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Atomfizika, optiskās tehnoloģijas un medicīnas fizika

Atomic physics, optical technologies, and medical physics

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- optiskie procesi gāzēs, šķidrumos, cietās vielās un bioloģiskos paraugos
- optikas metodes diagnostikai, ķīmiskai analīzei un optisko sensoru tehnoloģijas
- kvantu optika un telekomunikācijas
- modelēšana
- jauni materiāli un to biomedicīniskie pielietojumi.

Poster section

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recent results achieved by IAPS researchers and the IAPS partners in the following research fields:

- optical phenomena in gas, liquid, solid state and biological samples
- optical methods for diagnostics, chemical analysis and optical sensor technologies
- quantum optics and telecommunication
- modelling
- novel nanomaterials and their biomedical applications

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Abstract ID: **1**

3D fotona kvantu modelis
3D quantum model of the photon

Content

Pareiza izpratne par gaismas būtību ir kļuvusi īpaši aktuāla pēdējās desmitgadēs, kad intensīvi tiek pētītas atsevišķu fotonu ģenerēšanas un detektēšanas tehnoloģijas. Viens fotons tiek uzskatīts par galveno elementu kvantu komunikāciju tehnoloģijās. Kvantu mehānika veiksmīgi izskaidro atomu un molekulu struktūru. Fotonu aprakstam Pauls Dīraks 1927. gadā ieviesa formālu kvantu noteikšanas procedūru Maksvela vienādojumiem, kas precīzi apraksta fotonu radīšanu un anihilāciju. Tā bija ļoti veiksmīga, taču šīs procedūras fizika nav skaidra: kas ir tas, kas svārstās, un kur laikā un telpā atrodas fotoni? Mēs izveidojām jaunu fotonu 3D modeli, izmantojot elektromagnētiskā lauka kvantēšanas procedūras matemātiku un fotona solitona modeļus. Papildus mijiedarbības potenciālam starp lādētu daļiņu un fotoniem, kas satur fotonu anihilācijas un radīšanas operatorus, ir atvasināta jauna brīvas izplatīšanās fotonu apraksta funkcija. Šī funkcija ir lauka vektora potenciāls, šī funkcija ir harmoniskā oscilatora īpašfunkcijas reizinājums ar precīzi definētu oscilatora koordināti un Gausa funkciju, atkarībā no polārā rādiusa šķērsvirzienā. Mūsu modelis nav pretrunā ar kvantēšanas procedūru un kvantu mehāniku, un papildus tas apraksta atstarošanu un refrakciju. Taču, lai pilnībā pārliecinātos par šī piedāvātā modeļa pamatotību, tas vēl ir jāpārbauda dažādos procesos, kuros iesaistīti fotoni. (Prezentēts EGAS 54 konferencē 2023.gada jūnijā)

The correct understanding of the nature of light has become particularly relevant in recent decades, when technologies for single photon generation and detection are intensively studied. The single photon is considered as the main element in quantum communication technologies. Quantum mechanics successfully explain the structure of atoms and molecules. For photon description, Paul Dirac in 1927 introduced a formal quantization procedure of Maxwell equations, which accurately describe the creation and annihilation of photons. It was very successful, but the physics of this procedure is not clear: what is there that oscillates and where are photons located in time and space? We constructed a new 3D model of photons using mathematics from the electromagnetic field quantization procedure and the soliton models of photons. Besides the interaction potential between the charged particle and the photons, which contains the annihilation and creation operators of photons, the new function for a description of free propagating photons is derived. This function presents the vector potential of the field, the function is a product of the harmonic oscillator eigenfunction with the well-defined coordinate of the oscillator and the Gaussian function of the polar radius in the transverse direction. Our model does not contradict the quantization procedure and quantum mechanics, and, additionally, it describes reflection and refraction. But to be fully convinced of the validity of this proposed model, it needs to be further tested in various processes involving photons. (Presented in the EGAS 54 conference, June 2023)

Primary author: Dr BĒRSONS, Imants (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Dr BALCERS, Ojārs; Dr VEILANDE, Rita (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Dr BĒRSONS, Imants (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **VEILANDE, Rita** on **Friday, December 22, 2023**

Abstract ID: **2**

Dzīvsudraba noteikšana savvaļas putnu paraugos ar Zēmana atomu absorbcijas spektrometrijas metodi
Determination of mercury in wild bird samples by Zeeman atomic absorption spectrometry

Content

Dzīvsudrabs ir viens no bīstamākajiem un indīgākajiem smagajiem metāliem, kas ir plaši izplatīts vidē. Tas ir toksisks visās tā formās. Tomēr dzīvsudrabs ir bīstamākais tā vispopulārākajā organiskajā formā - metildzīvsudrabā, kā arī tā sauktajos bioakumulācijas un biomagnifikācijas procesos barības ķēdē. Mūsu darbs ir veltīts precīziem Hg mērījumiem putnu (galvenokārt melno stārķu) bioloģiskajos paraugos, lai izdarītu secinājumus par dzīvsudraba izplatību vidē. Hg monitoringu ar putniem var veikt, izmantojot dažādus indikatorus, piemēram, olu čaumalas, iekšējās membrānas, izkārnījumus. Šim pētījumam tika izmantota ļoti jutīga metode - Zēmana atomu absorbcijas spektrometrija ar gaismas polarizācijas augstfrekvences modulāciju. Zēmana fona korekcijas un daudzceļu analītiskās kameras izmantošana nodrošina augstu mērījumu selektivitāti un jutību. Viena no galvenajām iekārtas sastāvdaļām ir augstfrekvences bezelektroda izlādes lampa, kas piepildīta ar dzīvsudraba izotopa tvaikiem (pāra izotops 198Hg vai 204Hg). Lampu ievieto pastāvīgā magnētiskajā laukā. Salīdzinot σ- komponentu intensitāti, var noteikt analizētajā pa- raugā esošā dzīvsudraba koncentrāciju. Cietvielu un bioloģisko paraugu analīzei var izmantot termiskās noārdīšanās ierīci. Rezultātā instruments ļauj tieši noteikt dzīvsudrabu bioloģiskajos paraugos (nav nepieciešama iepriekšēja apstrāde) ar zemu noteikšanas robežu - 1-3 ng/g. Analizējot 320 paraugus, tika konstatēts, ka Hg koncentrācija olu čaumalās ir vidēji 15 ng/g, ar augstākajām vērtībām ap 130 ng/g, savukārt membrānās vidējā koncentrācija ir 200 ng/g, bet ir paaugstinātas vērtības, kas pārsniedz 1500 ng/g. Saskaņā ar Latvijā spēkā esošajiem tiesību aktiem dzīvsudraba maksimāli pieļaujamā koncentrācija virszemes ūdeņu biotā ir 20 ng/g.
Pētījumu atbalstīja LZP projekts Nr. lzp-2020/1-0005. (Prezentēts EGAS 54 konferencē 2023.gada jūnijā)

