Biomolecules", April 26-28, 2007 in Bad Honnef, Germany).
- **K.W. Kratky, D. Diepold** and **A. Schäfer**: The effect of acoustic stimuli on heart-rate variability (International Congress on Complementary Medicine, May 11-13, 2007 in Munich, Germany).
- **K.E. Kürten**: Novel phenomena in magnetic particles and Josephson junctions (invited poster at the 7th ESF and JSPS International AQDJJ conference "Frontiers of Josephson Physics and Nano-science (FJPN07)", September 23-28, 2007 in Palinuro, Italy).

TEACHING AND WEB-BASED DIDACTICS

W. Gruber

Vorlesung "Brain Modelling I + II, Physikalische Modelle für das Gedächtnis", steht auch online zur Verfügung: http://brain.exp.univie.ac.at

Im Rahmen dieser Lehrveranstaltung werden aktuelle Forschungsergebnisse aus den Bereichen der Neuroscience vorgestellt und ihre Relevanz diskutiert. Der Streifzug durch die Neuroscience beginnt bei der Beschreibung von Neuronen, technischen neuronalen Netzen und dem Vergleich zu biologischen Netzwerken. Nach der Vorstellung von einigen konkreten Modellen aus der Biologie (Beispiele: Erkennen von Objekten durch das visuelle System, Synchronisation im Gehirn, Steuerungen und Regelungen im Nervensystem) endet der Streifzug bei philosophischen Fragestellungen. Da in diesem Forschungsgebiet noch viele Fragen offen sind beziehungsweise noch gar nicht gestellt wurden, wird auch auf die Grenzen des aktuellen Wissens hingewiesen.

DIPLOMA THESES – PHD THESES (Supervisor: K.W. Kratky)

a. CURRENT DIPLOMA THESES

- **M. Fukac**
  Simulation des menschlichen Sehsystems

b. CURRENT PHD THESES

- **W. Gruber**
  Synchronisationszustände des Gehirns und die Bedeutung für die Informationsverarbeitung
- **P.F. Hüttner**
  Zeitreihenentwicklung von metabolischen Systemen: Analyse, Vorhersage, Steuerung
- **S. Ibrahim**
  Naturwissenschaftliche Grundlagen der medizinischen Systeme
- **I. Lucić**
  Der Einfluss unterschiedlicher Frequenzen auf biologische Systeme

MISCELLANEOUS

K.W. Kratky

- Member of the Scientific Board of the journals 'Systeme' and 'Research in Complementary and Classical Natural Medicine'.
- Member of the Scientific Board of the Viennese International Academy of Complementary Medicine as well as the Institute of Ethno-music Therapy, Schloß Rosenau, Austria.
- Fellow of the International Institute for Advanced Studies in Systems Research and Cybernetics, Windsor, Ontario, Canada.
- Member of the Board of Governors of the Scientific Society 'Dynamics – Complexity – Human Systems'.
- Lecturer at the Inter-University Master Course for Complementary, Psycho-social and Integrative Health Care, Graz, Austria.
- Lecturer at the International Pilot Course for Oriental Music Therapy, Schloß Rosenau / Vienna.

K.E. Kürten

- Guest Scientist and Lecturer.

W. Gruber

- General Editor at CISCI (Cinema and Science), an EU-Project for teaching physics.
- Lecturer at various adult evening classes ("Wiener Volkshochschulen") within the context of the project "University meets public".
- Accountant of the Austrian Biophysical Society.

COURSES IN THE ACADEMIC YEAR 2006/07

K.W. Kratky

WS: Komplexe dynamische Systeme - von der Physik zur Medizin (Schwerpunkt: Analyse von Puls und Atem)	VO, 2std.
WS: Komplementärmedizin - naturwissenschaftliche, psychologische und ethnologische Zugänge	SE, 2std.
WS: Privatissimum für Diplomanden und Dissertanten des Instituts für Experimentalphysik (als Mitveranstalter)	PV, 6std.
SS: Komplexe dynamische Systeme - biophysikalische Aspekte	SE, 2std.
SS: Gemeinsamkeiten komplementärmedizinischer Methoden – aus naturwissenschaftlicher und interkultureller Sicht	VO, 2std.
SS: Privatissimum für Diplomanden und Dissertanten der Experimentalphysik (als Mitveranstalter)	PV, 6std.

K.E. Kürten

WS: Einführung in die Theorie vernetzter Systeme I: Vom zellulären Automaten zum neuronalen Netzwerk	VO, 2std.
WS: Neuere Entwicklungen in der Theorie vernetzter Systeme	SE, 2std.
SS: Einführung in die Theorie vernetzter Systeme II: Vom zellulären Automaten zum neuronalen Netzwerk	VO, 2std.
SS: Spezielle Anwendungen in der Theorie vernetzter Systeme II	SE, 2std.

W. Gruber

WS: Biophysikalisches Praktikum (als Mitveranstalter)	PR**,** 6std.
WS: Brain Modelling I – physikalische Modelle für das Gedächtnis	VO+UE, 3std.
WS: Komplexe dynamische Systeme mit Computerübungen I	VO+UE, 1std.
WS: MEi:CogSci Cognitive Science Ringvorlesung (als Mitveranstalter)	VO, 2std.
WS: Wie erkläre ich es meinen SchülerInnen?	VO, 2std.
SS: Brain Modelling II – physikalische Modelle für das Gedächtnis	VO, 3std.
SS: Praktikum für Schulversuche II (als Mitveranstalter)	PR, 8st.

H.G. Löw

WS: Biophysikalisches Praktikum (als Mitveranstalter)	PR**,** 6std.
