



PROJECTS FUNDED BY

**MARIE CURIE EXCELLENCE GRANT
(EXT)**

AND CHAIR (EXC) ACTIONS

MATHEMATICS, INFORMATION SCIENCE

ENGINEERING AND ENVIRONMENT

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Sweden

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University of Lund 01-06-04

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Driscoll, Judith
The Chancellor, Masters and
Scholars of the University of
Cambridge 01-06-05

The Design of Morphing Aircraft

Friswell, Michael Ian
University of Bristol 01-01-05

Dynamic 3D modelling and simulation for landscape and environmental management.

Gold, Christopher
University of Glamorgan 01-09-04

Designed Ecosystem Services for Biological Treatment

Graham, David William
University of Newcastle Upon
Tyne 01-04-06

Nanoscience with Metal-Based Polymers

Manners, Ian
The University of Bristol 01-01-05

York Institute for Tropical Ecosystem Dynamics

Marchant, Robert
The University of York 01-09-05

Model Theory, Pure and Applied

Pillay, Anand
The University of Leeds 01-09-05

EUROPEAN CENTER FOR TIME-FREQUENCY ANALYSIS (FOUNDATIONS, ALGORITHMS AND APPLICATIONS) (EUCETIFA)

EUCETIFA

The objective of the project is the development of the mathematical foundations and efficient algorithms for applications in the areas of communication theory, signal- and image processing, astronomy, geosciences, and related areas. EUCETIFA will promote the systematic transfer of knowledge from problem identification in science or technology to working computer code based on the following principles: a) Openness towards real applications and active identification of promising areas of future relevance; b) Mathematical modelling leading to rigorous and detailed mathematical descriptions of those problems; c) Development of a mathematical framework that ensures correct treatment based on mathematical analysis; d) Development of efficient numerical algorithms that address the numerical and implementational questions; e) Interaction with applied scientists to test these algorithms and establish a "best practice"; f) Education and training for team-members and associated PostDocs and PhD students. Spearheaded by the tremendous impact of wavelets, applied harmonic analysis has proven to be a powerful tool for the treatment of time-varying systems. A recently developed approach with time-frequency methods opens a new view on important classes of pseudo-differential operators of high practical relevance, e.g., for communication theory and for applications in geophysical signal processing. It is one of the goals of this project to bridge the gap between the mathematical analysis and the concrete applications in these areas in order to enable further advances and breakthroughs. The scientific cornerstones are formed by three work-packages: (A) Pseudo-differential operators and time-varying systems and their applications, (B) Sampling and time-frequency analysis (for the optimal extraction of information from valuable data), and (C) Localization methods based on Banach algebra methods, and their consequences for applications.



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MICRO-SPECTROSCOPY OF RADIATION-DAMAGED MINERALS

MINSPEC

The application of techniques based on the spectral analysis of light (e.g., Raman, infrared absorption, optical absorption, and luminescence spectroscopy) in Earth sciences research has dramatically increased in the past few years. Successful applications span virtually the full range of earth science disciplines, and more and more research teams have become interested in using light spectroscopy techniques. This positive development is in apparent contrast to generally limited training opportunities and research expertise at Earth science institutions in traditional geoscience disciplines.

The main objective envisioned for the new Chair for Mineral Spectroscopy, hosted by the Institute for Mineralogy and Crystallography of the University of Vienna, is to make significant contributions towards overcoming this contradiction through improving the teaching and research opportunities in the area of mineralogical micro-spectroscopy. The holder of this Chair is Professor Lutz Nasdala, a leading expert in the field of light spectroscopy techniques in Earth sciences research. After completing his Ph.D. in mineralogy in Freiberg, Germany and Moscow, Russia, Dr. Nasdala acquired a strong record of research experience through appointments at the University of Hawaii, the University of Vienna, the Curtin University of Technology, Perth, and the University of Mainz, Germany. After working as a Professor of Mineralogy at the University of Mainz from 2002 to 2006, Dr. Nasdala recently moved to the Institute for Mineralogy and Crystallography, University of Vienna, to begin his current position. This institute, a former European Union Marie Curie training site, has internationally recognized expertise in both fundamental and applied areas of mineralogical research.

The primary objectives envisioned for the Chair of Mineral Spectroscopy include: (i) training of undergraduate and Ph.D. students, postdoctoral fellows, and visitors; (ii) development of practical experience in the application of spectroscopic techniques to the above group of people through participation in a world-class mineralogical research environment and through external collaborations; (iii) dissemination of research results; and (iv) the establishment of a European Centre for Mineral Spectroscopy housed at the University of Vienna. Research activities will mainly be focused on the investigation of geological materials that have suffered radiation damage. The main aim of these research activities is to obtain a better understanding of radiation effects in minerals, and in particular to improve the reliability of radioisotope-based age determinations and to contribute to the performance assessment of potential host materials for the safe long-term storage of nuclear waste.



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UNDERSTANDING THE IRREGULARITY OF SEISMIC CYCLES: A CASE STUDY IN TURKEY

SEISMIC CYCLES

Why do large earthquakes not always occur at regular time interval on a given fault? Present-day physical models on repeating ruptures are poorly constrained and can yield inconsistent predictions. To be able to anticipate future seismic catastrophe, we need to measure and understand the irregularities in the seismic cycle. The observed aperiodic seismic behavior may have different causes, including intrinsic properties of faults, seismic or postseismic interactions between faults, or variations in strain accumulation. To get deeper insights in the mechanisms at work, we propose to establish the seismic history over several thousand of years of a main strike-slip fault system in Turkey. The targeted North Anatolian plate-boundary is particularly suitable because of the type of faulting, its rapid deformation rate (up to 24 mm/yr), its relative structural simplicity and its particularly simple seismic behavior characterized by cascading sequences of $M > 7$ earthquakes. Another remarkable feature is the seeming correlation between the seismicity of the North Anatolian Fault and of adjacent strike-slip plate-boundaries (the East Anatolian Fault and the Dead Sea Fault). This transfer in seismic activity needs to be confirmed and would have broad implications regarding continental-scale seismic coupling. The present project seeks to obtain a most extensive chronology of past events along both the North and the East Anatolian Faults. For that purpose, we plan to use a diverse array of complementary techniques, involving trenching across the fault combined with subsurface geophysics, dating of displaced geomorphic features and drilling of lake sediments along the fault trace.

