Spis treści

Project title	Supervisors	Abstract
Biological sciences		
The significance of pigmentation in melanoma biology and treatment	dr hab. Anna Brożyna, prof. UMK, NCU prof. Andrzej T. Slominski, University of Alabama at Birmingham, USA	Malignant melanoma is the most rapidly increasing malignancy in the white population and its mortality rate is surpassed only by lung cancer. Unfortunately, since many years there has been no significant progress in efficiency of advanced melanoma therapies and survival rate of patients with metastatic melanomas. Surgical excision is an effective treatment only for cure of an early stage melanomas. Melanoma is a type of skin cancer that arises from melanocytes, the cells producing melanin, present predominantly in the skin. Its major role is protection against the harmful actions of solar radiation. It has been well accepted that melanin could act as protector against skin cancers and melanoma. However, under pathological conditions (e.g., melanoma), melanogenesis can induce genotoxic and mutagenic effects via toxic intermediates of the pathway, thus contributing to tumor progression. Melanin precursors and intermediates can facilitate melanoma progression and further development of the disease. The antioxidative properties of melanin, under physiological conditions protects skin against environmental insults, but under pathological conditions can attenuate radio- photo- and chemotherapy, with net undesirable clinical effect. The results of our previous research showed significant differences in biology and behavior of amelanotic and pigmented melanomas, both in in vitro experiments and in clinical samples. We found that melanogenesis shortens overall survival and disease-free survival in patients with metastatic melanoma. Patients with pigmented melanomas treated with radiotherapy showed significantly shorter survival when compared to amelanotic once. In melanoma microenvironment melanin was related with lower number of intratumoral and peritumoral lymphocytes in primary lesions indicating, that melanin demonstrates powerful immunosuppressive properties. In addition amelanotic but not pigmented melanoma cells were sensitive to chemotherapeutic action of several drugs and natural compounds and ionizing radiation, suggesting that inhibition of melanogenesis could sensitized melanoma cells to radio and chemotherapy and could be useful method of augmenting efficiency of radiotherapy or chemotherapy in metastatic melanoma.

		The aim of this study is analyzing: -the cytoskeleton of melanoma cells in relation to pigmentation -the effects of melanoma pigmentation, its regulation on adhesion and migration -WNT/β-Catenin pathways in melanoma in relation to pigmentation - WNT/β-Catenin pathways modulation by natural compounds, as melatonin or vitamin D -effects of natural compounds, as melatonin or vitamin D on adhesion, cytoskeleton and migration of melanoma cells. -adhesion, cytoskeleton, migration of melanoma cells and WNT/β-Catenin pathways after melanogenesis inhibition. The abovemantioned aims should allow to identify the molecular pathways and/or processes chracterized by therapeutic potential.
The effect of endomycorrhiza on the development of viral diseases in solanaceous crops	prof dr hab. Katarzyna Hrynkiewicz, NCU dr hab. Christel Baum, University of Rostock, Germany dr Edyta Deja-Sikora, NCU	**Introduction** Growth and productivity of crop plants are affected by both, symbionts and phytopathogens co-infecting the same host. Solanaceous crops establish symbiotic association between their roots and arbuscular mycorrhizal fungi (AMF). This endomycorrhizal association provides plants with nutritional compounds and increases host resistance to both phytopathogen attack and development of phytopathogen-induced disease. Viruses, that are transmitted by insects, belong to the most important phytopathogens of *Solanaceae*, e.g. potato and tobacco. The application of insecticides seems to be ineffective in viral infection control. New, potentially successful strategies to manage viruses may involve the utilization of AMF acting as bioprotective factor. **The main goals of the study are:** (i) to determine the effect of endomycorrhiza on the development of virus-induced diseases in *Solanaceae*, (ii) to check the ability of AMF to inhibit or alleviate the expression of viral infection symptoms, (iii) to study the application potential of AMF as antiviral plant protection factor. **We hypothesise that:** (i) endomycorrhiza decreases the susceptibility of solanaceous crops to virus infection by stimulation of plant immune system, (ii) AMF improve the performance of virus-infected plants by alleviating the disease symptoms and increasing the crop yield.

