ANNUAL REPORT 2011

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
Volunteers:	Mag. Werner Gruber, Mag. Dr. Hans Günter Löw
Administration:	Andrea Hnizdo
Diploma students:	Matthias Fukac, Martina Hatzl, Jasmin Kölndorfer, Marvin Kovacs
PhD students:	Mag. Werner Gruber, Dr. Said Ibrahim, Rozhin Penjweini MSc

RESEARCH

The research group "Physics of Physiological Processes" deals with complex dynamical systems in general and with the physics of the human body in particular. The following topics are considered: nonlinearity and feedback, chaos and fractals, self-organization and synchronization, neuronal and neural networks as well as cellular automata. These areas are interdisciplinary, connecting physics especially with biology, medicine, economy and ecology. They are treated in various ways: from a fundamental point of view, studying computer experimental results and interpreting experimental data. The group's fields of research in more detail:

Inter- and transdisciplinary aspects of the physics of physiological processes

By means of studying complex dynamical systems, 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 our view-point.

Interconnected dynamical systems: From cellular automata to genetic and artificial neural networks

Physical, biological, ecological and economical processes are treated using mathematical modeling and computer visualization. Topics:

- Pattern recognition, memorization and retrieval of information
- Self-organizing systems at the borderline between order and chaos
- Evolutionary economics and econophysics, neural network applications

Neurophysics

The aim of the research is to build up a programming environment to create better biological neuronal networks in order to verify medical and psychological theories of the brain. Then it is possible to build up very complex simulations by use of a few neurons in order to describe synchronization of neurons as well as of complex neural systems. Thus, different problems of theoretical neuroscience, as cognitive learning, stammering or the perception of speech can be easily tackled.

The response of heart-rate variability (HRV) to various influences and stimuli

- Humans were exposed to various optical and acoustical stimuli. Data of biophysical parameters (e.g. via ECG) were acquired and then analyzed by nonlinear time series and other methods. Heart-rate variability (HRV) is a major aspect in these investigations.

- Calculating the breathing rate via HRV (utilizing the respiratory sinus arrhythmia) yields another interesting variable that makes new interpretations possible. This may be compared to direct measurements of the breathing rate, which also allows considering the breathing rate variability BRV, the counterpart of HRV.
- HRV (and BRV) are not only influenced by external stimuli, but also by internal ones, e.g., Hathayoga breathing techniques. For details, see the diploma thesis of M. Kovacs.

Biophysics and Medical Physics

The following topics are dealt with:

- Energetic metabolic parameters of muscle tissue during electrostimulation
- Miniaturized fluorescence diagnostic components using single cellular and molecular spectroscopy methods
- Biophysical investigations of photosensitization within mitotic cell cycle. Electromagnetically induced nonlinear dose-effect relations monitored by novel optical detection methods. For details, see the doctoral thesis of R. Penjweini.

In addition to the research, several courses are offered, e.g., "Complex dynamical systems", "Properties of biophysical systems in theoretical models and experiments", "Physics of physiological processes", "Complementary medicine" and "Theory of complex interconnected systems I & II".

PUBLICATIONS

a. ARTICLES (contributions in scientific journals and books)

- **K.E. Kürten** and F.V. Kusmartsev, *Bose-Einstein distribution of money in a free market economy. II.* Europhysics Letters **93**, 28003 (2011)

We argue apply methods of statistical mechanics to free economy (Kusmartsev F.V., Phys. Lett. A, **375** (2011) 966) and find that the most general distribution of money or income in a free market economy has a general Bose-Einstein distribution form. Therewith the market is described by three parameters: temperature, chemical potential and the space dimensionality. Numerical simulations and a detailed analysis of a generic model confirm this finding.

- D.M. Forrester, **K.E. Kürten** and F.V. Kusmartsev, *Fundamental design paradigms for systems of three interacting magnetic nanodiscs.* Appl. Phys. Lett. **98**, 163113 (2011)

The magnetic properties of a system of three interacting magnetic elliptical discs are examined. For the various levels of shape anisotropy investigated a complicated series of phase transitions exists. These are marked by the critical lines of stability that are demonstrated in an applied magnetic field plane diagram.

- **K.E. Kürten**, *Dynamical rewiring processes in binary decision networks*. In: M. Sato, S. Matsuoka, P.M. Sloot, G.Dick van Albada and J. Dongarra (eds.) Proceedings of the International Conference on Computational Science, ICCS 2011; June 1-3, 2011; Singapore. Procedia Computer Science **4** (2011) 1441-1447.