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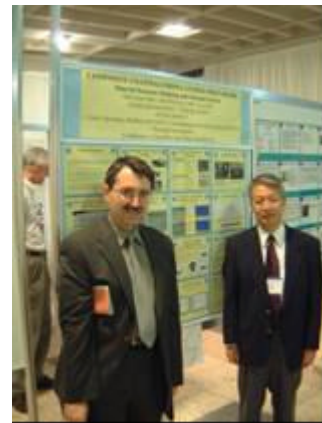
NANOCOMPOSITE MATERIALS MANUFACTURING BY ULTRASONIC WELDING

ULTRANANOMAN

Delivering the promise of nanotechnology to society for much-awaited products and jobs, hinges critically on manufacturing technology transfer to industrial production. This project introduces novel affordable, efficient and environmentally safe manufacturing of nanocomposite materials, by ultrasonic welding of foils with sandwiched nanoparticles. Research goals thus arise to study and control the material process-structure-properties interactions during nanocomposite fabrication and utilisation, by laboratory analysis, computational simulation and process control of materials for universal industry use. Training of postgraduate students and research experiences for undergraduates will be fostered, by thesis supervision, new curricula with laboratory exposures, and nanomanufacturing seminars and conferences. Outreach will benefit pre-college students and teachers, by nanotechnology modules, demonstrations and laboratory open house; industries by applied projects and student internships; women students by role models; and the public by hands-on exhibits, continuing education and web self-study. Although based at the University of Cyprus host, this Marie Curie project will be broadly shared across Europe, in collaboration with institutions in EC states and USA, by mutual visits, web/video-conferencing, meetings and student exchanges. The Chair initiatives will be pioneered by Prof. Haris Doumanidis, founding Director of Nanomanufacturing at NSF, Presidential Faculty Fellow of the White House, and ASME/National Academy of Eng. distinguished authority in thermal manufacturing at MIT, Tufts University and industry. This project will transfer his international excellence activities to Europe, and together with key expertise in Cyprus and abroad, will nucleate a signature European network for Nanomanufacturing, establishing global leadership of the ERA and attracting the best investigators and students worldwide to this area.



From NSF-EC Workshop on Nanoscale Manufacturing and Processing, San Juan, Puerto Rico, January 2002



*Poster with Prof. Teiichi Ando
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ADVANCED TEACHING AND RESEARCH IN ENVIRONMENTAL MICROBIOLOGY / BIOTECHNOLOGY

TERESEN

The EC priorities in research and education include (a) Sustainable Development, Global Climate Change and Ecosystems, and (b) Life Science, and Biotechnology for Health. The objectives of the Chair are concerned with the dissemination of advanced knowledge and international experience among students, scientists, NGOs, and other interested audiences in the Czech Republic in some particular topics of the very complex fields. An emphasis should be laid on

- Microbiological and biochemical characterization of natural and polluted soil and water resources, including remediation activities
- Identification and differentiation of some pollutants degrading and health relevant bacteria in environmental samples
- Microbiological deterioration and degradation of natural and man made polymers of major ecological importance

Professor Zdenek Filip who retired from a post of a Director & Professor at the Federal Environmental Agency in Berlin (Germany), and taught Environmental Microbiology at the Technical University Berlin will offer advanced courses and tutorial activities related to the above indicated topics. He will utilize his broadly based international contacts in environmental sciences in favor of exchange programs for undergraduate and graduate students of the Institute of Chemical Technology Prague (ICTP). Furthermore, in a co-operation with the ICTP colleagues he attempts to write a textbook, and undertake effort needed to establish a curriculum in environmental microbiology/biotechnology at the host university permanently.

The ICTP represents the largest institution of higher education in its field in the former Eastern Europe, and with its more than 2000 students, and highly capable scientists and teachers is an optimum host for the Marie Curie Chair in Environmental Microbiology/Biotechnology. The activities of the Chair should support educating of specialists to combat environmental problems existing in the Czech Republic, and in many other countries.



*from left to right : Assoc. Prof. J. Pazlarova, Prof. Z. Filip (Chair Holder),
Prof. K. Demnerova (Project Coordinator)*

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Chair Holder: Prof. Zdenek Filip

CHEMICAL COMMUNICATION CODE OF INSECT SOCIETIES

CODICES

Social insects are important model systems for studying social evolution and complex systems. There are thousands of species with colonies of different size, kinship structure and nesting environment, that have each evolved evolutionary stable strategies to cope with challenges of social conflict, disease pressure and demands for efficient communication. Social insect communication is mostly chemical and is preferentially directed towards kin and nestmates. Efficient communication is critically important to protect colonies from robbing and parasitism and for the regulation of potential reproductive conflicts between members of the same colony. The proposed project aims to achieve an interdisciplinary understanding of the chemical, neurophysiological and evolutionary principles that have shaped chemical communication across insect societies of different sizes, kin structures and disease pressures. The research will use social Hymenoptera as model systems and will address generally important questions about the honesty and reliability of communication signals as a function of cost efficiency and risk of abuse by non-cooperative individuals. The objectives will be achieved by a combination of behavioural experiments, genetic, chemical and neurophysiological studies. The work is inspired by general principles of kin-selection and economic optimality, allowing predictions both on proximate and ultimate aspects of communication systems. This will allow an explicitly hypothesis-testing approach and an extent of rigour that has not been attempted before in social insect chemical ecology. The objectives and methodologies match the already interdisciplinary research profile of the team leader, and the association with the host group and other international collaborators make this ambitious project highly feasible. The proposed research therefore has a high potential to help maintain and expand the leading European position in the field of fundamental chemical ecology.