		Methodology: To test hypotheses the following analyses are planned: (i) examination which AMF species are natural colonizers of solonaceous crop under field conditions, (ii) selection of compatible AMF-plant system for laboratory experiments, (iii) preparation of pot experiments and field experiments with selected AMF species, solanaceous plants and different plant viruses, (iv) examination of growth parameters and virus infection incidence rate in mycorrhizal plants. **Expected results:** It is expected that the study will extend the understanding of interaction between endomycorrhiza and plant viruses. The results will enable practical application of endomycorrhizal fungi for alleviation of virus negative impact on solanaceous crops productivity. Development of new microbiological methods for plant bioprotection from viruses is of great environmental, social and economical significance as partial withdrawal from the use of chemical protection agents is a priority.
Intra annual density fluctuations in wood- what we know about atypical radial growth	dr hab. Marcin Koprowski, prof. UMK, NCU Filipe Campelo, Ph.D. Centre for Functional Ecology – Science for People & the Planet (CFE) Department of Life Sciences University of Coimbra	**Project goals:** Intra-Annual Density Fluctuations (IADFs) can be considered as tree-ring anomalies that can be used to better understand tree growth. We want the answer the question whether IADFs, in temperate climate, resulting from a prompt adjustment to fluctuations in environmental conditions to avoid stressful conditions and/or to take advantage from favorable conditions? **Outline**: In the current research project we will use a collection of the 1500 samples taken in years 1999-2018 and deposited at the Department of Ecology and Biogeography, Faculty of Biological and Veterinary Sciences. Using this samples 4 papers were published in years 2006-2013. However in the previous studies only the tree-ring widths were considered. Atypical growth called Intra-Annual Density Fluctuation is currently under the interest because of the climate change and its impact on forest, especially drought effect. PhD student will analyse this growth using the classification proposed by Campelo et al. (2012). On the selected samples the micro-anatomical wood analysis were prepared in order to identify climate or site parameters affected wood growth. **Work plan:** Student will visually identify atypical growth on the collected samples and next will prepare statistical analysis according the methodology proposed by Klisz et al. (2016). Next on the selected samples PhD student will prepare micro-sections in order to study effect of temperature and precipitation on atypical growth.

A new view on freeze tolerance/avoidance in land snails - role of HSP/CSP proteins	dr hab. Anna Nowakowska, prof. UMK, NCU dr. Grita Skujiene, Vilnius University, Life Science Center, Institute of Biosciences	Adaptation to environmental stress is essential for survival of land snails since drastic changes such as cold, heat, and osmotic shocks are lethal for them. During heat/cold shock, the cell membrane fluidity, enzymatic activity and other physiological processes are changed. Heat shock proteins (HSPs) protect organism from detrimental effects of heat and oxidative stress while the crucial role in cold adaptation play cold shock proteins (CSPs). Despite of the fact that the adaptation to changes in environmental conditions is extensively investigated in different species of animals, the role of heat and specially cold shock proteins in land snails have not been fully studied yet. **Hypothesis:** the snails occupying extreme environments should employ a "preparative defence" strategy involving maintenance of high constitutive levels of HSP/CSP in their cells as a mechanism for protection against periods of extreme and unpredictable stress. Knowledge about the role of HSPs in snails in still poor, therefore it is interesting whether the stress tolerance depends on the synthesis of HSPs. I assume that their upregulation may enhance survival under stress conditions by rescuing critical proteins and reducing the energetic cost associated with protein damage. Given that winter temperature for snails vary from above 0 to -20C or less, the constitutive chaperone defenses could also be necessary to stabilize protein conformation over wide ranges of environmental temperatures, as well as during freeze/thaw cycles. Identification of CSPs in snails will be one of the main objectives of the project. CSPs have a highly conserved (from bacteria to higher plants and animals) nucleic acid binding domain, called the cold shock domain. In plants they play essential roles in acquiring freezing tolerance. Taking into consideration that there are no data concerning the proteins involvement in freeze tolerance or freeze avoidance of animals, I would like to determine expression of the proteins during exposure to freezing in snails. It should be stressed that *direct relation of CSPs level with functionality of these protein during feeze/thaw cycles was not investigated so far.* **The experiments will be performed** on snails exposed to different temperatures and humidities under controlled laboratory conditions, and concentration of HSPs and CSPs will be measured during the seasonal hypometabolism/activity cycles. Western blot analysis will be used to detect HSPs and CSPs, but quantitatively HSPs and CSPs will be analyzed by ELISA. Moreover, immunoprecipitation experiments should allows to identify proteins that interact with HSPs and CSPs. At the beginning we will check if CSPs are present in the snails' cells. It is known that some of them are multifunctional proteins involved in the regulation of transcription

		and translation, drug resistance, cell proliferation and one of them was identified as an essential regulator of larval development in *C. elegans* and still others play a role in reprogramming human somatic cells into pluripotent stem cells or participate in differentiation of muscular tissue. However, there is still no clear answer about the physiological role of the proteins in land snails. The project is the first attempt to combine interdisciplinary methods of physiology and molecular biology to determine the adaptation of snails to environmental stress (especially cold shock/freezing). **It is expected that** HSP/CSP expression determines dehydration tolerance in the natural annual cycles of activity/hypometabolism such as activity/estivation (during summer) and activity/overwintering (in winter), resceptively.
Ecological goal functions and the assessment of Natural Capital and Ecosystem Services	dr hab. Agnieszka Piernik, NCU prof. Pier Paolo Franzese, Pathenope University of Naples, Italy dr hab. Elvira Buonocore, Pathenope University of Naples, Italy	Goal Functions (GFs) can be viewed as propensities towards which the evolution of ecosystems is oriented and can be used to characterize the state and the functional and structural features of ecosystems. From a thermodynamic viewpoint, ecosystems favour those system configurations able to use matter and energy inputs more efficiently, maximizing the flux of useful energy and the rate of material recycling, building ordered structures dissipating entropy flows in their external environment. Healthy ecosystems are capable of maintaining their structures and functions, ensuring the generation and maintenance of natural capital stocks and ecosystem services flows. Protected areas are recognized as important tools to conserve natural capital and biodiversity while achieving human well-being and sustainable development goals. In this project, we aim at applying a biophysical approach to environmental accounting to unfold the role of matter and energy flows exchange in the functioning of ecosystems, with a particular focus on the assessment of natural capital and ecosystem services. The project will focus on implementing the biophysical assessment of natural capital and ecosystem services in selected protected areas and UNESCO-MAB Biosphere Reserves located in Poland and Italy. Three different human-managed ecosystems will be investigated: forest and lake ecosystems located in the Tuchola Forest Biosphere Reserve (Poland) and a coastal lagoon ecosystem located in the Marsala Nature Reserve (South Italy). Biophysical environmental accounting methods will be used to assess sustained environmental costs (i.e., matter and energy input flows converging to generate natural capital stocks), received benefits (i.e., ecosystem goods and services flows benefited from humans), and generated impacts (i.e., emissions and their potential impact due to natural resources exploitation). We expect to produce high quality research results of international interest related to the functioning of natural ecosystems and the benefits they provide to humans. The results will boost the scientific knowledge in this timely field of science while