We present a dynamical binary opinion model for the emergence of collective decision making based on a generalization of the majority and the minority principle. The network consists of N interacting agents, whose connectivity structure is dynamic governed by a rewiring process controlled by actual the network state. Damage spreading techniques show how the dynamical stability of these models can be largely enhanced. The model is meant to give possible explanations for social behaviour, in particular for the stability and instability of the individual and global opinion during an electoral campaign.

- **R. Penjweini**, **H.G. Loew**, M.R. Hamblin and **K.W. Kratk**y, *Long-term monitoring of live cell proliferation in presence of PVP-Hypericin: a new strategy using ms pulses of LED and the fluorescent dye CFSE*. J. of Microscopy **145**$_1$ (2012) 100-108.
  doi: 10.1111/j.1365-2818.2011.03555.x. Published online Oct 4, 2011.

During fluorescent live cell imaging it is critical to keep excitation light dose as low as possible, especially in presence of photosensitizer drugs, which generate free radicals upon photobleaching. During fluorescent imaging, stress by excitation and free radicals induces serious cell damages that may arrest the cell cycle. This limits the usefulness of the technique for drug discovery, when prolonged live cell imaging is necessary. This paper presents a strategy to provide gentle experimental conditions for dynamic monitoring of the proliferation of human lung epithelial carcinoma cells (A549) in presence of the photosensitizer PVP-Hypericin (PVP: polyvinylpyrrolidone). The distinctive strategy of this paper is based on the stringent environmental control and optimizing the excitation light dose by i) using a low-power pulsed blue light-emitting diode (LED) with short pulse duration of 1.29 ms and ii) adding a non-toxic fluorescent dye called carboxyfluorescein-diacetate-succinimidyl-ester (CFSE) to improve the fluorescence signals. To demonstrate the usefulness of the strategy, fluorescence signals and proliferation of dual-marked cells, during 5-hour fluorescence imaging under pulsed excitation, were compared with those kept under continuous excitation and non-marked reference cells. The results demonstrated 3% cell division and 2% apoptosis due to pulsed excitation compared to no division and 85% apoptosis under the continuous irradiation. Therefore, our strategy allows live cell imaging to be performed over longer time scales than with conventional continuous excitation.

- M.L. Kürten and **K.E. Kürten**, *Elastic collisions of hard spheres versus wealth exchange interactions.* In: I. Spanulescu (ed.), ENEC 2011. Proceedings of the International Conference on Econophysics, New Economy and Complexity, 26-28 May 2011, Bucharest, Victor Publishing House 2011 (pp. 292-304).

We discuss the widely accepted deeper analogy between the theory of market economics and the kinetic theory of ideal gases. We first derive the microscopic collision equations of a simplified model of a gas of hard spheres of arbitrary dimension. Assuming that the distribution of the velocities is identical in all regions of space we avoid to track the spatial position of the individual particles during our random walk. Instead, we simply select randomly pairs of particles which are supposed to collide and to exchange a fraction of their energies. In spite of this dramatic simplification, commonly adapted in wealth exchange models, the velocity as well as the resulting energy distributions compare well with the theoretical Maxwell-Boltzmann distributions.

The microscopic collision equations which describe the time evolution of the macroscopic variables are then compared with those commonly adapted in various wealth exchange models. It turns out that their formal structure is identical, however the dynamical outcome depends strongly on the choice of the microscopic interaction rules which are often taken ”ad hoc” in these models. Depending on the choice of the microscopic interactions, which might not necessarily reflect the physics of collision, one can find all kinds of distributions such as uniform, Gaussian, Gamma, inverse power law and to some extent distributions which do not even manifest a stable equilibrium.

We conclude that the analogy between the theory of market economics and the kinetic theory of ideal gases is not that deep as commonly believed. However, Maxwell-Boltzmann theory can serve as a first rate tool for the analytic and numerical analysis of wealth exchange models, even if the microscopic interactions are not at all modelled according to the fundamental laws of the physics of collision.

- **K.E. Kürten** and F.V. Kusmartsev, *When rich get richer there arises financial crisis and Bose-Einstein condensation in a wild economy*. In: I. Spanulescu (ed.), ENEC 2011. Proceedings of the International Conference on Econophysics, New Economy and Complexity, 26-28 May 2011, Bucharest, Victor Publishing House 2011 (pp. 23-38).