Objectives:

1. *Kin recognition, kin assessment, and suppression of nepotism and worker reproduction.* This project will provide the first explicit tests of inclusive fitness predictions for the adaptive chemical structure of recognition compounds in insect societies of specific kin structure.
2. *Chemoreception and neuro-perception of socially active chemical compounds.* This will be the first analysis of chemo- and neuroperception of key communication compounds in social insects (outside the honeybee).



Dr. Patrizia D'Ettorre during field work

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RAPID MICROBIAL ADAPTATION VIA HORIZONTAL GENE TRANSFER

RAMADA

Horizontal gene transfer (HGT) has been an important process in microbial evolution, as confirmed by increasing amounts of retrospective analysis. In addition, it remains an ongoing process in extant (currently existing) microbial communities. HGT can, indeed, be a central process in various ecological phenomena like microbial adaptation to new environmental factors (e.g. presence of xenobiotic chemicals), but also in gain or loss of virulence by commensal or pathogenic strains. The goal of the proposed research is to examine, describe, and control the incidence of extant HGT in microbial biofilm communities found in groundwater and drinking water treatment and distribution systems.

The results of this project will answer questions with acute environmental and public health relevance: Can this natural process of rapid microbial adaptation via HGT be harnessed to steer microbial attenuation of xenobiotic (e.g., pesticide) laden groundwaters? Does HGT need to be considered in a precautionary fashion when examining the fate of pathogenic traits in a drinking water distribution context?

This project will employ advanced methods like novel molecular biomarkers to permit single-cell resolved detection of microbial growth and gene transfer dynamics; advanced microscopic tools and image analysis, innovative biomathematical approaches to model microbial activity from individual cell behavior to yield emergent system properties, and environmentally relevant biological and physico-chemical materials and conditions.

This study can lead to innovative approaches to detoxify pesticide-laden groundwaters, and may drastically reform fate assessment of pathogenic and bioterrorism micro-organisms by explicit consideration of the survival of their horizontally transmissible genes.

The central core of the proposal responds directly to 6th FPs call for enhancement and structuring of the European Research Area via its HRM activity. It will support 2 early and 2 mid-career scientists who will join a trans-national, leading-edge, and interdisciplinary research programme with European dimension, built around a young EU researcher, returning from the USA where he established an excellent autonomous research program, in direct response to the goal of counteracting brain drain under the MC Excellence Grant action..



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MATHEMATICAL METHODS IN BIOLOGICAL IMAGE ANALYSIS

MAMEBIA

The aim of the MAMEBIA project is the development of theoretical and concrete mathematical methods to model and analyse biological image data, with an emphasis on complex-valued methods and phase information.

At the moment, the mathematical models and transforms regarded in biological contexts, apart from the Fourier transform, are mostly real-valued. This restriction is often based on the assumption that all biological data is real valued, and that complex-valued methods only increase the needed storage space and computation time of algorithms, but don't contribute to better analysis quality.

But researchers in image analysis become more and more aware that even for real data complex-valued methods yield much better performance. These methods extract phase, which gives directional information for edge detection, and codes local features. Most information of an image is coded in the phase. But its extraction with mathematical transforms and its interpretation is not yet fully understood. This might be the reason why phase information is rarely used for biological image analysis.

The MAMEBIA project aims to bridge this gap. The team will model biological problems, and formulate them in a sound mathematical manner. On this basis, the team will develop new, and adapt existing complex-valued transforms to extract the modelled image features. Particularly, harmonic and nonharmonic Fourier transforms, as well as multiresolution approaches, as Gabor analysis and complex continuous and discrete wavelet methods will be emphasized, and their phase information will be evaluated. Algorithms and concrete programs will be developed and implemented. The team will closely cooperate with collaborators from biology to ensure the high quality of the models and to have a significant validation. This close cooperation allows the amalgamation of knowledge and know-how, and ensures that both mathematics and biology benefits strongly from this interdisciplinary research.



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UNIFYING HIGH-SPEED INTERCONNECTS

UNIXIX

This project examines fundamental issues in the area of building general-purpose computing and storage infrastructure for future datacenters that will support IT activities. Today, such datacenters include various types of servers that support compute, storage I/O, client network I/O, and high-speed LAN applications. The requirement to support a variety of IT services leads to multi-tier architectures that require connectivity among different levels.

One of the main issues in current approaches to building such architectures is the specialization of each tier to a specific type of functions or applications. Future datacenters would benefit significantly from the ability to shift resources between tasks by dividing subsystems within a datacenter in a logical as apposed to a physical manner. Such uniform and symmetric architectures are possible since computing resources in each subsystem within a datacenter are very similar, and in most cases PCs or workstations. However, the main remaining obstacle is the use of different interconnects for each subsystem: A storage area network usually provides access to scalable storage, a system area network connects compute nodes, and a high-speed LAN carries generic traffic. The use of multiple communication protocols and interconnects leads to high management complexity and cost that compromise the evolution of datacenters and their ability to support applications in a cost-effective manner.

Our work examines how next-generation interconnection network technology can address these issues. We are investigating how multiple, domain-specific communication protocols can be supported on top of a single, high-speed physical layer, and the implications for higher system layers.