		supporting policy-makers in charge of developing nature conservation and sustainable development strategies. Research results will be disseminated through the publication of peer reviewed scientific articles in indexed international scientific journals, the participation in international conferences, and the organization of international scientific workshops. The project will be conducted in cooperation with the Department of Science and Technology of Parthenope University of Naples and the UNESCO Chair in "Environment, Resources and Sustainable Development" of which NCU is an official partner (www.unescochair.uniparthenope.it).
Hepato-protective action of Indian Medicinal Herbs – explanation of molecular biological mechanism on pig model	prof. dr hab. Chandra Pareek, NCU prof. Sanjita Sharma, Veterinary College, Jaipur, India prof. dr hab. Mariusz Pierzchała, IGHZ, PAN, Jastrzębiec	The aim of proposed PhD project is to investigate the porcine liver functioning based on transcriptomic and proteomic profiling in context to effects of ***Andrographis paniculata*** bioactive components as food-derived supplement. This Indian herb is a famous therapeutic supplement for treatment various infections and in particular hepatic disorders. ***Andrographis paniculata*** regulate liver metabolism inducing hepatoprotective and hepatostimulating activities. Still there is lack of comprehensive information about changes in gene and protein expression caused by this herb. The molecular mechanism of this action is poorly understood. Additionally, planed PhD studies are aimed to characterise dose dependent influence of this herb on pig health and performance traits. Furthermore, pig is a good animal model, especially useful to mimic human liver metabolism. The proposed PhD research will focus on the effect of selective feeding of healthy and unhealthy nutrients diets supplemented with ***Andrographis paniculata*** on the hepatic genes expression, on transcriptome and proteome level. As a study materials two pig breeds: namely Polish Landrace and Duroc will be investigated. Bioinformatics approach assume to perform complex system analysis combining transcriptome and proteome what allows deep explanation of gene expression regulation by ***Andrographis paniculata***. The proposed PhD project hypothesis is that unhealthy nutrients (saturated fatty acids, and carbohydrates) diets affects the liver genes expression activity reflected on transcriptome and proteome level. Moreover we assume that two divergent pig breeds Polish Landrace and Duroc, allow to point out basic similar changes in gene expression and breed/phenotype specific response for herbal treatment. This study will answer the following questions:

		1. What is the physiological state hepatic gene and protein expression profiling in Polish Landrace and Duroc pigs? 2. How does hepatic gene and protein expression profiling in Polish Landrace and Duroc pigs after weaning? 3. Does transcriptome/proteome profiling analysis on pig liver significantly affect the hepatic expression crucial genes and proteins which could be used as biomarkers of health status? In this PhD project, the expected investigated results will allow us to identify not only the large diet and breed specific set of RNA-seq and proteomics data, but also allow us to detect the biomarkers of healthy metabolic status of liver important for pig performance traits. Moreover, it will also allow the explanation on molecular level how ***Andrographis paniculata*** improve the liver metabolism, and how it is similar or different according to healthy/unhealthy diets. The expected investigated results will also allow us to characterize the biological mechanisms as indicators/biomarkers for early liver metabolic disturbance in order to help in diagnose the development of the metabolic disorders such as obesity, cardiovascular diseases, and diabetes.
Loss of ecosystem services due to natural and anthropogenic extreme events	dr hab. Agnieszka Piernik, prof. UMK, NCU prof. Pier Paolo Franzese, Parthenope University of Naples, Italy dr hab. Elvira Buonocore, Parthenope University of Naples, Italy	Healthy and resilient ecosystems are capable of maintaining their structures and functions, ensuring the generation and maintenance of natural capital stocks and ecosystem services flows. The long-term management of natural capital stocks is essential for the stable and resilient flow of ecosystem services for future generations facing climatic uncertainty. Climate change is increasing the frequency of extreme events such as droughts, wind storms, intense rainfalls, and wildfires, posing a serious threat to the provision of ecosystem services vital for human economy and well-being. In this project, we aim at developing and applying an integrated framework for assessing the loss of ecosystem services due to natural and anthropogenic extreme events. In particular, the project will focus on two main case studies dealing with human-managed ecosystems located in Poland and Italy: 1) the Vesuvius Volcano National Park (Italy) that in 2017 was subjected to a major wildfire burning more than 84% of the forest cover, and 2) the Tuchola Forest