We model one of the main laws of the wild market where rich get richer, while poor get poorer. The model reflects the main principle of the wild capitalism namely that richness attracts more richness. A fixed number of trading agents exchange and transfer money according to one main rule, when two agents are trading the money transfers from the poorer agent to the richer one.

We show that in such wild market arises a new phenomenon analogous to a Bose-Einstein condensation (BEC), where many agents lose all their money. The remaining agents are fighting to become richer. With the time the condensation fraction increases; correspondingly, the number of rich or active agents decreases. The probability of the "excited" or active agents to have some money is well described by Bose-Einstein (BE) distribution. The fit is better when the trading time increases. When a majority of agents are losing all their money, the Bose-Condensation arises and the chemical potential vanishes. With growing time the condensation fraction increases. At the first stage the shape of the money distribution is well described by the Bose-Einstein one only for a low-energy/money region, while the high energy/money region is described by a Pareto power law with very large power coefficient β=12. At very later times the money distribution becomes dispersed, especially in the tail, and cannot be uniquely described by overall probability distribution. It rather covers the region in the probability-money plane, where many events happen with low probability. The boundaries of the money distribution dispersion may be also described by a Pareto power laws with different power law coefficients, larger and smaller than one.

The Bose-Einstein condensation and condensate fraction growth describe a start and a development of the financial crisis, respectively. We show that this crisis may arise in different market economies when the law the "rich get richer" dominates. We argue that to stop or to avoid the financial crisis one has to remove the BE condensate, where agents are frozen from any economic activity. This may occur due to the new money flow into the market. Then the condensed agents will be excited and take again an active part in the market activity. They can again compete obeying the rich get richer law and become poor. Thus, the financial crisis can be avoided if the measures to stop the BEC or to remove the Bose-Condensed fraction will be taken. Thus we may define the financial crisis as the time when the majority of population are excluded from trading or from the money exchange process. Such a view dictates direct measures what to do to avoid any financial crisis, i.e. by making active all existing economic agents.

- Schäfer, **K.W. Kratky** and K. Schulmeister, *The effect of colored illumination on breathing rate and cardiorespiratory dynamics*. In: J. Merrick (ed.), Alternative Medicine Yearbook 2009, Nova Science, Hauppauge, NY, USA 2011 (Chapter 31).

In 2006 we published results on the effect of colored illumination on the heart rate variability (HRV) of 12 healthy volunteers (colors of the fluorescent light tubes: red, green, and blue). Then, in 2008 we described two new methods that estimate average breathing rates from HRV via respiratory sinus arrhythmia (RSA) sufficiently well: Count-adv and ACF-adv. The HRV recordings made during our experiments with colored light are re-analyzed. We determine average breathing rates, besides mean heart rates and the ratio of the two quantities, the heart-breath quotient. The three best methods to quantify breathing rates are used: Count-orig (old) as well as Count-adv and ACF-adv (new). Significant results show that the subjects were mostly breathing at faster rates during red and green illumination. On the other hand, blue light induced a narrower distribution of the heart-breath quotient; probably around a value of 4, which is characteristic of states of relaxation. These results are consistent with our earlier findings, suggesting that short wavelengths of visible light has a different physiological effect compared to those in the range from red to green.

b. ABSTRACTS IN CONFERENCE PROCEEDINGS

- **R. Penjweini**, **H.G. Loew** and **K.W. Kratky**, *Illumination using pulsed LED reduces phototoxicity and photobleaching in fluorescence imaging of living cells.* (Abstracts of the ESTRO Anniversary Congress, 8-12 May 2011, London, UK). Radiotherapy & Oncology **99**, Suppl. 1 (2011), S 433.

Purpose: Imaging of living cells, including fluorescent dyes, using sophisticated light microscopes, has received much attention in recent years due to its facilities, which offer researchers to study cellular dynamics and functions in great detail. The technique now spans all fields of the life sciences and extends to the physical sciences as well. However, it is crucial to ensure that the physiological and biological processes that are under investigation are not altered in any way during the imaging.