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IP FLOWS OVER OPTICAL AND WIRELESS

IP-FLOW

Despite the fact that the telecommunications and data networks are in an economic down-turn, this industry remains critical to the economic future of the world. Although it is clear that all future networks will be based on the Internet protocol (IP), there are many open technical issues. Proper solutions to those open issues are critical for the recovery of the telecom industry which motivated this research. Consequently, this research project is focused on several IP packets flow issues through IP networks, from the optical core to the wireless edges. Thus, this project is called: IP FLOws over Optical and Wireless or IP-FLOW. In general, there are two issues concerning the transport of IP packets: (1) routing – determining the path a packet travels on from source to destination, and (2) flow control (“flow” for short) – how a packet is forwarded (and stored), primarily with respect to time, along the selected path. The chair holder, Dr. Ofek, is a world-class expert in data network flow control, timing and synchronization, and therefore, the focus is on the second issue regarding the flow of IP packets over the Internet. Timing and flow control are critical since they directly affect how users perceive the quality of IP-based services, such as, voice-over-IP, video-over-IP, multimedia content delivery, and how much users are willing to pay for such IP-based services.

The IP-FLOW project will have three research areas: Research Area 1 – UTC-based pipeline forwarding for IP flows for solving (optical) switch and (wireless) link bottlenecks; Research Area 2 – TrustedFlow: a general method for run-time authentication of codes and protocols, in order to guarantee correct execution; and Research Area 3 – for delivering high fidelity content over wireless (Wi-Fi) to consumers with mobile devices. The following briefly describes the first two areas of this project, which represent hardware oriented activities, in Research Area 1, and software oriented activities, in Research Area 2.

Research Area 1 – UTC-based pipeline forwarding will be investigated as a solution to the following two major bottleneck problems:

Using UTC (coordinated universal time, available from GPS and Galileo) with pipeline forwarding for solving the switch bottleneck problem – specifically, how to construct a multi-terabit (e.g., 40 terabit) switch in a single chassis; and

Using UTC with pipeline forwarding for solving the bandwidth mismatch problem between optical and wireless network, which is a link bottleneck problem.

Proper solutions of the two bottleneck problems are critical for ensuring proper network operation and users’ satisfaction, and consequently, improving the IP networks services and business perspective. The two bottleneck problems are solved using UTC-based pipeline forwarding, which is a method known to be optimal and independent of specific implementations. (Pipeline forwarding was invented by Henry Ford about 100 years ago for the assembly line in the car industry. Pipeline forwarding is still the most efficient manufacturing process today. All computers today operate using pipelines, a simple extension of Ford’s assembly line.) The motivation for pipeline operation is to provide efficiency, speed, and scalability. In this project, we will design a scalable time-driven IP switch whose switching operation is based on the pipeline forwarding of IP packets over global networks.

The proposed activities in this project will result in a detailed chassis design that shows how pipeline forwarding can solve the electronic switching bottleneck while optimizing physical space– specifically, packaging a 40 Tb/s (terabit per second) switch in a single chassis. Dynamically, this switch will have switching granularity that ranges from 1 Mbps (megabit per second) to a full channel capacity of 10 Gb/s (gigabit per second), and can be deployed from the core to the edges of the network. Accordingly, the proposed activities will advance the discovery and understanding of the limitations of optical and electronic switching packaging. Beyond just packaging, though, the outcome of this project will have a broad impact on both IP packet-switched networks and on many services. Networks will be closer than ever to being outfitted with highly improved switching equipment that will satisfy the Internet’s insatiable need for capacity – doubling every 12 months or 1000-fold in 10 years.

Research Area 2 – TrustedFlow: a method for authenticating software (protocols and codes) execution in run-time – e.g., ensuring proper IP flows as a result of authenticated execution. Software, especially in the context of data networks, suffers from some inherent problems. These include modifications, either by a malicious or inadvertent attacker, malware distribution (e.g., viruses and

Trojan horses), and the use of malicious software remotely for penetration, intrusion, denial-of-service (DoS), distributed DoS (DDoS). TrustedFlow ensures correct execution of: window flow control protocol, digital right management software, web client software, services to mobile users and more.

TrustedFlow is a software solution to the problem of remotely authenticating codes and protocols during execution, which aims at assuring that the software is not changed prior to and/or during execution. The solution is achieved by continuously emanating a flow of idiosyncratic signatures. These signatures authenticate the software, from which they have emanated. The idiosyncratic signatures are generated by a secret function that is hidden and periodically replaced in the software and whose execution is subordinated to the proper execution of the software being authenticated. The flow of signatures is validated at a remote computing component. This generation and validation method of idiosyncratic signature is called TrustedFlow protocol. The TrustedFlow protocol is a general add-on protection tool that complements other security tools such as trusted computing platforms, authentication and encryption protocols.



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Relevant links:

http://www.unitn.it/en/internazionale/area_ric/projects/IPflow.htm

http://www.dit.unitn.it/people/user_ldap?id=yoram.ofek&lang=en

[HTTP://WWW.DIT.UNITN.IT/~OFEK](http://WWW.DIT.UNITN.IT/~OFEK)

EXCHANGE PROCESSES IN THE LAND SURFACE - ATMOSPHERE SYSTEM

MCT-ELSA

The exchange of energy, trace gases and particles between the land surface and the atmosphere depends on their continuous production and/or consumption through biochemical processes, and on the physical transport across surface-air boundaries. Consequently, all land-atmosphere exchange responds to climatic variation. But relatively small alterations in its magnitude in response to climate forcing will influence climate in turn through a number of important biogeochemical feedbacks: directly, for example, by mediating the surface's energy balance and albedo, or indirectly through the radiative forcing potential of emitted trace gases, their tropospheric chemistry and cloud-formation properties.