		Biosphere Reserve (Poland) that in 2017 was subjected to a catastrophic wind storm damaging over 100,000 ha of forest cover. The project will apply an integrated systems approach placing natural capital and ecosystem services into a broader decision-making context by exploring the link between natural and anthropogenic extreme events and the loss of benefits for humans. The project will contribute to finding novel approaches evaluating the vulnerability of natural ecosystems to potential climatic impacts and their effects on human economy at different scales. We expect to produce high quality research results of international interest related to natural ecosystems management and the benefits they provide to humans. Research results will be disseminated through the publication of peer reviewed scientific articles in indexed international scientific journals, the participation in international conferences, and the organization of international scientific workshops. The project will be conducted in cooperation with the Department of Science and Technology of Parthenope University of Naples and the UNESCO Chair in "Environment, Resources and Sustainable Development" of which NCU is an official partner (www.unescochair.uniparthenope.it). **Scientific background** Healthy and resilient ecosystems are capable of maintaining their structures and functions, ensuring the generation and maintenance of natural capital stocks and ecosystem services flows (Häyhä and Franzese, 2014, 2015). The long-term management of natural capital stocks is essential for the stable and resilient flow of ecosystem services for future generations facing climatic uncertainty (Monge and McDonald, 2020). Climate change is increasing the frequency of extreme events such as droughts, wind storms, intense rainfalls, and wildfires, posing a serious threat to the provision of ecosystem services vital for human economy and well-being (Tomczyk et al., 2016). Managing ecosystems to provide ecosystem services in the face of global change is a pressing challenge for policy and science. **Aims**

		In this project, we aim at developing and applying an integrated framework for assessing the loss of ecosystem services due to natural and anthropogenic extreme events. In particular, the project will focus on two main case studies dealing with human-managed ecosystems located in Poland and Italy: 1) the Vesuvius Volcano National Park (Italy) that in 2017 was subjected to a major wildfire burning more than 84% of the forest cover, and 2) the Tuchola Forest Biosphere Reserve (Poland) that in 2017 was subjected to a catastrophic wind storm damaging over 100,000 ha of forest cover. **Methods** Ecosystem services assessment is a growing field of science addressing the evaluation of the benefits that ecosystems provide to humans. Since the late 1960s, the issue of human societies' dependence on nature has been discussed in the scientific literature, highlighting the ability of natural ecosystems to provide vital services in support of human economy and well-being. In this project, an integrated assessment framework will be developed and applied to evaluate the vulnerability of natural ecosystems to potential climatic impacts and their effects on human economy in terms of loss of provisioning, regulating, and cultural ecosystem services. The assessment framework will place natural capital and ecosystem services into a broader decision-making context by exploring the link between natural and anthropogenic extreme events and the loss of benefits for humans. **Expected results** We expect to produce high quality research results of international interest related to natural ecosystems management and the benefits they provide to humans. Research results will be disseminated through the publication of peer reviewed scientific articles in indexed international scientific journals, the participation in international conferences, and the organization of international scientific workshops. The project will be conducted in cooperation with the Department of Science and Technology of Parthenope University of Naples and the UNESCO Chair in "Environment, Resources and Sustainable Development" of which NCU is an official partner (www.unescochair.uniparthenope.it). **References**

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Enhancement of endogenous neuroprotective mechanisms – therapeutic strategies in brain damage	prof. dr hab. Justyna Rogalska, NCU prof. Karol Dokładny, University of New Mexico, USA	The research planned to be performed under the PhD thesis is the part of the **Emerging Field** project**:** "**New insight into chronic diseases: from risk factors, through prevention, diagnosis to treatment"** The pathophysiology of neurological disorders involves deleterious changes in cellular homeostasis. The mechanisms that lead to neuronal injury are complex and multifactorial. During these diseases the cellular functions can be disturbed by excitotoxicity, overproduction of reactive oxygen species or inflammation. Neurons have developed their own endogenous cellular protective systems. The chronicity of neurodegenerative diseases allows the brain to engage compensatory mechanisms to counteract neuronal damage. Some of them are preventing cell death and others are allowing functional recovery after injury. The endogenous neuroprotective factors involved in neurons survival, include neurotrophic factors and their signalling pathways, processes regulating the redox status, and different pathways regulating cell death. Improving the effectiveness of this natural protection might help the remaining neural circuits to compensate for lost or broken circuits and enhance overall network performance and neurological function. The high efficiency of these mechanisms is crucial for cell survival. However, over time, these compensatory mechanisms can fail, and some may even become co-pathogenic. From a therapeutic perspective, it is crucial to determine how to encourage the neuroprotective mechanisms or alleviate the pathogenic once. The research will focus on interaction of cerebrovascular disease e.g. stroke and