Mercury is one of the most dangerous and poisonous heavy metals and is widely distributed in the environment. It is toxic in all its forms. However, the main danger of mercury is its most popular organic form – methylmercury, and in so-called bioaccumulation and biomagnification processes in the food chain. Our work is dedicated to accurate measurement of Hg in biological samples of birds (mostly the Black stork) in order to draw conclusions about the distribution of mercury in the environment. Hg monitoring with birds may be done by using various indicators, such as eggshells, inner membranes, faeces. For this study very sensitive technique – the Zeeman atomic absorption spectrometry with high-frequency modulation of light polarization – was used. The use of the Zeeman background correction and a multi-path analytical cell provides high selectivity and sensitivity of measurements. One of the main components of the equipment is a high-frequency electrodeless discharge lamp, filled with mercury isotope vapor (pair isotope 198Hg or 204Hg). The lamp is placed in permanent magnetic field. Comparison of the intensities of the σ-components allows to determine the concentration of mercury present in the analysed sample. For the analysis of solid and biological samples, an attachment for thermal decomposition can be used. As a result, the instrument allows direct determination (no pre-treatment is required) of mercury in biological samples with a low detection limit of 1–3 ng/g. Analysing 320 samples, it was found that Hg concentration in eggshells is on average 15 ng/g, with the highest values around 130 ng/g, whereas for membranes the average concentration is 200 ng/g, but there are elevated values exceeding 1500 ng/g. Under current legislation in Latvia, the maximum permissible concentration of mercury in surface water biota is 20 ng/g.
The research has been supported by LCS Project No. lzp-2020/1-0005. (Presented in the EGAS 54 conference, June 2023)

Primary author: Dr VEILANDE, Rita (Institute of Atomic Physics and Spectroscopy, University of Latvia)
Co-authors: Ms RIMŠA, Antonija (Institute of Biology, University of Latvia); Dr SKUDRA, Atis (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy, University of Latvia)
Presenter: Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy, University of Latvia)
Status: ACCEPTED
Submitted by **VEILANDE, Rita** on **Friday, December 22, 2023**

Abstract ID: **4**

The Laser Spectroscopy of Ions in Beams and Traps at University of Latvia

Content

We report on new research direction started in Institute of Atomic Physics and Spectroscopy at University of Latvia. The aim of our research is to obtain new information about atomic structure and dynamics. The accurate experimental data for energy levels and lifetimes of excited states in atomic ions are demanded in order to test theoretical models and correctly describe the rules for atomic systems. We are collaborating with large-scale facilities where an advanced experimental set up is available. And we present the preliminary results for first measurements of lifetimes for Barium metastable ion, and studies of photodetachment threshold for Clorine- isotopes.

The idea to develop the research of ions in beams and traps weas created in frame of ERA chair project "Development of quantum optics and photonics in University of Latvia" and based on our experience in using ion beam technologies [1-3]. The research is carried out in close cooperation with groups of scientists from CERN and Swedish universities: Stockholm, Gothenburg, and Malmö, where final experiments are performed on advanced set-ups in large scale facilities. Information on the structure of electron shell and nuclei is obtained by measuring the electron attachment energy for various isotopes of chlorine negative ions using the radioactive ion trap at ISOLDE in CERN [4] Electron and ion dynamics are studied by measuring the lifetimes of long- lived metastable ions in a space-like environment using the ion ring DESIREE in Stockholm [5]. The preparation for experiments at partners sites and the control experiments will be performed on ion beam set-up GRIBA [6] in our laboratory.

We have performed short term scientific missions and obtained preliminary results. This indicates that submission of joint papers in the world's leading journals is realistic. In the future we plan to develop our collaboration with both facilities and send more students to the short and middle term scientific missions to CERN and DESIREE and as well the visits from them to us at University of Latvia.

Acknowledgement. Work is supported by Fundamental and Applied Research Project (Nr. lzp- 2023/1-0199): "The Laser Photodetachment Spectroscopy on Negative Ions", from Latvian Council of Science.

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Primary author: Dr Hab BĒRZIŅŠ, Uldis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Dr Hab BĒRZIŅŠ, Uldis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **BĒRZIŅŠ, Uldis** on **Sunday, January 7, 2024**

Abstract ID: **7**

Dzīvsudraba 253,7 nm spektrāllīnijas Zēmana supersīkstruktūras sašķelšanās pētījumi

Investigation of 253.7nm of Mercury line hyperfine splitting due to the Zeeman effect

Content

Šajā darbā ir izklāstīti rezultāti, kas iegūti, pētot supersīkstrūktūras sašķelšanos [1] dzīvsudraba emisijas spektrāllīniju gadījumā magnētiskajā laukā pielietojumam Zēmana atomu absorbcijas spektrometrā. Darbā pētīta dzīvsudraba rezonanses līnijas 253,7 nm (atomu enerģijas līmenis $_1S^0$-> $_3P^1$) sašķelšanās atkarībā no magnētiskā lauka intensitātes.

Šī izpēte tika veikta, izmantojot augstfrekvences bezelektrodu izlādes lampas (ABL) kā gaismas avotus. ABL tika uzpildītas ar dabīgo dzīvsudraba izotopu maisījumu.

Ir zināms, ka [2] dzīvsudraba dabisko izotopu maisījumā ir septiņi stabili izotopi, tostarp pieci bozoni: ^{196}Hg (0.15%), ^{198}Hg(9.97%), ^{200}Hg (23.1%), ^{202}Hg (29.86%), ^{204}Hg (6.87%) un divi fermioni: ^{199}Hg (16.87%: ^{199A}Hg -5,62% un ^{199B}Hg -11,25%, ^{201}Hg (13.18%: ^{201a}Hg -6,59%, ^{201b}Hg -4,39%, ^{201c}Hg- 2,2%).