The biosphere thus has had a major influence on the development of contemporary atmospheric conditions, and it still has. But human influence via land use, land use change and fossil fuel burning has resulted in major alterations of the naturally evolved synergies, particularly in the last 200-250 years or so. This has led to the, at least partial, attribution of observed climatic changes in the 20th century to human activities; and increasing scientific evidence for man-made, large-scale alterations of the earth's environment implies that predictions of the future environment ought to be the basis for national and global environmental policy. These predictions remain highly uncertain however, as important processes in the land-atmosphere system are only imperfectly understood. Further progress will hinge on the *simultaneous* study of the interactive biogeochemical cycles through field and modelling experiments. For instance, increasing evidence suggest tight coupling of slow (CO₂) and fast reactive carbonaceous trace gas exchange: with each other, to the surface energy balance, and to the dynamics of vegetation. Yet to date, studies of ecosystem energy balance and CO₂ exchange, and those concentrating on reactive carbon compounds and their physical and chemical transformation products have too often been conducted in parallel scientific communities.

The Team (MCT-ELSA), hosted by the Department of Physical Geography & Ecosystems Analysis at Lund University, addresses some of the fundamental gaps in our understanding of the interactive processes underlying reactive and inert trace gas and aerosol fluxes, and their interactions with atmospheric properties. The research combines corresponding field and modelling studies on biogenic reactive organic carbon compound (RCC) and aerosol fluxes in representative ecosystems of the northern latitudes. RCC play an important role in surface-atmosphere feedback loops: in determining the atmospheric methane growth rate via their effect on the hydroxyl radical concentration, in contributing to the formation and growth of secondary organic aerosols, and in being a significant fraction of the net carbon budget in many ecosystems. The team's activities thus significantly broaden existing departmental research on surface-atmosphere exchange processes on CO₂, CH₄ and water vapour fluxes.

The regional focus lies with ecosystems of the northern latitudes that in climate change scenarios are regarded as 'hot spots' in the Earth System. In these systems a significant amount of carbon is stored in the biosphere and expected, most likely already occurring temperature and precipitation increases have the potential for negative feedbacks to regional and global carbon and other element cycles, and ultimately global climate.



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EARTH SYSTEM AND PLANETARY STUDIES

ESPS

In this project, research is conducted in the following two areas:

- (1) The co-evolution of life and the chemical composition of the atmosphere over Earth history
- (2) Studies of the surface and climate of the planet Mars.

The overall research falls can be described as “astrobiology”, which is a new branch of science concerned with the origin, history and future of life on Earth and the possible variety of life beyond Earth. Both research areas (1) & (2) are consistent with the joint European Commission/European Space Agency (ESA) policy on space, as well as the Marie Curie Chair action objective to promote research in new and emerging interdisciplinary areas.

Currently, there is no theory of Earth's bulk atmospheric composition. Consequently, in research area (1) , the main goal is to produce a quantitative understanding of how Earth's atmosphere originated and evolved. Because all the gases in air (except argon) are biologically mediated to some degree, this quantitative understanding relies upon computer models of atmospheric chemistry linked to models of the evolving biosphere in Earth history. Models are validated using data from the geologic record. In area (2), data from spacecraft are used, including data from NASA's various Mars spacecraft and ESA's Mars Express. The purpose is to understand the history of the surface and climate of Mars. This history is one where liquid water has apparently been available at the surface in the past, and the action of ice ages and wind have also played significant roles. An important goal is to establish whether the environment on Mars was ever conducive to life. A further goal is a vigorous training programme. This includes new university courses in planetary science, global change, and Earth history at the graduate and postgraduate levels. Research seminars, public lectures, conference activity, and activity in scientific networks at the European level will disseminate the results of astrobiology research to a large audience, including the general public.



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ELECTROMAGNETIC BRAIN ACTIVITY: A NOVEL MATHEMATICAL APPROACH

BRAIN

The existing functional imaging techniques for the brain have excellent space resolution, but their time resolution is of the order of 1s, which is too slow for the study of the brain. The only non-invasive techniques with adequate time resolution are magnetoencephalography (MEG) and electroencephalography (EEG). The main reason that MEG is not yet established as an acceptable clinical technique is the lack of uniqueness, namely there exist many currents which give rise to the same magnetic field. However, it has been recently shown that for the case that the brain can be approximated by a sphere, the current is uniquely determined from the measurements, provided that one assumes that it minimizes the integral of its square. Furthermore, the numerical implementation of the minimizing current has been tested successfully with real data. The basic limitation of the above result is that the brain is not a sphere. A realistic approximation of the brain is provided by a tri-axial ellipsoid and the main objective of the project is to extend the above result from the spherical to ellipsoidal geometry and to take into consideration the cerebrospinal fluid. Mathematical techniques to be used include expansion in terms of ellipsoidal harmonics and the technique of generalized transforms which has been recently introduced in the literature. Graduate students and young researchers will be trained on these topics.



Prof. George Dassios

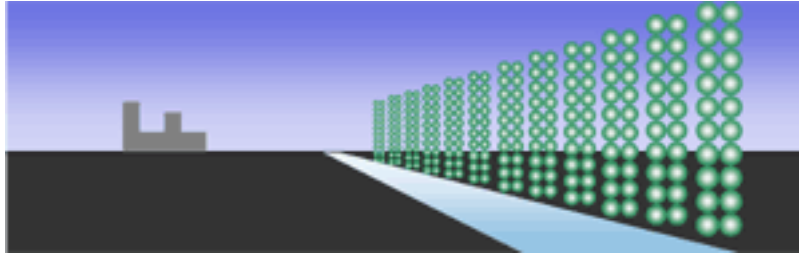
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Chair: Prof. George Dassios

NOVEL NANO-SCALE MULTIFUNCTIONAL MATERIALS ENGINEERING

NANO FEN



The study and development of novel functional materials are critical to the development of future device technologies. At the mesoscopic scale, new physics can be realised, which is highly relevant for the future generation of nano-electronic devices and thus is of considerable industrial importance. Hence, the enabling factor for study of functional materials is the ability to process different forms of the materials on different scales, as well as to interface them on the nano-scale.