		neurodegeneration. It seems that new therapeutic targets could include protection of the endothelium, the blood-brain barrier, and other components of the neurovascular unit. Previous studies have shown that the activation of mineralocorticoid receptors (MR) raise the chance of neuronal survival, suggesting that it presents an adaptive mechanism, activated in response to damage. However, some data demonstrate that increased hippocampal MR expression is associated with a shift towards increased expression of pro-inflammatory genes at the expense of anti-inflammatory factors. As the consequence the inflammation-induced injury of vascular system can develop. Thus the protective role of MR receptors is not clear-cut. In order to develop effective therapies based on the properties of the described receptors, it is crucial to elucidate the consequences of MR activity under pathological conditions in the nervous system. There are no detailed, molecular studies focusing on processes occurring in the neurons after MR activation. The **aim of the project** is to evaluate methods of the encouragement of endogenous mechanisms to compensate for lost or broken neural circuits. The **state-of-the-art technologies** will be used including molecular techniques (e.g. qRT-PCR, Bio-Plex Multiplex immunoassays, Flow cytometry), biochemical analysis and spectrophotochemical techniques; cell culture techniques; microscopy (confocal, TEM - transmission electron microscope); experimental techniques on animals (behavioural tests, electrophysiology). Our foreign partner prof. Karol Dokladny, who is a physiologist will manage the part of the project concerning the neurovascular interaction and inflammation. Due to our interdisciplinarity (biology, medicine), we can look at neurodegenerative diseases in an **innovative, multidirectional** way. The identification of neuronal adaptive processes may facilitate the design of novel drugs that mimic the self-protective capacity of the brain or develop/improve the therapies to encourage the adaptive mechanisms.

Chemical sciences		
Innovative and eco-friendly concept for cosmetic chemistry – alternative cosmetic formulations with reduced water content	dr Timothy E.L. Douglas, Lancaster University, UK dr Justyna Kozłowska, NCU	Water is essential to life on Earth and covers 71% of our planet. However, only 3% of the world's water consists of freshwater, hence two-thirds are unavailable for our use. Furthermore, clean and accessible water resources are shrinking rapidly. According to the World Wildlife Fund (WWF), two-thirds of the world's population may experience water shortages by 2025. Water scarcity has been listed in Global Risks Report 2020 prepared by the World Economic Forum as one of the largest global threats in terms of potential impact and likelihood over the next decade. One of the industries using large amounts of water is the cosmetics industry. Water is the main constituent of numerous cosmetic and personal care products. It can be found in skin, body, hair, oral and sun care products. The vast majority of consumers use several cosmetic and personal care products every day. However, water has no cosmetic effect on the skin: it is only the base component and solvent of other ingredients in most cosmetic forms. Water is an excellent breeding ground for microorganisms and therefore water-based formulas can be very easily contaminated by bacteria and other microorganisms. Hence, the addition of preservatives and substances supporting the preservative effect by reducing the activity of water is essential to maintain the microbiological purity. Cosmetic production is enormous: according to Socio-Economic Contribution of the European Cosmetics Industry 2019 prepared by Cosmetics Europe, the European cosmetics market in 2018 was valued at €78.6 billion, making Europe the largest market for cosmetic products in the world. Waterless cosmetic products present opportunities in product development with reduced water consumption. The absence or minimal amount of water in cosmetics may increase their shelf life and also contribute easier and lower-cost packaging, storage and transport of products. Formulating products with reduced water amount is a responsible attitude towards the climate change and global water crisis. The main goal of the project is to develop and characterize novel formulations of cosmetic products with reduced water consumption, which present many environmental benefits and innovative opportunities. Microencapsulation, which is one of the quality preservation techniques of sensitive substances and a method for production of materials with new valuable properties, will be used for the purpose of

		execution of this project. Expected project results will contribute to significant development in the cosmetics industry. Furthermore, the project enables cooperation with other scientific centers and conduction of interdisciplinary scientific research.
The interaction of cosmetic ingredients incorporated into several emulsions with the skin	prof. dr hab. Alina Sionkowska, NCU prof. Michel Grisel, Université Le Havre Normandie, France	The project is focused on the study of skin properties after topical application of the cosmetic formulation. In this project several emulsions will be prepared containing selected active agents, antioxidants, color ingredients and the skin properties after topical application of the cosmetic formulation onto the skin will be studied. Naturally occurring polymers will be modified to improve the adhesion of the cosmetic formulation to the skin surface. New surfactants based on natural compounds will be proposed and synthesized as well as their properties will be studied. The chemical structure of new compounds will be studied by means of FTIR and NMR spectroscopy, UV-Vis spectrometer and XRD. Several polymers will be tested as rheology modifiers. Rheological properties of the cosmetic emulsions with several biopolymers (collagen, hyaluronic acid, chitosan, elastin, keratin) as well as man-made polymers (silikons, PEG, PVP) will be studied. For the study of skin properties the following instruments will be used: corneometer, sebumeter, colorimeter, ARAMO TS for study the skin elasticity and general look. As a result of this project implementation new knowledge will be generated about skin properties after cosmetic emulsion application. The knowledge generated by this project can be useful for development of new generation personal care cosmetics and color cosmetics. **References:** 1. Sionkowska, A., Kaczmarek, B., Michalska, M., Lewandowska, K., Grabska, S. Preparation and characterization of collagen/chitosan/hyaluronic acid thin films for application in hair care cosmetics. Pure and Applied Chemistry, **2017**, 89, 1829-1839 (IF=5,294; MNiSzW=140) 2. Sionkowska A., Skrzyński S., Śmiechowski K., Kołodziejczak A. The review of versatile application of collagen, **2017**,Polymer for Advanced Technologies