Dzīvsudraba 253,7 nm spektra mērījumi tika veikti izmantojot Furjē transformācijas spektrometru istabas temperatūrā. Iegūtie spektrāllīnijas profili tika aprakstīti ar Fredholma pirmās kārtas integrāla vienādojuma palīdzību [3] un atdalīti no instrumentālās funkcijas, risinot nekorektu ap- griezto problēmu ar metodi, kas balstīta uz Tihonova regularizācijas principu.

Dzīvsudraba izotopu enerģijas līmeņu nobīde Zēmana efekta dēļ un magnēta dipola enerģijas atkarība no magnēta lauka tika iegūtas kā fermionu, tā arī bozonu gadījumā.

Pateicības: Pētījumu atbalstīja LU ASI

The present paper reports the results of our investigation of hyperfine splitting due to the Zeeman effect [1] in the case of natural Mercury for its application in Zeeman atomic absorption spectrometry. The emission resonance line of mercury 253.7nm (the atomic energy level of interest $^1S_0$ -> $^3P_1$) was studied. This investigation was made by using electrodeless discharge lamps as light sources. The lamps contained the natural isotope mixture of Mercury.

The natural isotope mixture of mercury has seven stable isotopes, including five bosons: ^{196}Hg (0.15%), ^{198}Hg (9.97%), ^{200}Hg (23.1%), ^{202}Hg (29.86%), ^{204}Hg (6.87%) and two fermions: ^{199}Hg (16.87%: ^{199A}Hg - 5,62% and ^{199B}Hg -11,25%, ^{201}Hg (13.18%: ^{201a}Hg -6,59%, ^{201b}Hg -4,39%, ^{201c}Hg - 2,2%) [2].

The mercury 253,7nm spectra were measured using a Fourier transform spectrometer at room temperature. Obtained profiles were presented in the form of Fredholm integral equation of the first kind [3] and separated from an instrumental function using a method based on Tikhonov regularisation to solve the ill–posed inverse problem.

The shift of energy levels of Mercury isotopes due to the Zeeman effect and the dependence of energy of magnet dipole on the magnet field was obtained in the case of fermions and of bosons as well.

Acknowledgments: The research was supported by UL IAPS.

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Primary author: Dr ZORINA, Natalja (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Dr RĒVALDE, Gita (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr SKUDRA, Atis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Dr ZORINA, Natalja (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **ZORINA, Natalja** on **Monday, January 15, 2024**

Abstract ID: **3**

Latvijas Universitāte *Times Higher Education World University* reitingos
University of Latvia in the Times Higher Education World University Rankings

Content

Times Higher Education (THE) World University Rankings [1] publicē augstskolu reitingus kopš 2004.gada. Latvijas Universitāte (LU), kā pirmā no Latvijas, tajos sāka piedalīties 2016.gadā, ierindojoties dalītā 601.-800.vietā (no 800 dalībniekiem). 2023.gadā LU bija dalītā 801.-1000.vietā (no 1800 dalībniekiem). 2024.gada izlaidumā daļa Baltijas augstskolu (Tartu universitāte, Latvijas Universitāte, Rīgas Stradiņa universitāte) piedzīvoja kritumu reitingā; turpretim Rīgas Tehniskā universitāte pakāpās. Jāatzīmē, ka reitinga pirmajā desmitā ietilpstošās augstskolas nav mainījušās, ir tikai mazliet izmainījusies to secība – ilgstoši labākā ir Oksfordas universitāte.

2024.gada izlaidums atspoguļo sasniegumus 2021.gadā. Atšķirībā no iepriekšējiem izlaidumiem, ir mainīta metodoloģija [2], liekot lielāku uzsvaru uz pētījumu kvalitāti. LU augstākais sasniegums 2024.gadā ir sadaļā 'Pētniecības vide / *Research environment*' – dalīta 537.vieta (no 1906).

Tabula 1. 2023.gada un 2024.gada vērtēšanas kritēriju salīdzinājums

Teaching 29.5% **Teaching 30%**	Teaching Reputation	15%	15%
	Student Staff Ratio	4.5%	4,5%
	Doctorate Bachelor Ratio	2%	2,25%
	Doctorate Staff Ratio	5.5%	6%
	Institutional Income	2.5%	2,25%
Research environment 29% **Research 30%**	Research Reputation	18%	18%
	Research Income	5.5%	6%
	Research Productivity	5.5%	6%
Research quality 30% **Citations 30%**	Citation Impact	15%	[1]
	Research Strength	5%	[1]
	Research Excellence	5%	[1]
	Research Influence	5%	30%
International outlook 7.5% **International outlook 7.5%**	International Students	2.5%	2,5%
	International Staff	2.5%	2,5%
	International Co-Authorship	2.5%	2,5%
	Studying Abroad (Exchange)		0
Industry 4% **Industry Income 2,5%**	Industry Income	2%	2,5%
	Patents	2%	[1]
			100%

Avots: [https://www.timeshighereducation.com/world-university-rankings

THE atsevišķi publicē arī universitāšu reitingus 11 atsevišķiem priekšmetiem - *World University Rankings by subject* [3]. Priekšmetiem tiek piemēroti individuāli kalibrēti ietekmes koeficienti, lai varētu tos līdzvērtīgi salīdzināt. Diemžēl, par fiziku atsevišķi datus no publiskajiem rezultātiem iegūt nevar, jo dabas zinātnēs (*Physical sciences*) aptver plašu lauku. Saskaņā ar THE datiem, fizika un astronomija Latvijā ir pārstāvēta Latvijas universitātē (601.-800.vieta no 1370 dabaszinātnēs kopēji), Igaunijā – Tartu universitātē (401.-500.vieta) un Tallinas Tehnoloģiju universitātē (601.-800.), Lietuvā – Viņas universitātē (801.-1000.), Kauņas Tehnoloģiju universitātē un Viļņas Ģedimina tehniskā universitātē (abas 1001+). Pasaulē labākās augstskolas dabzinātņu laukā ir Kalifornijas Tehnoloģiju institūts (Pasadena), Harvardas universitāte un Stenfordas universitāte.