NanoFen (Novel Nano-scale Multifunctional Materials Engineering) involves novel materials processing, the growth of functional nano-wires, the exploration of routes for ordered nano-wire growth, the production of multifunctional nano-composites, and the demonstration of simple, novel (multi)functional devices. In order to transform the promises of the nano-scale phenomenon into industrial applications, practical approaches will be adopted, and hence there will be an emphasis on chemically based processing routes. There will also be a particular emphasis on the study of oxide materials.

In summary, the main objectives of NanoFen are to:

1. Develop novel processing technologies for growth of nano-structured functional materials
2. Apply an intelligent combinatorial approach to realising nano-composite architectures
3. Demonstrate simple, novel (multi)functional devices

The project will be conducted by an Excellence Team of Researchers (including the Principal Investigator, Dr. Judith Driscoll). We are looking to recruit **3 post-doctoral workers** for up to 2 yrs. each in the first instance **and 1 PhD student**. The project will be based at the University of Cambridge in the Dept. of Materials Science.



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Team Leader : Dr. Judith Louise Driscoll (jld35@cam.ac.uk)

Url Team Leader : <http://www.msm.cam.ac.uk/Department/DeptInfo/StaffProfiles/Driscoll.html>

THE DESIGN OF MORPHING AIRCRAFT

MORPHING AIRCRAFT

Morphing aircraft structures are flight vehicles that change their shape to effect both a change in the mission of the aircraft and to perform flight control without the use of discrete control surfaces or seams. Aircraft constructed with morphing technology promise the distinct advantages of being able to fly multiple types of missions, to perform radically new manoeuvres not possible with conventional control surfaces, to be more fuel efficient, and to provide a reduced radar signature. The Wright brothers used a method of wing-warping to twist the wings for roll control, and today many aircraft use flaps for take off and landing. The difference with morphing aircraft is the full integration of the shape control into the wing structure; a truly smart structure. In the limit one could envisage a flying wing with no discrete control surfaces at all. This project will take a systems view of morphing aircraft structures and will consider the structural design, airflow, structural dynamics, flight control system, aeroservoelasticity, and sensors and actuators. All these areas interact extensively, for example designing how the structure changes shape is critically dependent on the aerodynamic loads and the required flight control. While each topic is a huge area in its own right, a systems approach is the only appropriate way forward. The primary objective of this project is to produce a fully integrated simulation of a morphing aircraft including the aerodynamics, compliant structures, structural dynamics and flight control. Of primary interest will be an accurate assessment of the loads required to actuate the structure that can be used to optimise the power requirements and controllability of the aircraft. As part of this overall objective wind tunnel models will be built, both to validate the predictions of the actuator loads, and to provide a demonstrator to encourage further development of this concept by industry.



Dr. Michael Ian Friswell

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www.aer.bris.ac.uk/contact/academic/friswell/

Team Leader Prof Michael Ian Friswell

DYNAMIC 3D MODELLING AND SIMULATION FOR LANDSCAPE AND ENVIRONMENTAL MANAGEMENT

D3D-LEM

The objectives of the Chair are concerned with the development and dissemination of spatial data structures and computer graphics in 2D and 3D. The main issues are:

- § Appropriate models of space
- § Vector and matrix algebra for graphics and modelling
- § Two dimensional data structures for graph traversal, network flow, etc.
- § Primal and dual graphs, triangulations and Voronoi diagrams
- § 2D Voronoi/Delaunay applications in map processing
- § Terrain modelling – interpolation, slope estimation and contouring
- § Surface reconstruction from contours, river networks or basins
- § Algorithms and applications for the Medial Axis Transform
- § Interactive Voronoi/Delaunay algorithms and applications
- § Kinetic data structures and dynamic mapping
- § Flow modelling and collision detection
- § Interactive CAD operations for landscape modelling
- § Spatial Decision Support systems
- § Interactive 3D Voronoi/Delaunay algorithms
- § Marine and oceanographic GIS and modelling
- § 3D data structures for geology, oceanography, etc.

The main motivation of the Chair is that spatial models and data structures are used in many application disciplines, such as geology, oceanography, GIS and forestry, to name only a few. However, the latest developments in Computer Science are often not readily accessible to these workers, and often they are not directly applicable without modification. Our aim is to develop, simplify and popularize a wide variety of general-purpose spatial modelling tools, and to show how they are applicable in individual disciplines.



Prof. Christopher Malcolm Gold

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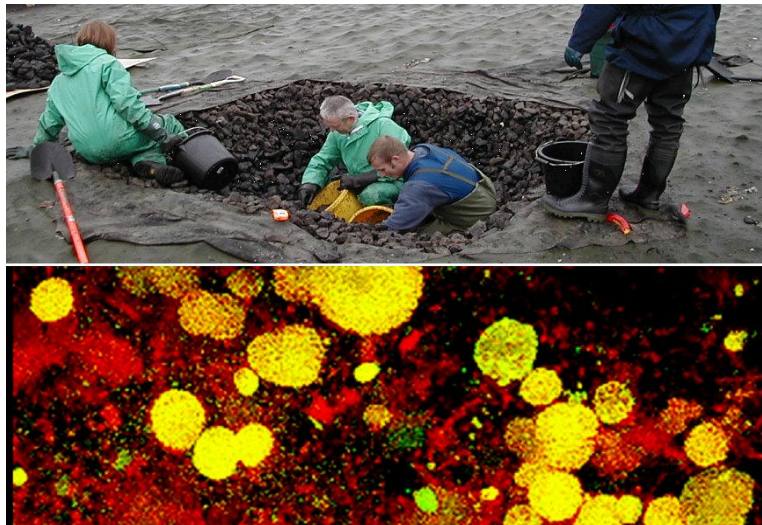
URL: <http://www.glam.ac.uk>