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New materials based on modified biopolymers for biomedical and cosmetic applications	prof. dr hab. Alina Sionkowska, NCU prof. Michele Laus, University East Piemonte, Alessandria, Italy	The aim of the project is a design and preparation of new biomaterials based on modified biopolymers. In the project several biopolymers (polysaccharides and proteins) will be used to prepare appropriate composite based on biopolymer blends. Dual crosslinking using physical and chemical methods will be used to optimize the materials properties. New biopolymer based materials will be studied as potential biomedical applications. Morphological and physico-chemical properties of new material will be modified in order to achieve good biological properties. The interaction with fibroblast and keratinocytes will be studied. Thermal and photochemical stability of the new materials obtained will be studied. Within the project mechanical properties, swelling, and biodegradation will be studied. Film forming properties of biopolymer blends will be studied for applications in hair care cosmetics. For chemical study the following techniques will be used: FTIR-spectroscopy, UV-Vis spectrometry, XRD, SDS-Page electrophoresis, GPC chromatography, HPLC. The surface properties will be studied by AFM and SEM microscopy, apparatus for contact angle measurements. Moreover, mechanical and thermal properties of new materials will be studied. For the study of hair properties after applications of new materials the following instruments will be used: microscope, sebumeter, colorimeter, ARAMO TS for study the hair general look. Biocompatibility of new materials prepared under this project will be studied by *in vitro* study. 1. A. Dodero, E. Brunengo, M. Alloisio, A. Sionkowska, S. Vicini, M. Castellano. Chitosan-based electrospun membranes: Effects of solution viscosity, coagulant and crosslinker. Carbohydrate Polymers **2020;** 235, no. 115976. 140 pkt

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Earth and related environmental sciences		
Spatial distribution, characteristics and environmental hazard of coastal acid sulfate soils in Poland	dr hab. Piotr Hulisz, prof. UMK, NCU dr Anton Boman, Geological Survey of Finland, Kokkola, Finland	Acid sulfate (AS) soils are commonly called as the nastiest soils in the world. They are mostly coastal soils which contain iron sulfides (mostly FeS2). When these soils are dehydrated, e.g. due to drainage or the impact of some other natural or anthropogenic factors, sulfuric acid is produced as a result of the sulfide oxidation. Then toxic quantities of such elements as Al, Cd, Co, Mn, Ni, Pb, and Zn , can be released. These toxic elements can be excessively concentrated in waters, plants, animals and humans. The Baltic Sea is still widely recognized as one of the most polluted seas in the world. That is why, the question arise if the AS soils can be a potential source of heavy metal contamination affecting the Baltic coastal environment? The aim of this project is analysis of spatial distribution, characteristics and environmental hazard of coastal AS soils in Poland. The following research tasks were defined:(i)Creation of AS soil probability maps using modelling techniques (e.g. artificial neural networks, random forest etc.) together with available spatial environmental and soil data. Application of maps toa detailed identification of environmental conditions favouring the formation of AS soils in the Polish coastal zone. Two coastal areas in the reverse delta of the Świna River and Puck Bay (50 km2each) will be selected in Poland. The results will be compared to results obtained from selected coastal areas in Finland, where mapping of AS soils are finished during 2020. (ii)Validation of probability maps based on

		field and laboratory tests according to international standards for mapping of AS soil materials. (iii)Analysis of relationships between the content of heavy metals and other soil properties in spatial (soil transects) and vertical patterns (soil cores) within validated AS soil sites. Evaluation of the environmental effects of heavy metals in surface and ground waters.(iv)Assessment of the environmental risk relating to the potential acidification of AS soils and release of heavy metals in the Baltic Sea coast using collected geo-spatial data. The results will help to complement the knowledgeon AS soils in the Baltic Sea region. The comparative spatial analyses of actual and potential threats caused by AS soils in Poland and Finland have not been done so far. The obtained results will be useful to formulate recommendations for the management related to the potential increase of soil acidification and release of heavy metals in coastal saline meadows and refuges of rare birds in areas included in the Nature 2000 network. Furthermore, based on the presented data, some suggestions will made to improve the Polish soil classification system.
Economics and finance		
Financial markets, institutions and systems	prof. dr hab. Magdalena Osińska, NCU prof. dr Mathias Moersch, University of Heilbronn	Financial markets developed rapidly over last decades bringing to life a variety of financial instruments and derivatives, institutions and systems. The role of financial sector became so huge that it dominated not only single economies but also the world economy. Financialization of the world economy became an issue of concern, particularly because of the global crisis in the years 2008-2009. At present the role of finance in economy is not decreasing however it seems to be better understood and modeled although the long run policy is often broken by unusual phenomena like COVID pandemic in 2020. It realizes that ways of adjustment should be included into financial solutions. The project is focused on finding the optimum proportion between financial and real side of economy, considering different financial markets, insurance institutions, pension systems and so on. The general hypothesis is that among many possible models one can find the optimal one taking into account specific institutions that are important in a given economic environment. The variety of individual projects can be considered. The open issues are related with financial risk evaluating and