Most cells, as part of their normal life cycle, are never exposed to light, and it is known that some light sources, when highly focused by the microscope, can produce toxic and damage the cells (phototoxi-

city). The phototoxicity is worsened if the cells incubate with fluorescent dyes. Photoexcitation of fluorescent dyes produce reactive oxygen species that are toxic toward many live cells and accelerate bleaching of the fluorophores during the course of extended or repeated measurements (photo-bleaching). Thus, for live-cell-imaging, it is best to reduce the amount of excitation light by optimizing the efficiency of the light path through the microscope, and by using detectors that are optimized to detect most of the light emission.

Materials: We recently developed a suitable cellular environment and an illumination system using a high power blue light-emitting diode (LED) for fluorescence microscopy. The blue LED can emit continuously or emit short pulses of light (0.5–2 ms) to excite fluorescent dyes. To demonstrate the usefulness of the new system, we compared images of human lung epithelial carcinoma cells (A549) proliferation incubated with carboxyfluorescein diacetate succinimidyl ester (CFSE) and PVP-hypericin fluorescent indicators and excited with either blue LED as a continuous excitation light source or the LED as a source of pulsed illumination with the same light intensity.

Results: We found that the proliferation of A549 cells decreased rapidly and photobleaching was relatively rapid under continuous illumination, whereas under pulsed LED illumination, photo-bleaching was much reduced.

Conclusions: In conclusion, fluorescence microscopy using LED-based pulsed illumination offers significant advantages for long-term live-cell-imaging, reducing the degree of phototoxicity, and extending the effective lifetime of fluorescent dyes.

- **R. Penjweini**, **H.G. Loew**, **K.W. Kratky**, M. Eisenbauer and P. Breit, *Fluorescence live cell imaging of A549 cells in presence of PVP-Hypericin: Modifying excitation light dose of blue LED.* (Abstracts of the 8th EBSA European Biophysics Congress, August 23-27 2011, Budapest, Hungary). Eur Biophys J **40**, Suppl. 1 (2011) S 152.

Live cell imaging of cancer cells is often used for in-vitro studies in connection with photodynamic diagnostic and therapy (PDD and PDT). Especially in presence of a photosensitizer, this live cell imaging can only be performed over relatively short duration (at most 1 hour). This restriction comes from the light-induced cell damages (photodamages) that result from rapid fluorescence photobleaching of photosensitizer. While these studies reveal exciting results, it takes several hours to discover the detailed effects of the photosensitizer on cell damage. Up to our knowledge, however, there is no general guideline for modification of excitation light dose to achieve that.

In this paper, the relation between excitation light doses, photobleaching of photosensitizer (PVP-Hyperycin) and cell vitality are investigated using human lung epithelial carcinoma cells (A549). The strategy of this paper is to reduce the excitation light dose by using a low-power pulsed blue LED such that the structures are visible in time-lapse images. Fluorescence signals and image quality are improved by labelling the cells with an additional non-toxic marker called carboxyfluorescein-diacetate-succinimidyl-ester (CFSE). In total we collected 2700 time-lapse images (time intervals 2 min) of dual-marked A549 cells under three different light intensities (4.41, 9.83 and 13.23 mW/cm^2) and a variety of pulse lengths (0.127, 1.29, 13, 54.5 and 131 ms) over five hours. We have found that there is a nonlinear relationship between the amount of excitation light dose and cell vitality. Cells are healthy, i.e. they commence and complete mitosis, when exposed to low light intensities and brief pulses of light. Light intensities higher than 9.83 mW/cm^2 together with pulse durations longer than 13 ms often cause cell vesiculation, blebbing and apoptosis. In all other cases, however, we found not cell death. In the future, this striking nonlinearity will be studied in more detail.

- **R. Penjweini**, **H.G. Loew**, M. Eisenbauer, P. Breit and **K.W. Kratky**, *Fluorescence imaging of living A549 cells combined with HLF cells: Reducing PVP-Hypericin side effects on HLF cells by modifying excitation light dose of pulsed blue LED.* ESP 2011, 14th Congress of the European Society for Photobiology, Sept 1-6 2011, Geneva, Switzerland. Book of Abstracts, p.90.

Modifying the excitation light dose in photodynamic therapy (PDT) of cancer is one of the challenging problems in medical practice as there is no available guideline to optimize the irradiation that can selectively kill cancer cells without adverse effect on normal living cells.

In this paper, imaging of living human lung cancer cells (A549) combined with human lung fibroblast cells (HLF) was used for studying the effect of PDT induced by the photosensitizer PVP-Hypericin.