Chair Holder : Prof. Christopher Malcolm Gold

DESIGNED ECOSYSTEM SERVICES FOR BIOLOGICAL TREATMENT

ECOSERV

Present day biological treatment systems have been developed primarily through empirical, incremental refinements of previously designed systems. This approach has delivered relatively effective biological treatment systems but the law of diminishing returns now governs the rate of process development. ECOSERV aims to free biological treatment design from the limitations of empiricism and provide fundamental principles founded in ecological theory to enable development of more reliable and predictable biological treatments systems. We aim to implement this vision by integrating skills in mathematical modelling, state-of-the-art measurement technologies and principles from theoretical ecology in the context of environmental engineering. New models for biological treatment systems based on a range of ecological theories will be developed and the predictive power of the models will be tested experimentally at laboratory, pilot and field scales. This will be achieved by assembling an excellence team comprising mathematicians, modellers, microbial ecologists and environmental engineers in an environment where they will work as an integrated unit with the best available facilities. If the principles uncovered are truly general, they will be applicable to understanding, manipulating and managing any biological system (not only biological waste treatment), anywhere, and thus the implications of ECOSERV are potentially very broad ranging indeed.



Sampling a trickling filter from a wastewater treatment plant (top panel) for the quantification of ammonia-oxidizing bacteria, using fluorescent in situ hybridization (FISH; bottom panel). Measurement methods such as FISH are being used in the ECOSERV program to calibrate theoretical models for the design of more reliable biological treatment processes

Contact Details

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<http://www.ceg.ncl.ac.uk/activities/microbial/microbial.htm>

Team Leader: Dr. David William Graham

Url team leader : <http://www.ceg.ncl.ac.uk/>

NANOSCIENCE WITH METAL-BASED POLYMERS

NANOMANN

The proposal seeks a Marie Curie Chair for Professor Ian Manners, a Briton currently working at the University of Toronto in Canada. This is to assist the University of Bristol, UK, to bring him back to a permanent position in Europe. The proposal amply meets the objectives of the Marie Curie Chairs (EXC) programme in that Manners is a world class researcher and an award-winning teacher of undergraduates and researchstudents. The proposal also meets a prime objective of the Work Programme in that Manners' research is in the area of Nanoscience and Nanotechnology, key activities that FP6 seeks to promote. The resumption of his career in Europe would be acclaimed and send a powerful signal. The proposed research programme is cutting edge. Synthetic polymers play a critical role in everyday life and their broad utility will only grow in the future. At present polymer science revolves around macromolecular chains constructed mainly from carbon atoms. The proposed research targets the use of transition elements to make polymer chains with the vision that new processable materials will be created with a range of properties that starts to approach that possible with inorganic solid state materials with two and three dimensional arrangements of atoms. In line with this philosophy, the proposed research focuses on an exciting new research direction - Nanoscience with Metal-Based Polymers. With Marie Curie funding it is proposed to expand research on polymetallocenes and other metal-based polymers (e.g. metal cluster-based materials) in new directions which will involve applications in nanoscience - an area of major worldwide challenge and interest for the 21st Century. The proposed research will involve three main projects: 1. Nanoscience with Metal-Containing Block Copolymers. 2. Metallopolymers and Metalloceramics for Catalysis and Photonic Applications. 3. Metallopolymer Sensors

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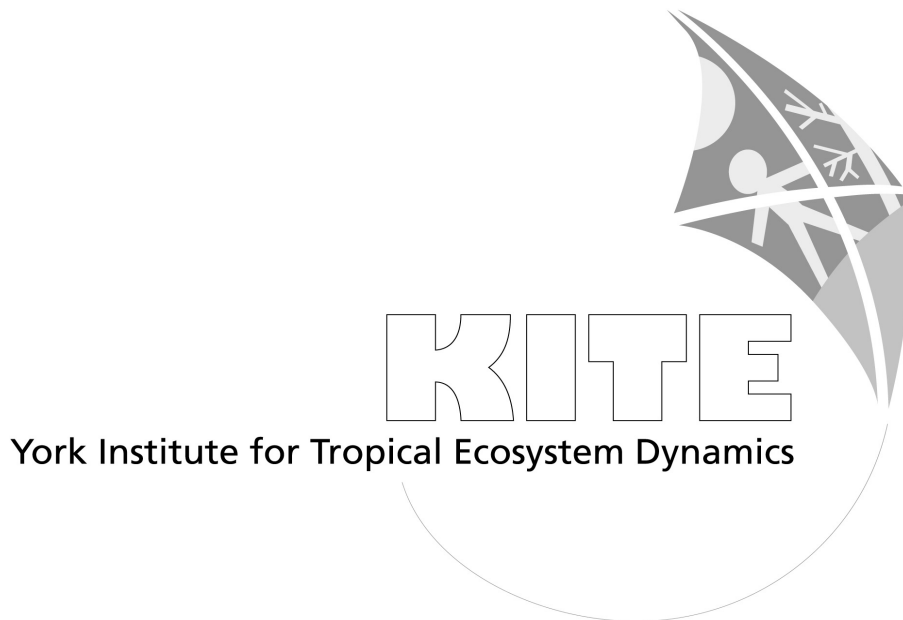
UK