Rezultāti nav objektīvi salīdzināmi ar iepriekšējo gadu rādītājiem jaunās reitinga metodoloģijas dēļ, galvenokārt nozīmīgāko zinātnisko publikāciju datubāzes SCOPUS citēto autoru indeksācija. Reitinga rezultātus katrā no zinātņu nozarēm veido studiju (mācību vides), pētniecības (apjoma, ienākumu un reputācijas), zinātnisko publikāciju citēšanas biežuma (pētniecības ietekmes savā nozarē), starptautiskās sadarbības (personāla, studentu un pētniecības) un ienākumu no sadarbības ar uzņēmumiem (inovāciju)

invertējums. Katrai zinātņu nozarei šo kritēriju nozīmīguma attiecības ir atšķirīgas.
Tematiski šaurāk pa priekšmetiem augstskolas vērtē QS *World University Rankings by Subject* [4]. Dabaszinātnēs (*Natural Sciences*) atsevišķi pieejami dati par fiziku un astronomiju. Saskaņā ar QS datiem, Latvijas augstskolās nav iekļuvušas starp vērtētajām dabaszinātnēs, t.sk. fizikā un astronomijā. Igaunijā Tartu universitāte fizikā un astronomijā ir 401.-450.vietā (no 621), Lietuvā – Viņas universitāte 351.-400. Pasaulē labākās fizikā un astronomijā ir Masačūsetsas Tehnoloģiju institūts, Harvardas universitāte un Oksfordas universitāte.

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3. World University Rankings by subject - https://www.timeshighereducation.com/world-university-rankings/by-subject (lapa skatīta 10.01.2024.)
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Primary author: BĒRZIŅA, Dina (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: BĒRZIŅA, Dina (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **BĒRZIŅA, Dina** on **Thursday, January 4, 2024**

Abstract ID: **5**

Zēmana atomu absorbcijas spektrometra izmantošana dzīvsudraba noteikšanai melnajos stārķos
Use of Zeeman AAS form mercury determination in black storks

Content

Melnie stārķi (*Ciconia nigra*) ir Austrumeiropā, tai skaitā, Latvijā, ligzdojoši gājputni. Ligzdojošo stārķu pāru skaits Baltijas reģionā sarūk, tādēļ melnie stārķi Latvijā uzskatāmi par aizsargājamu putnu sugu. Stārķi ir piemēroti kā bioindikatori dzīvsudraba noteikšanai, jo līdzīgi kā ūdensputni, tie uzturā pārsvarā patērē zivis. Zivīs dzīvsudrabs pārsvarā sastopams metildzīvsudraba formā. Metildzīvsudrabs veidojas ūdens vidē un bioakumulējas barības ķēdē, tādējādi nelielas Hg koncentrācijas vidē var rezultēties augstās Hg koncentrācijās organismos, kas atrodas augstāk barības ķēdē, piemēram, putnos.
Šī darba ietvaros pētīts dzīvsudraba piesārņojums Latvijā, izmantojot melno stārķu olu čaumalas, membrānas un fēces. Mērījumi veikti, izmantojot Zēmana atomu absorbcijas spektrometru Lumex RA-915M, kas papildināts ar krāsni paraugu termiskai sagraušanai.
Kopumā izmērīti vairāki simti paraugu. Vidējā koncentrācija fēcēs ir aptuveni 100 ng/g, ar nelielām atšķirībām atkarībā no ligzdas atrašanās vietas un putnu vecuma (cāļi vai pieaugušie). Olu čau- malās dzīvsudraba koncentrācijas ir robežās no 2 līdz 100 ng/g.

Primary authors: BRIKE, Zanda; Dr RĒVALDE, Gita; RIMŠA, Antonija; Dr SKUDRA, Atis; Dr STRAZDS, Maris; Dr VEILANDE, Rita; Dr ĀBOLA, Anda

Presenter: Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy)

Status: ACCEPTED

Submitted by **ĀBOLA, Anda** on **Tuesday, January 9, 2024**

Abstract ID: **6**

Pašmodulācija arsēna augstfrekvences bezelektrodu lampās
Self-modulation in arsenic high-frequency electrodeless lamps

Content

Noteiktu pildījumu augstfrekvences bezelektrodu lampās iespējams novērot divus darbības režīmus - stabilu, kad lampas starojuma intensitāte nemainās vai mainās neievērojami, un pašmodulējošu, kad starojuma intensitāte laikā periodiski mainās - pieaug un samazinās.
Šī darba ietvaros tika pētītas arsēnu saturošas augstfrekvences bezelektrodu lampas, kam noteiktos apstākļos ir novērojama pašmodulācija.
Pašmodulācijas pētījumiem tika izmantotas arsēna 189,0 nm, 193,8 nm un 197,3 nm rezonanses līnijas. Spektri uzņemti ar *Jobin Yvon* spektrometru. Lampu ierosmei izmantots ģenerators ar frekvenci 100 MHz, ģeneratora darba spriegums izvēlēts no 23V līdz 29V.
Pašmodulācijas norise saistāma ar lampā notiekošajiem procesiem. Iegūtie spektri parāda, kā mainās arsēna un argona starojuma intensitātes. Tāpat novērots, ka paaugstinot ierosmes ģeneratora spriegumu, pašmodulācijas periods saīsinās eksponenciāli.

Primary authors: Dr RĒVALDE, Gita; Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **ĀBOLA, Anda** on **Tuesday, January 9, 2024**

Abstract ID: **8**

Fragmentation of tyrosine by high-energy electron impact

Content

The experimental mass spectra of the amino acid tyrosine molecule were measured at different microtron accelerator-induced high-energy electron irradiation doses, i.e., 0, 5, and 20 kGy, and have been identified and analysed [1]. Along with the experimental investigation, we have carried out numerical calculations based on the Becke's three-parameter hybrid density functional approach with non-local correlation by Lee, Yang, and Parr (B3LYP) [2]. Our calculations were performed utilizing the cc-pVTZ basis set, as well as a modified cc-pVTZ basis set, in which we introduced correction coefficients into the wave-functions of the s− and p− orbitals. The correction coefficients were implemented via the Anisotropic Gaussian type orbital method to reflect the elongation of electron orbitals and densities caused by the magnetic field of radiation, similarly to our previous work [3].

The results of our investigation show that the geometrical structure of the molecule could be changed due to the presence of the electric field, and the molecule could decompose in an electric field with strength higher than 0.31 a.u. We also found that the electromagnetic radiation field is capable of facilitating the intramolecular hydrogen migration, quenching at the same time some fragmentation processes in the tyrosine molecule. The inclusion of the influence of the magnetic radiation field in our numerical studies showed the possibility for further decomposition of the fragments, thus indicating that magnetic field effects are crucial for the intramolecular hydrogen migration and/or electron transfer processes.