The effect of photosensitizer on the behaviour of the A549 cancer cells was tested as compared with that of normal HLF cells before, during and after irradiation. The strategy of this paper was to reduce the excitation light dose by using a low-power pulsed blue LED such that the structures remain visible in time-lapse images. The A549 cancer cells were additionally marked with the non-toxic marker CFSE for easy distinction between the two cell types. In several experiments, we varied light intensity and pulse length and thus determined the threshold of side effects on HLF cells and the optimum dose for therapy applications.

In total, we collected 2700 time-lapse images (time intervals 2 min) of A549 and HLF cells for three different LED light intensities (1.59, 6.34 and 14.27 mW/cm^2) and a variety of pulse lengths (0.127, 1.29, 13, 54.5 and 131 ms) over four hours. The relation between the resulting light doses, photobleaching of the photosensitizer, and cell vitality were investigated.

We have found that there is a nonlinear relationship between the amount of light dose and cell vitality. The results showed that all tested light doses of pulsed blue LED inhibited division of the A549 cells. PVP-Hypericin proved to be effective in inducing blebbing and apoptosis among A549 cells for pulse lengths ≥ 13 ms at all studied light intensities. HLF cells are healthy, i.e. they commence and complete mitosis, when exposed to light intensities < 6.34 mW/cm^2 together with pulse durations < 54.5 ms.

Therefore, the optimum light intensity for treatment of A549 cells is 1.59 mW/cm^2 together with pulse durations of 13 ms which has the minimum side effect on HLF cells. In this paper, for the first time normal HLF and cancer A549 cells are combined to study the side effects of photo-excited PVP-Hypericin (using pulsed irradiation) on normal cells at tissue culture level.

- **M. Kovacs**, A. Schäfer and **K.W Kratky**, *The Effects of Yoga Breathing Techniques on Heart Rate Variability*. in: S. Thurner and M. Szell (eds), European Conference on Complex Systems ECCS'11, 12-16 Sept 2011, Vienna, Austria. Book of Abstracts, p.197.

The human organism is a highly complex system of intertwined variables, their mutual dependence being not fully understood yet. To determine the impact of controlled breathing on some of these variables, our group has done research on the effects of specific yoga breathing techniques (Pranayama). For this purpose we recorded the electrocardiogram (ECG), blood volume pulse, thoracic and abdominal breathing amplitude, skin conductance and oxygen saturation during periods of rest, as well as during the performance of breathing exercises. Some of the 24 probands were yoga teachers with different levels of experience, others were students.

One focus of our analysis up until now is the heart rate variability (HRV) derived from ECG data, the most notable results being a significant decrease in heart rate after the application of breathing techniques, a stronger decrease of heart rate variance for higher adeptness levels of yoga and several differences regarding sex. Further analysis will include the thorough assessment of breathing activity: breathing rate variability (BRV) will be examined as well as possible correlations between HRV and BRV. Additional results concerning the evaluation of breathing data and skin conductance levels will be discussed at the conference.

We feel confident that this kind of interdisciplinary and intercultural research is crucial when it comes to exploring new ways of enhancing as well as preserving well-being and health

- **R. Penjweini**, **K.W. Kratky**, H.-U. Dodt and S. Saghafi, *Characterizing the effects of coherent laser beams and noncoherent LED beams on annihilation of bread mould fungus.* 4th EOS Topical Meeting on Optical Microsystems (OMS'11). Advance Programme of the EOS Topical Meetings at Capri 2011, 26-28 Sept 2011, Capri, Italy, p.39.

In this paper, Spectrophotometric and Fluorescence Microscopic techniques are employed to detect the bread mould fungus. The effects of coherent beams (laser) and non-coherent beams (LEDs) on eradication of bread mould fungus are investigated. It is shown that green beams generated from second harmonics.

- **K.W. Kratky**, *Gemeinsamkeiten traditioneller Heilsysteme: Achsen und Elemente*. (Abstracts of the Congress "Menopause – Andropause – Anti-Aging 2011", 8-10 December 2011, Vienna, Austria). J Gynäkol Endokrinol **21$_4$** (2011) 17.