		management, portfolio optimization and pension systems optimization. In the case of considering the proportion between saving, investment and consumption the life cycle hypothesis is important since it changes the perspective of the individuals towards their future. The methodology used in solving the mentioned problems is related with numerical simulations, econometric time series models including volatility models (univariate and multivariate GARCH and SV models), optimization models, univariate and multivariate distribution models. The problem of business cycle must be considered when the long run is considered. The qualitative analysis, particularly interviews with experts will be helpful in determining contemporary and future trends. The initial conditions and budget constraints must be defined to provide a reasonable solution. Familiarity and experience in R, Eviews, Mathlab and other computer packages is strongly recommended.
Fine arts and conservation		
Comparative study of Chinese and European historical mural decorations. Materials' identification, painting and gilding techniques recognition and conservation issues	dr hab. Mirosław Wachowiak, prof. UMK, NCU prof. Liu Chang, Tsinghua University, Beijng, China	Chinese and wider Asian traditions of mural decoration have developed in different cultural and geographical environment than the European ones. Some of them varied in functions, and represent different iconography. These cultural aspects are expressed also within different material matters used in exceptional way. The aim of the project is a comparison of the main wall painting techniques, pigments and special solutions used for gilding when such decoration is included to achieve unique aesthetical results distinguishable for both regions, yet not deeply researched and revealed, especially in the case of Chinese objects that just begun to be deeply studied. Some starting point meaning the object choice to be investigated for the Chinese tradition could be the exceptional murals in the early Yuan Dynasty style from around 1240 discovered lately in the Shenggu Temple in Gaoping City in the complex of well preserved architecture. Especially Xiangu Ancestral Paintings are executed at very high artistic level, using rich colour decoration and several ancient gilding techniques to be found in China, like "sgrafitto like technique (拨金)". Additionally a unique Chinese Xuan paper covers the surface of the paintings. This extraordinary example is still to be researched

		whether it was decorative or rather protective purpose or combination of both. Objects to represent the examples of the European tradition of wall painting could be just discovered fragments of gothic decorations in St James church in Toruń, broadened with data gathered from already researched and conserved objects from the gothic period, like gilding techniques of Torunian *Last judgment* in St Johns' Cathedral presbytery. Identification of pigments, and recognition of painting and gilding decoration technique is going to be the main part of the Ph. D. project. In the first step non - invasive methods like UV florescence imaging, IR reflectography, X-ray fluorescence (XRF) and possibly portable Raman spectroscopy will be implemented. Following research will be conducted on taken samples from which prepared cross-section will be observed in ViS and UV light under microscope and investigated using SEM-EDX, and possibly using micro FTIR and micro Raman spectroscopic techniques as well as FTIR ATR, and if needed X-ray diffraction. Identified materials and recognized techniques will be compared and wider conclusions proposed basing on material analysis of real objects juxtaposed to the information in existing historical recipes and treatises like Theophilus (On Divers Arts, about 12th cent.) and Cennino Cennini (Treatise on painting, 15th cent.) for European paintings and 《营造法式》, 《**匠作**则例汇编》for Chinese. Important output of the project would be translation with technological comments of Chinese sources becoming available for Western researchers for the first time ever. The comparison of techniques would be fulfilled with juxtaposition of "Oriental" and "Western" conservation attitudes. Both are going to be considered in synergic interweaving of different heritage protection philosophies, resulting in best proposition of conservation treatment for Asian and European objects, combining in creative way different cultural backgrounds and material and technical traditions. **Candidate expectations**: Chinese fluent speaking and reading, conservation education on M. A. level, some experience in conservation of Chinese murals and paper objects.