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Primary author: Dr KIROVA, Teodora (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Prof. ROMANOVA, Liudmila (Institute of Electron Physics, National Academy of Sciences of Ukraine); Prof. SNEGURSKY, Alexander (3Institute of Electron Physics, National Academy of Sciences of Ukraine); Prof. TAMULIENE, Jelena (Institute of Theoretical Physics and Astronomy, Vilnius University); Dr VUKSTICH, Vasyl (Institute of Electron Physics, National Academy of Sciences of Ukraine)

Presenter: Dr KIROVA, Teodora (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **KIROVA, Teodora** on **Tuesday, January 16, 2024**

Abstract ID: **9**

Towards WGM resonator laser doped with organic dye

Content

Whispering gallery mode (WGM) resonators confine light within a circular optical path using total internal reflection from the curved surface of the dense optical medium and ambient surroundings. A wide variety of geometries and materials can be used for WGM resonator fabrication, and they have extensive application prospects. The combination of high-quality factor (Q) and small mode volume helps to enhance the light-matter interactions, making them suitable to achieve low threshold and narrow linewidth lasers. Several strategies can be used to achieve lasing, for example, introducing dope organic gain material into the WGM resonator cavity. The flexible texture of organic WGM resonators makes them compatible with organic dyes. The material of the resonator cavity can be functionalized by embedding an active dye into solid-state host material. This way lasing with selective wavelength for novel applications could be realized. Potential organic dye material - an orange powder - para-phenylenediamine (pPD) was dissolved in DSMO then 50 µL of the solution was drop cast on a glass slide, which was placed on the hot plate to aid with solvent evaporation. The resulting thickness of the pPD coating was very uneven - between 100 and 300 nm. Next, the lasing properties of the pPD compound were investigated using a 355 nm laser. Stimulated emission peaks at different wavelengths were observed depending on the pPD compound coating thickness. Figure 1a shows photo-luminescence at 570nm. The slope of photo-luminescence at higher laser power was larger than at lower power (Fig 1b).

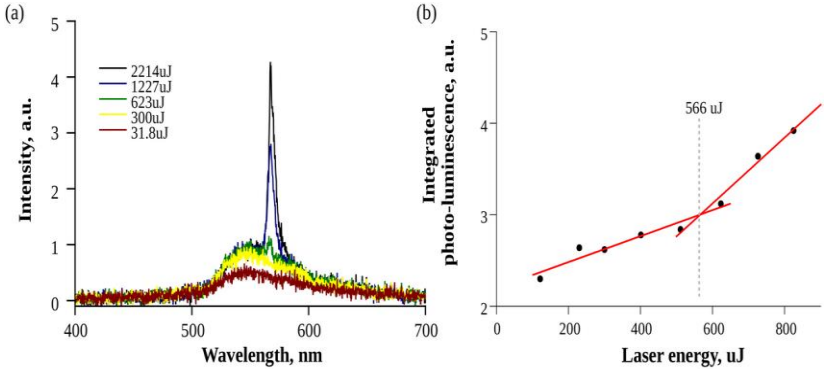

Figure 1. (a) Photo-lumiscence at 570 nm of pPD excited with 355 nm laser at different excitation energies and (b) critical energy at 566 µJ

Non-linear properties were investigated using Z-scan method, which is performed by translating the sample through a focused laser beam and measuring the transmitted power. Drop-casted pPD samples were challenging to measure due to the variation of thickness therefore liquid pPD solution inside 2 mm cell was used. The open aperture (OA) Z-scans obtained with 13, 22, and 32 µJ laser energy at 1064 nm 30 ps pulses show saturable absorption of the pPD solution and it increase with the increase of pulse energy as the transmittance of pPD sample increased when approaching the focal plane (Fig. 2a). The closed aperture (CA) Z-scans show positive sign of the nonlinear refractive index when exposed to 13 - 32 µJ of 1064 nm, 30 ps pulses (Fig. 2b).

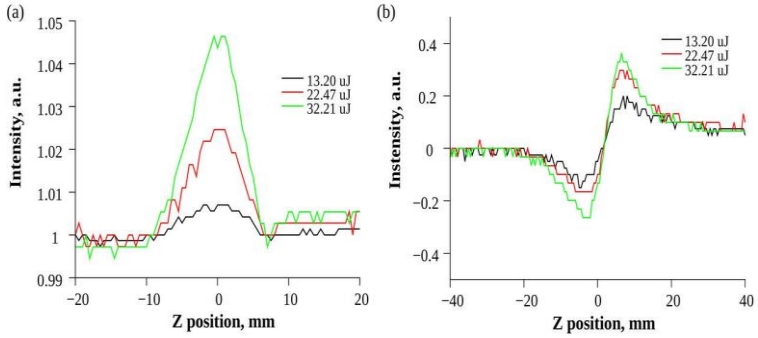

Figure 2. (a) OA Z-scans and (b) CA Z-scans of the pPD dissolved in DSMO measured at different energies of 1064 nm laser pulses

Orange powder pPD shows great potential as a dye to functionalize polymer for WGM resonator fabrication. It has demonstrated strong emission 570 nm and 620 nm when excited with 355 nm pulsed laser.

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Primary author: Dr BRICE, Inga (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Dr ALNIS, Jānis (Institute of Atomic Physics and Spectroscopy, University of Latvia); BARHUM, Hani (Department of Electrical Engineering, Tel Aviv University; Triangle Regional Research and Development Center); Dr GANEEV, Rashid A. (Institute of Fundamental and Applied Research, TIIAME National Research University; Department of Physics, Faculty of Physics and Chemistry, Chirchik State Pedagogical University); GINZBURG, Pavel (Department of Electrical Engineering, Tel Aviv University); KIM, Vyacheslav V. (Institute of Fundamental and Applied Research, TIIAME National Research University; Department of Physics, Faculty of Physics and Chemistry, Chirchik State Pedagogical University); MĪLGRĀVE, Lāse (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Dr BRICE, Inga (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **BRICE, Inga** on **Wednesday, January 24, 2024**

Abstract ID: **11**

RGB lāzera-šķiedras ierīce endoskopiskai spektrālās attēlošanas diagnostikai

Content

Endoskopijā diagnozes bieži nosaka, vadoties pēc iekšējo dobumu gļotādu krāsas izmaiņām un paļaujoties uz ārsta krāsu redzi un monitora ekrāna krāsu pārneses kvalitāti; reizēm abas var pievilt. Projekta ideja: endoskopiem ar digitālo krāsu kameru piedāvājam papildus aprīkojumu mērķa audu baltam apgaismojumam, kombinējot trīs lāzera spektrāllīnijas no zilā, zaļā un sarkanā spektra apgabala. Tas paver ārstam jaunu iespēju analizēt trīs šaurjoslas spektrālos attēlus, kas izdalīti no viena krāsu attēla datiem. Šādu attēlu apstrāde nodrošina objektīvāku endoskopisko diagnostiku, pateicoties labākai krāsu izšķirtspējai un iespējai kartēt gļotādas pigmentu sadalījumu.