In vielen traditionellen Heilsystemen lässt sich eine Einteilung in Prinzipien (z.B. "Elementen") finden, sie sich sowohl auf die Welt als ganzes als auch insbesondere auf den Menschen in Gesundheit und Krankheit beziehen. So haben die alten Griechen 4 Elemente unterschieden (die später durch den Äther ergänzt wurden). Den Elementen entsprachen dann die so genannten Temperamente und bestimmte Krankheitsanfälligkeiten. Sie wurden zusätzlich in Beziehung zur Temperatur- und Feuchtigkeitsachse gesetzt. Ein solcher Ansatz ermöglicht übrigens eine geometrische Beschreibung der betrachteten Phänomene.

Ähnliche Einteilungen finden sich auch in den Heilsystemen Chinas, Indiens und Tibets sowie in der jüdischen, germanischen und keltischen Tradition. Die Zahl der Prinzipien ist zwar unterschiedlich, was im Vortrag genauer erläutert wird. Im Wesentlichen läuft es aber nur auf eine unterschiedlich feine Einteilung hinaus. Genaueres siehe unter [1,2].

Die Schulmedizin hat übrigens in kurzer Zeit einen radikalen Paradigmenwechsel vollzogen: Zunächst war eine einzige Medizin für ALLE Menschen das Ziel, dann kam die geschlechtsspezifische Medizin auf, und nun wird im Licht der Genetik eine individualisierte Zugangsweise angepeilt. Der stabil gebliebene traditionelle Ansatz mit ein paar Grundtypen bietet hier eine reizvolle Vergleichsmöglichkeit.

[1] Karl W. Kratky, Komplementäre Medizinsysteme. Vergleich und Integration. Ibera / European University Press, Wien 2003 (ISBN 3-85052-148-6)
[2] Karl W. Kratky, Complementary Medicine Systems: Comparison and Integration. Nova Science, Hauppauge, New York 2008 (ISBN 1-60456-475-X)

c. PATENTS

H.G. Löw, Extraktionsvorrichtung zur zerstörungsfreien Manipulation und Analyse flüssig-heterogener Partikelsuspensionen. Patent AT 506663, erteilt am 15.3.2011.

LECTURES, CONFERENCE CONTRIBUTIONS, POSTERS

a. LECTURES

K.W. Kratky

- *Weltbilder komplementärmedizinischer Richtungen* (Ringvorlesung "Komplementärmedizinische Methoden. Grundlagen und Praxis" an der Medizinischen Universität Wien, Austria), 9.3.2011
- *Komplementäre Medizinsysteme* (Weiterbildung "Energetische Modelle und Methoden – Therapeutische Berührung", Zentrum – Lebensenergie, Wien), 8.4.2011
- *Gemeinsamkeiten traditioneller Heilsysteme: Achsen und Elemente* (Aton-Seminar, Hausbrunn, Austria), 16.9.2011
- *Alte und neue Versionen der chinesischen Medizin* (Aton-Seminar, Hausbrunn, Austria), 16.9.2011
- *Vergleich und Integration komplementärmedizinischer Verfahren* (Modulbilanz für Gr. 38 & 39, Masterlehrgang für Komplementäre, Psychosoziale und Integrative Gesundheitswissenschaften, Interuniversitäres Kolleg für Gesundheit und Entwicklung, Schloss Seggau, Austria), 18.9.2011

K.E. Kürten

- *Wealth distribution interactions versus collision dynamics in conventional physics* (Collegium Budapest, Hungary), 30.3.2011
- *The stabilizing role of unate Boolean interactions in genetic network models* (Department of Molecular Cell Biology, Leuven, Belgium), 2.9.2011
- *Wealth exchange models: from Boltzmann to Pareto: Modelling realistic social interactions* (Department of Physics, Loughborough University, UK), 26.9.2011

b. CONFERENCE CONTRIBUTIONS

K.W. Kratky

- *Gemeinsamkeiten traditioneller Heilsysteme: Achsen und Elemente* (eingeladener Vortrag beim Kongress "Menopause, Andropause, Anti-Aging 2011", 8.-10. Dezember 2011; Vienna, Austria), 10.12.2011