Władysław Hasior's works - selected conservation issues, history, and new perspectives on preservation	dr. hab. Sławomir Adam Kamiński prof. UMK, NCU prof. akad. mal. Tomáš Lahoda, University of Pardubice , Faculty of Restoration	Modern art poses entirely new challenges to a conservator, especially within the orbit of material. In conservation of traditional art the already developed methodology enables rather safe functioning within the framework of professional ethics, whereas works of every modern artist and their "own technique" requires profound research. Characteristic issues associated with conservation of modern art are perfectly visible in pieces of Władysław Hasior, the classic of Polish artistic avant-garde of the second half of the 20th century. The project focuses on the conservation issues concerning thirteen of his artworks. The collection belonging to National Museum of Poznań serves as a very good representation of his artistic achievements – it contains works created over the course of two decades for several cycles, constructed from wide variety of non-pictorial materials. In that it constitutes an excellent starting point to formulate research and conservation methodology not only for this particular artist's legacy but for modern art in general. Although many papers on Władysław Hasior and his artistic creations were written, we still lack a wider study on technical and conservation issues. One of the main problems of the collection are deficient records, disenabling to explicitly determine the original appearance and condition of particular pieces. The situation results from inadequacy of standard documentation methods to constructions of modern artworks. Multiple-element spatial compositions are easily deformed, even due to its own parts (structural issues), are extremely sensitive to external factors (material with adversarial humidity-temperature needs), are very difficult to transport and require individual exhibition system. These and other factors, like previously mentioned limitations of documentation methods and conservation tutelage conducted without profound material and structural analysis led to the situation when during in situ examination one cannot answer many simple questions. How did the artwork look like when bought by the museum? What was the original configuration of its elements? What is the scope of previous interferences and why were they conducted? Atypical construction of these artworks makes the standard documentation methods, based on written descriptions and photography, insufficient as repertories of the information. Having a brush with pieces of such complicated

		structure as Hasior's assemblages, it is essential to attach to the documentation 3D scans of the objects, allowing to properly monitor its aging changes and deformations resulting from transportation, exposition and storage. Juxtaposition of various materials requires numerous identification investigations and formulation of new conservation guidelines in cooperation with conservators of different specialisations. The work on the repertory will be preceded by a query embracing the biggest collections of Władysław Hasior's pieces. Subsequently a wide state of research will be devised, material and structural examination of the discussed group conducted, what can cause a reformulation of some ethical aspects and – through taking concrete actions – a refinement of past conservation and preservation methods of this type of artworks. One of the main goals of the Ph. D. project is determination of the original form of the objects, and the artist's intentions. Material identification and construction recognition will not only enable conservation of the relevant objects but also development of their safe transport, storage and a main premises of conservation prophylaxis. All these actions will set an example of not unitary, but broad approach to modern art and so will have an impact on recognition of conservation issues and delineating course of further dealing not only with artworks of Władysław Hasior, but also of other modern artists.
Management and quality studies		
People in Organizations	prof. dr hab. Aldona Glińska-Neweś, NCU prof. dr hab. Miguel Pereira Lopes, University of Lisbon	Human behaviors are among the key determinants of all economic phenomena and processes, both in the microscale (organization) and the macroscale (economy). Research proposed within the project may concern individual and group level of organizational behaviors. First perspective includes individual traits and psychological mechanisms while the second one is linked with issues such as social relationships, communication and cooperation, organizational and national culture. Within the aforementioned general project, there will be specific problems elaborated in PhD thesis, including: - Organizational Citizenships Behaviors and its antecedents, - Entrepreneurial behaviors.

Physical sciences

Quantum Electrodynamics with 2D materials	prof. dr hab. Ireneusz Grabowski, NCU prof. Carsten Rockstuhl, Karlsruhe Institute of Technology dr Karolina Słowik, NCU	**Research scope and expected impact** Two-dimensional materials (e.g. graphene, hexagonal boron nitride, transition-metal dichalcogenides), offer a unique opportunity to design their optical properties by tuning them with electric, optical or chemical means or by combining them among each other. In consequence, their optical response may span a broad region of the electromagnetic spectrum, ranging from microwave to ultraviolet wavelengths. One particularly appealing feature is the ability of 2D materials to support strongly confined electromagnetic modes, whose length scales range from microns down to a few nanometers. The confinement is accompanied by local field intensity enhancement, which unlocks the possibility to achieve extraordinarily strong interactions with atomic systems (atoms, molecules) which might be positioned in the focal volume. The scope of this project is to exploit tunable two-dimensional materials to tailor light-matter interactions at the nanoscale. Coupling strength, emission properties, spectral properties, nonlinear interactions in addition to a dynamic control of material properties enables multiple applications for signal processing at the quantum level, construction of new types of quantum logic gates, generation of multiphoton nonclassical states of light, or coupling of atomic systems that could be activated on demand. In this project we aim to lay down the ground for such devices, to be based on atomic systems coupled to nanostructures made of 2D materials. The project will be carried out in collaboration with Prof. Carsten Rockstuhl, Karlsruhe Institute of Technology,Germany, expertize area: nanophotonics Prof. Andres Ayuela, Donostia International Physics Center, San Sebastian, Spain, expertize area: solid state theory, 2D materials Supervisors in Toruń: many-body physics, quantum optics **Methods** 2D materials (finite flakes, extended ribbons, etc.) will be described with the quantum tight-binding Hamiltonian. Modeling of light-matter interactions will exploit self-consistent potential based on the dipolar coupling scheme. Dynamics of the system will be described with a master equation. The group has developed Python codes to model dynamics of graphene subject to electromagnetic radiation. Extensions to include other materials quantized fields will need to be implemented by the student.