Primary author: Prof SPĪGULIS, Jānis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: KRIEVIŅA, Agate Kristena (HEADLINE klīnika); Dr KVIESIS-KIPGE, Edgars (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr RUBINS, Uldis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Prof SPĪGULIS, Jānis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **SPIGULIS, Jānis** on **Thursday, January 25, 2024**

Abstract ID: **10**

Dermatoloģijas sistēma pilna ķermeņa spektrālai attēlošanai šķiedroptiskā apgaismojumā

Content

Dermatoloģijā aizvien populārāka kļūst ādas veidojumu kompleksa analīze, izmantojot vairākus no dažādām pusēm uzņemtus pacienta ķermeņa attēlus (*whole body imaging*). Komerciāli pieejamās iekārtas ir ļoti dārgas (~ 200 k$) un ar ierobežotu funkcionalitāti. Projekta ideja – izstrādāt un aprobēt lētāku un funkcionālāku prototipu, kas nodrošina gan krāsaino, gan arī spektrālo attēlu uzņemšanu, paverot iespēju papildus analizēt pigmentu sastāvu ādas veidojumos. Izveidots prototips ar 3 spektrāllīniju apgaismojumu, izmantojot Līvānos ražotu sānstarojošu optisko šķiedru.

Primary author: Prof SPĪGULIS, Jānis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Dr KVIESIS-KIPGE, Edgars (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr RUBINS, Uldis (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr SAKNĪTE, Inga (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: Prof SPĪGULIS, Jānis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **SPIGULIS, Jānis** on **Thursday, January 25, 2024**

Abstract ID: **12**

Azimuthal Dependence of Electromagnetically Induced Grating in a Double V-type Atomic System near a Plasmonic Nanostructure

Content

We present numerical studies of the performance of a 2D electromagnetically induced grating in a 4-level double V-type quantum system, situated near a plasmonic nanostucture (PN) 1. The PN con- sists of metal-coated dielectric nanospheres in a periodic 2D arrangement. The system is coupled by a weak probe laser, a spatially-dependent standing wave field and a Laguerre- Gaussian field. The plasmonic metamaterial creates quantum interference in the spontaneous emission from the two closely situated upper states 2, causing the amplitude and phase modulations of the probe light to be dependent on the azimuthal angle and the orbital angular momentum of the vortex beam. In the absence of the PN this behaviour is not observed due to the lack of quantum interference.

Our numerical calculations demonstrate that by adjusting the parameters of the vortex beam and the distance to the PN, the amplitude and phase modulations of the probe laser, as well as the Fraunhofer diffraction patterns of the grating can be controlled. Thus, the weak probe light energy can be directed to high-orders. The spatially dependent coupling light causes the Fraunhofer diffraction to have an asymmetric patterns, when a negative or a positive value of the winding number is applied.

Thus, our work demonstrates a simple scheme for double control over the diffraction efficiency of the 2D grating by utilising both the winding number of the vortex field and the distance between the PN and the quantum system as control knobs.

Such a scheme can be experimentally realized in hyperfine sublevels of D-lines in alkali-metal atoms, such as 85Rb or 87Rb [3], or using dual CdSe/ZnS/CdSe quantum dots [4].

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Primary author: Dr KIROVA, Teodora (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: PASPALAKIS, Emmanuel (Materials Science Department, University of Patras, Patras, Greece); HAMEDI, Hamid Reza (Institute of Theoretical Physics and Astronomy, Vilnius University); ASADPOUR, Seyyed Hosein (Institute for Research and Fundamental Sciences, Tehran, Iran); YANNOPA-PAS, Vassilios (National Technical University of Athens, Athens, Greece)

Presenter: Dr KIROVA, Teodora (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **KIROVA, Teodora** on **Monday, January 29, 2024**

Abstract ID: **13**

Jaunas metodes un iekārtas šķiedru apstrādei un dezinfekcijai, izmantojot auksto atmosfēras spiediena plazmu un UV starojumu

Content

Darbā pētīta aukstās plazmas un ultravioletās gaismas UV-C un UV-A starojuma iedarbība uz dažādiem patogēniem, tai skaitā baktērijām un RNS saturošiem vīrusiem. Pētījumos izmantoti specifiski UV-C gaismas avoti ar dažādu metālu tvaiku pildījumu, intensīva UV-A lampa un aukstas atmosfēras plazma (CAP). Konstatēts, ka alternatīvie gaismas avoti ar spektra līnijām zem 240 nm iznīcina *E.coli* baktērijas pie starojuma dozām no 5 līdz 19 mJ/cm^2.Lai panāktu līdzīgu iedarbību ar UV-A starojumu nepieciešamas daudzkārt lielākas dozas, jo darbojas cits inaktivācijas mehānisms.

The work investigates the effect of cold plasma and ultraviolet light UV-C and UV-A radiation on various pathogens, including bacteria and RNA-containing viruses. Specific UV-C light sources with different metal vapor filling, intense UV-A lamp and cold atmospheric plasma (CAP) are used in the research. It has been established that alternative light sources with spectrum lines below 240 nm destroy E.coli bacteria at radiation doses from 5 to 19 mJ/cm^2. To achieve a similar effect with UV-A radiation, many times higher doses are required, because of other inactivation mechanisms.