K.E. Kürten

- *Elastic collisions of hard spheres versus wealth exchange interactions* (invited lecture, ENEC 2011. International Conference on Econophysics, New Economy and Complexity; May 26-28, 2011; Bucharest, Romania), 27.5.2011
- *Dynamical Rewiring Processes in Binary Decision Networks* (invited lecture, ICCS 2011: International Conference on Computational Science; June 1-3, 2011; Singapore), 2.6.2011
- *Elastic collisions of hard spheres versus the physics of wealth exchange models* (invited lecture, 3rd International Conference on Econophysics and Summer School on Teaching and Enterprise; September 24-29, 2011; Loughborough University, UK), 25.9.2011
- *Dynamical Phase Transitions in Biological and Social Networks: Binary Opinion Networks at the Edge of Instability* (invited lecture, Conference "Sociophysics: Do humans behave like atoms?"; November 14-16, 2011; Paris, France), 15.11.2011

R. Penjweini

- *Fluorescence imaging of living A549 cells combined with HLF cells: Reducing PVP-Hypericin side effects on HLF cells by modifying excitation light dose of pulsed blue LED* (ESP 2011, 14th Congress of the European Society for Photobiology; Sept 1-6, 2011; Geneva, Switzerland), 4.9.2011

M. Kovacs

- *The Effects of Yoga Breathing Techniques on Heart Rate Variability* (European Conference on Complex Systems ECCS'11; Sept 12-16, 2011; Vienna, Austria. Satellite Meeting "PhD Research-in-Progress III: Lab to Society - Opportunities in Complexity"), 14.9.2011.

c. POSTERS

R. Penjweini

- Illumination using pulsed LED reduces phototoxicity and photobleaching in fluorescence imaging of living cells. (Poster 1164 at the ESTRO Anniversary Congress; May 8-12, 2011; London, UK), 8.5.2011
- Fluorescence live cell imaging of A549 cells in presence of PVP-Hypericin: Modifying excitation light dose of blue LED (Poster P-432 at the 8th EBSA European Biophysics Congress; August 23-27, 2011; Budapest, Hungary), 25.8.2011

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

a. CURRENT DIPLOMA THESES

- **M. Fukac**
  Simulation des menschlichen Sehsystems
- **M. Hatzl**
  Die Wirkung von optischen und akustischen Reizen auf die HRV (heart-rate variabiltiy): Interpretation und Auswertung der Experimente
- **J. Kölndorfer**
  Klassifizierung von Sprache und Geräuschen mittels eines Biologischen Neuronalen Netzwerks von Integrate-and-Fire Oszillatoren
- **M. Kovacs**
  Die Auswirkung von Hathayoga-Atemtechniken auf die Herzfrequenzvariabilität (The effect of Hathayoga breathing techniques on heart-rate variability)

Abstract of the results up to now:

ECG and breathing data of the measuring device NEXUS-10 (Mindmedia Company) were used. A whole session took one and a half hours for each of the 24 probands. There were alternating phases of relaxation (lying, sitting) and breathing exercises (Pranayama). In each session, 11 measurements of 3 minutes each took place. In the following, we stick to the variables P (pulse or heart rate), B (breathing rate), Q (quotient P/B) and SDNN, which is in essence the standard deviation of heart rate.

Comparison between the results of the different measurements (average of all probands): Concerning P, B and Q, there were highly significant differences between the lying periods at the beginning and the end of a session and all other phases.

As to the differentiation between the behavior of different subgroups of probands, the results are less impressive. In essence, only SDNN showed clear significances at some phases, viz. concerning the difference between yoga beginners and very experienced people as well as the difference between yoga disciples and experienced instructors.

b. CURRENT PHD THESES

- **W. Gruber**
  Synchronisationszustände des Gehirns und die Bedeutung für die Informationsverarbeitung
- **S. Ibrahim**
  Naturwissenschaftliche Grundlagen der medizinischen Systeme
- **R. Penjweini** (Co-Supervisor: **H.G. Löw**)
  Biophysical investigations of photosensitization within mitotic cell cycle. Electromagnetically induced nonlinear dose-effect relations monitored by novel optical detection methods

Abstract of the results of 2011:

We dealt with 5-hour fluorescence imaging of living human lung epithelial carcinoma cells (A549). The presence of PVP-Hypericin modified the necessary excitation light dose for in-vitro photo-dynamic applications. A number of time-lapse imaging experiments was performed using a low-power blue LED operating in either continuous or pulsed mode. The light intensities (I^*) were 1.59, 6.34 and 14.27 mW/cm^2, the pulse lengths (L) being 0.127, 1.29, 13, 54.5, 131 and 60,000 ms. Fluorescence signals and image quality were improved by dual-marking of cells with a non-toxic fluorescent dye CFSE in addition to PVP-Hypericin. Then, the relation between different I^*, various exposure times, photobleaching of PVP-Hyperycin and phototoxicity (apoptosis and necrosis) was investigated.