<http://www.bristol.ac.uk>

Chair Holder : Prof. Ian Manners

YORK INSTITUTE FOR TROPICAL ECOSYSTEM DYNAMICS

KITE



In a world where the debate on climate change has moved on from questioning what is the evidence for Global Warming? To, what will be the nature of the impact of climate change ? It is clear future ecosystem composition, structure and functioning will be different in the future. The York Institute of Tropical Ecosystem Dynamics (KITE) will be located in the [Environment Department, University of York](#). The research group will combine new environmental data sets with modelling initiatives to explore past, present and future ecosystem dynamics at a number of sites along the [Eastern Arc Mountains](#) of Kenya and Tanzania, an area encompassing one of the world's hotspots of plant and animal biodiversity. KITE will combine the expertise of [Dr Rob Marchant](#) and [Dr Jon Lovett](#), amongst others, to understanding how ecosystems respond to climate change and societal impacts, and enhance our predictive capability to manage a changing environment. By linking findings of pure research, policy and economics it is possible to move away from reactionary response and management of many urgent environmental and development issues. For example, KITE will determine why the area is so biodiverse - do high levels of biodiversity depend on buffering from global climatic changes, due to the close proximity of the Indian Ocean monsoon system, or is this a response to high climatic and environmental variability, and what role, if any, have human impacts imparted on the ecosystem. These scientific innovations will be complimented by integrating research findings to management / policy development: demonstrating that interdisciplinary research findings will offer more substantive ways to inform policy and economics.

The research outcomes will improve the prospect for forecasting impacts of climate variability on agriculture, ecosystem functioning and health and will lead to an increased scientific understanding regarding land use, environmental conservation and climate change. Some of the research is site-specific and highly focused whereas other aspects are more generic to global change research.

The key elements of the research are to:

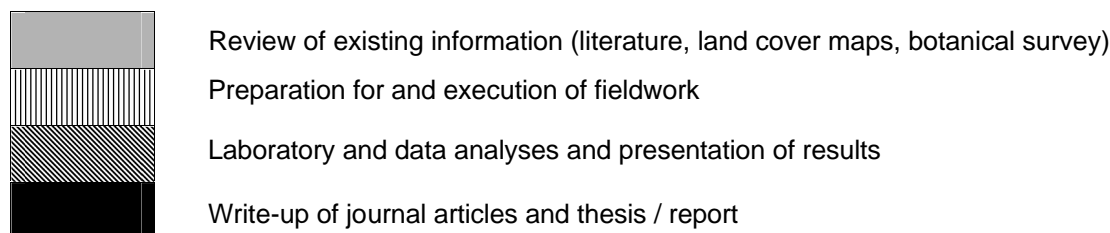
- 1) Determine ecosystem response to climate change by focusing on an area of particularly high biodiversity.
- 2) Determine the role of human impacts on present forest composition and long-term ecosystem functioning.
- 3) Develop methods to link information on past and present ecosystem composition
- 4) Develop and test models to link past, present and future ecosystem functioning at different spatial scales.
- 5) Produce results to inform management and policy formation both in the study area and more generically.

Marie Curie Excellence Grants (EXT)

The benefits from the research are not purely scientific, KITE will encourage better research networking and dissemination of knowledge between Europe and Africa, ensure better access to data sets for researchers in Africa. Research excellence will be developed in global change research in its broadest sense with expansions to horizontal developments that have implications for land-use policy and conservation in the context of changing climate. KITE will foster and develop international relationships that will be increasingly important as policies on managing the consequences of global climate change move from the national to the International political arena. Such issues will develop North-South collaboration - identified as being importance for sustainable development by the World Summit on Sustainable Development. Policy relevant outputs from the project will help meet European obligations under the Kyoto Protocol and the United Nations Framework Convention on Climate Change, the Convention for Biological Diversity, and the World Summit on Sustainable Development. More locally, KITE will publish research findings in prestigious disciplinary journals and disseminate results to a wide audience through popular media. KITE will further reinforce the capability of the Environment Department to attract research funds, world-class research and develop an international profile for environmental change research at University of York.

KITE will be co-ordinated by Dr Rob Marchant, presently based at the University of Leicester, and will comprise 5 early stage research projects (2 being externally funded) and a senior researcher. The first three appointments will be made in September 2005 with two appointments being made from September 2006 (see table below). KITE will be used as a springboard to develop research links between the universities of York and Leicester and leverage research funds available nationally and internationally.

PROJECT*	YEAR 1	YEAR 2	YEAR 3	YEAR 4
PROJECT 1	CASSIAN MUMBI BASED AT THE UNIVERSITY OF AMSTERDAM (WOTRO-DG)			
PROJECT 2	STEPHEN RUCINA (NSF-START)			
PROJECT 3				
PROJECT 4				
PROJECT 5				
POST-DOC				



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Team Leader: Dr. Robert Alistair Marchant

MODEL THEORY, PURE AND APPLIED

MODPAP

Marie Curie Excellence Grants (EXT)

The chair holder Pillay is a world-class mathematician and researcher in model theory who has built up centres of excellence in the USA (Notre-Dame and Urbana) over the past 20 years. Model theory is a branch of mathematical logic and deals with definability in mathematical structures and classes of structures. Pillay's project concerns the opening up of new directions in 'pure' model theory as well as applications to and interactions with areas of mathematics such as complex and diophantine geometry and the algebraic theory of differential equations. Pillay will bring to the UK a unique expertise in stability theory and its applications. Outcomes of the project include major advances in the subject, the training of a new generation of postgraduate students and young researchers, as well as the publication of texts on the state-of-the-art in the field. The model theory and logic group at Leeds is already integrated into various EC schemes: it coordinates the multi-partner EST scheme MATHLOGAPS in mathematical logic and applications, and is a partner in the model theory RTN MODNET. Pillay will make a major contribution to the research and training programme of MODNET, and the large number of network activities will facilitate his integration into the European model theory community. Other than conducting research, Pillay will supervise a number of students and postdocs, teach annual graduate courses in model theory and applications, and organize research workshops on topical areas. Leeds has offered Pillay a permanent position to take on conclusion of the Marie Curie Chair.'



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