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Primary authors: Dr RĒVALDE, Gita (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr ZAJAKINA, Anna (Latvian Biomedical Research and Study Centre); Dr MARTINOVS, Andris (Rezekne Academy of Technologies); Dr SKUDRA, Atis (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr SPUNDE, Karina (Latvian Biomedical Research and Study Centre); Dr ĀBOLA, Anda Institute of Atomic Physics and Spectroscopy, University of Latvia); MARTINOVS JR, Andris (Rezekne Academy of Technologies); RUDĒVIČA, Žanna (Latvian Biomedical Research and Study Centre); KOĻČS, Guntis (Rezekne Academy of Technologies); GUDERMANIS, Rolands (Institute of Atomic Physics and Spectroscopy, University of Latvia); TRETJAKOVA, Rasma (Rezekne Academy of Technologies)

Presenter: Dr SKUDRA, Atis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **RĒVALDE, Gita** on **Wednesday, February 7, 2024**

Abstract ID: **15**

Processing of rare skin disease multispectral images

Content

In the European Union there are 6000 to 8000 diseases that qualify as rare – their prevalence is less than 1 in 2000 people. However, in total the affected population is 3.5-5.9% 1. This means that there is a number of diseases that lack adequate diagnostic and treatment options even though they can be associated with significant disability and early death. Some of these diseases, such as Neurofibromatosis Type 1 and Fabry disease are multi-organ diseases, however, they have characteristic cutaneous manifestations [2,3] which can be investigated with multispectral imaging methods for potential assessment.

The aim of this study was to analyse rare skin disease images using multi-parametric methods to find a method of distinguishing rare skin disease lesions from common skin lesions of similar appearance. Preliminary results have shown that Neurofibromatosis Type 1 lesions that appear in adolescence exhibit an increased diffuse reflectance signal under 526 nm illumination compared to more common types of lesions of similar characteristics. For Fabry disease, the difference in signal is more pronounced under 663 nm and 964 nm illumination.

The proposed method that utilizes multispectral imaging and a multi-parametric image processing could be used for a more in-depth analysis of systemic rare diseases with cutaneous manifestations.

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Primary author: PLORINA, Emilija V. (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: Dr BLIZNUKS, Dmitrijs (Riga Technical University, Institute of Smart Computing Technologies, Riga, Latvia); Dr KISS, Norbert (Department of Dermatology, Venerology and Dermatooncology, Semmelweis University, Budapest, Hungary); Dr LIHACHEV, Alexey (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr LIHACOVA, Ilze (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr LINOVA, Tatjana (4Health Centre 4, Dermatology Clinic, Riga, Latvia); Dr RUDZITIS, Ainars (Pauls Stradiņš Clinical University Hospital, Riga, Latvia); SAULUS, Kristina (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: PLORINA, Emilija V. (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **PLORINA, Emilija Vija** on **Wednesday, February 7, 2024**

Abstract ID: **16**

Mercury contamination in wild birds in Latvia

Content

We studied presence of mercury in eggshells and egg membranes of wild birds in Latvia, mainly focusing on the Black Storks (Ciconia nigra). For comparison, we measured mercury in egg remains of White Stork, European Roller, Grey Heron, Osprey, White-tailed Eagle, Eagle Owl, Lesser Spotted Eagle, Goshawk and Common Buzzard.

We used atomic absorption spectrometer with Zeeman correction LUMEX RA-915M and its attachment for pyrolytic analysis PYRO-915+ to detect the total mercury concentration in samples. Pyrolytic combustion allows direct measurements without specific pre-treatment procedures, diminishing possible sample contamination and providing almost instant results. Altogether 562 samples (collected mostly between 2003-2022) have been analysed.

The number of analysed samples for each bird species varies significantly, however, the differences between the species indicate possible sources of mercury contamination. The highest values were found in White-tailed Eagle and Eagle Owl, both top predators and in Black Stork and Grey Heron, while Osprey and land-feeding raptors had notably smaller concentrations. The less contaminated eggs were those of White Stork and European Roller.

As for the Black Stork, mercury levels did not provide any straightforward links to the survival of the chicks. However, all of the highest concentrations were associated with failed breeding. Apart from possible sources of mercury contamination, we shall discuss the fluctuation of mercury con- centration over time, as well as other aspects discovered during this study, such as thinning of eggshells and other possible factors that impact Black Stork breeding success.

Acknowledgements: The research was supported by the Latvia Council of Science Project No. lzp-2020/1-0005.

Primary authors: RIMŠA, Antonija; Dr STRAZDS, Maris; Dr ĀBOLA, Anda (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr VEILANDE, Rita (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: RIMŠA, Antonija

Status: ACCEPTED

Submitted by **RIMŠA, Antonija** on **Friday, February 9, 2024**

Abstract ID \: **17**

Study of morphological, spectral, and nonlinear optical characteristics of nanoparticles

Content

We report findings from a study whose results have been recently published [1]. The goal of the research was to synthesize gold and silver nanoparticle solutions with laser ablation method in different liquids – salt and sugar dissolved in water. We studied spectral characteristics of absorption, disappearance of surface plasmon resonance in solutions containing salt.

Nanoparticles were formed by laser ablation of metals, silver and gold, placed in cells containing liquid, it was performed using 30ps, 1064nm pulses at 50 Hz repetition rate. Laser pulses were focused on the surface of the target metal. The diameter of the laser beam was 0.3mm. The liquids used were distilled water, water + dissolved salt, water + dissolved sugar, solutions were created by dissolving 5g of sugar or 6.8g of salt in 25mL of distilled water. The cells were moved along the focal plane using an X-Y translating stage. During the ablation the plasma spectra was measured using a fibre spectrometer. Targets were ablated for 0.5 hours. Absorbance spectra of the obtained suspensions was measured using a fibre spectrometer.

We found that sugar and salt can either maintain the conditions of NP formation during laser ablation of metals by picosecond pulses or significantly change the process of the maintenance of the already synthesized species. We have demonstrated the disappearance of the SPRs of Ag and Au during their ablation in the salt-containing solutions.

Acknowledgements. We would like to express our sincere gratitude to R.A. Ganeev, V.V. Kim, A. Bundulis, A. Sarakovskis for help with research. Work was supported by Fundamental and Applied Research Project (Nr. lzp-2023/1-0199): “The Laser Photodetachment Spectroscopy on Negative Ions”, from Latvian Science Council and ERDF projects: No. 1.1.1.5/19/A/003: “Development of quantum optics and Photonics in University of Latvia”

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Primary author: KALNIŅŠ, Kalvis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: KALNIŅŠ, Kalvis (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **KALNIŅŠ, Kalvis** on **Friday, February 9, 2024**

Abstract ID: **18**

Formation of MXene Thin Films Suitable for the Detection of Pharmaceutical Metabolites by Surface Enhanced Raman Spectroscopy

Content

MXenes are the class of 2D nanomaterials with unique electrical and optical properties discovered in 2011 by Yury Gogotsi and his research group 1. Since then, the interest in applying these nanostructures has been in high demand. To date, it is reported that MXenes have found applications in many areas, such as energy storage, photocatalysis, water purification, sensors, biosensors, electrochromic devices, and triboelectric nanogenerators [2,3].