Results showed a nonlinear relationship between the amounts of excitation dose and cell vitality. Among all experimental I^*, the least phototoxicity and photobleaching was detected when cells were exposed to brief pulses of light ($L \leq 13$ ms). The maximum phototoxicity of PVP-Hypericin (~100%

cell death) was monitored upon irradiation with $I^* = 14.27$ mW/cm^2 and $L \geq 131$ ms, the latter being comparable with the phototoxicity for continuous excitation. At $I^* = 14.27$ mW/cm^2, L higher than 131 ms did not further increase the efficacy of PVP-Hypericin.

PRESENCE IN THE MEDIA

W. Gruber

- He features on all relevant media – as print, radio and television – in Austria, Germany and Switzerland.

MISCELLANEOUS

K.W. Kratky

- Member of the Editorial Board of the "Journal of Alternative Medicine Research" and of the Scientific Board of the journals "Systeme" and "lebensweise".
- Member of the Scientific Board of the Viennese International Academy of Holistic Medicine as well as the Institute of Ethno-music Therapy, Gföhl, Austria.
- Member of the team of the Interuniversity College for Health and Development, Graz / Castle of Seggau, Austria. There, also lecturer at the European Master's Degree Program for Integrated Health Sciences.
- Member of the "Beirat für Traditionelle Asiatische Medizin im Bundesministerium für Gesundheit" (Vienna, Austria).
- Chairman of the session "Ökumene in der Medizin – Komplementäre Medizinsysteme" at the Congress "Menopause, Andropause, Anti-Aging 2011", 8.-10. Dezember 2011; Vienna, Austria.

K.E. Kürten

- Guest Scientist and Lecturer.
- Visiting professor (Loughborough University, UK)

W. Gruber

- Volunteer and Lecturer
- 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".
- Member of the "Science Busters".
- Vorstandsmitglied der VHS Meidling, Wien, Austria.
- Wissenschaftlicher Beirat der KPH Krems, Austria.

H.G. Löw

- Volunteer and Lecturer.
- Co-supervisor of the PhD thesis "Biophysical investigations of photosensitization within mitotic cell cycle. Electromagnetically induced nonlinear dose-effect relations monitored by novel optical detection methods" of R. Penjweini.

COURSES IN THE ACADEMIC YEAR 2010/11

K.W. Kratky

SS:	Eigenschaften biophysikalischer Systeme in Modell, Theorie und Experiment	(als Mitveranstalter)	VO, 2h
SS:	Facetten naturwissenschaftlichen Denkens (Ringvorlesung)	(als Mitveranstalter)	VO, 2h
SS:	Gemeinsamkeiten komplementärmedizinischer Methoden – aus naturwissenschaftlicher und interkultureller Sicht		VO, 2h

K.E. Kürten

WS:	Einführung in die Theorie vernetzter Systeme I - Vom zellulären Automaten zu genetischen und neuronalen Netzwerkmodellen		VO, 2h
WS:	Neuere Entwicklungen in der Theorie vernetzter Systeme		SE, 2h
SS:	Einführung in die Theorie vernetzter Systeme II - Vom zellulären Automaten zu genetischen und neuronalen Netzwerkmodellen		VO, 2h
SS:	Spezielle Anwendungen in der Theorie vernetzter Systeme II		SE, 2h

H.G. Löw

WS:	Biophysikalisches Praktikum für Vorgeschrittene	(als Mitveranstalter)	PR, 5h
WS:	Biophysikalisches Praktikum für Vorgeschrittene, Vertiefung und Ergänzungen	(als Mitveranstalter)	PR, 1h
SS:	Eigenschaften biophysikalischer Systeme in Modell, Theorie und Experiment	(als Mitveranstalter)	VO, 2h

W. Gruber

WS:	Biophysikalisches Praktikum für Vorgeschrittene	(als Mitveranstalter)	PR, 5h
WS:	Wie erkläre ich es meinen SchülerInnen?		VO, 2h
WS:	Fachdidaktische Vertiefung – Methoden der Physikdidaktik	(als Mitveranstalter)	SE, 1h
SS:	Praktikum für Schulversuche II	(als Mitveranstalter)	PR, 6h

---