In this study, the MXenes thin film substrates were prepared using the drop-casting method. It was discovered that these thin films are suitable for application in surface enhanced Raman spectroscopy (SERS). After a series of tests, sensitivity to salicylic acid, which is a metabolite of pharmaceutical acetylsalicylic acid, also known as Aspirin, was detected. The detection mechanism is predicted to be related to the chemical bonding between the –COOH group of salicylic acid and Ti from the MXenes structure.

This project has received funding from the Research Council of Lithuania (LMTLT), agreement No S-PD-22-155.

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Primary author: Dr RAMANAVICIUS, Simonas (Department of Organic Chemistry, State Research Institute Center for Physical Sciences and Technology (FTMC))

Co-authors: Dr POPOV, Anton (NanoTechnas-Center of Nanotechnology and Materials Science, Faculty of Chemistry and Geosciences, Vilnius University); Prof. RAMANAVICIUS, Arunas (Department of Physical Chemistry, Faculty of Chemistry and Geosciences, Institute of Chemistry, Vilnius University); Prof. NIAURA, Gediminas (Department of Organic Chemistry, State Research Institute Center for Physical Sciences and Technology (FTMC)); Dr TALAIKIS, Martynas (Department of Organic Chemistry, State Research Institute Center for Physical Sciences and Technology (FTMC)); Dr GOGOTSI, Oleksiy (Materials Research Center Ltd.); ADOMAVICIUTE-GRABUSOVE, Sonata (Institute of Chemical Physics, Vilnius University); Prof. SABLINSKAS, Valdas (Institute of Chemical Physics, Vilnius University); Prof. GOGOTSI, Yury (A.J. Drexel Nanomaterials Institute, Department of Materials Science and Engineering, Drexel)

Presenter: Dr RAMANAVICIUS, Simonas (Department of Organic Chemistry, State Research Institute Center for Physical Sciences and Technology (FTMC))

Status: ACCEPTED

Submitted by **RAMANAVICIUS, Simonas** on **Monday, February 12, 2024**

Abstract ID: **19**

III-V Nanowire based optical neural network implementation using geometry induced weights

Content

Optical signals offer advantages in terms of speed and power consumption for connectivity in neural networks. However, to implement different communication weights between the neural nodes, without a large network footprint, is a challenge. In this study, we investigate the use of III-V semiconductor nanowire components as neural nodes in a single quasi 2D waveguide using a broadcasting scheme to achieve weighted light signals between the nodes. The strength of connections between emitting and receiving nanowires then depends on their placement, orientation, and angular light absorption and emission patterns. Through detailed simulations, we determine the connection strength based on angular rotation and radial separation between the nanowires. Our findings reveal a complex distribution, indicating that specific patterns of nanowire placement on a surface can achieve complex and highly variable connectivity in neural networks. To demonstrate applicability, we implement a reservoir network using a hexagonal pattern of nanowires with random angular orientations, showcasing its ability to perform tasks such as time series prediction and function generation.

Primary authors: DRAGUNS, Kristians (Institute of Atomic Physics and Spectroscopy, University of Latvia); Dr FLODGREN, Vidar; Prof. MIKKELSEN, Anders; Dr WINGE, David

Presenter: DRAGUNS, Kristians (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **DRAGUNS, Kristians** on **Tuesday, February 13, 2024**

Workshop
Nanomaterials for biomedical applications

https://conferences.lu.lv/e/413

Programme

Chair: Dr. Maksym Pogorielov

9.00–9.20	***Anastasia Konieva***, Sumy State University, Sumy, Ukraine; Department of Anatomy, University Clinic Essen, Essen, Germany	MXene-PDA-anti-CEACAM1 complex as a new agent for targeted melanoma treatment
9.20–9.40	***Volodymyr Deineka***, University of Latvia, Latvia	2D nanosheets of niobium carbide (Nb_4C_3) as a universal photosynthesizer
9.40–10.00	***Linda Giro***, Department of Biomedical Sciences, University of Padua, Italy	An alternative immune cell labeling system based on the new two-dimensional nanomaterials MXenes
10.00–10.20	***Valeriia Korniienko***, Biomedical Research Center, Sumy State University, Ukraine	MXene-based photothermal therapies for antibacterial applications
10.20–11.00	Coffee break, discussions	

Chair: Dr. Viktoriia Korniienko

11.00–11.20	**Kateryna Diedkova**, University of Latvia, Latvia	New MXene-containing electroconductive polymer scaffolds for tissue engineering
11.20–11.40	***Anna Butsyk***, Sumy State University, Ukraine	Copper nanoparticles (CuNPs) and their application in biomedicine
11.40–12.00	***Yevheniia Husak***, Silesian University of Technology, Poland; Sumy State University, Ukraine	Silicates and phosphates anions cooperation during PEO of magnesium implants
12.00–12.20	***Anna Yanovska***, Sumy State University, Ukraine	Gold modified ZnO nanoparticles for biomedical application
12.20–13.00	Conclusions, discussions	

This Workshop supported by Horizon Europe MSCA-SE projects:
MX-MAP (101086184), **ESCULAPE** (101131147) and **ARGO** (101086441)

Abstract ID: **7**

MXene-PDA-anti-CEACAM1 complex as a new agent for targeted melanoma treatment

Content

Background. Melanoma is considered one of the most malignant and difficult to cure cancer. Despite the variety of treatments available for melanoma, unfortunately, more than 50 % of patients do not respond to these treatment options. Thus, the search for new methods of treating melanoma is a pressing issue. One promising method considered is photothermal therapy (PTT). In our study, we use MXenes (Ti3C2Tx), a novel class of 2D nanomaterials, as optical absorbing agents for PTT. To ensure the attachment of nanoparticles to melanoma cells, we developed an MXene-anti-CEACAM1 complex. Anti-CEACAM1 monoclonal antibody clone B3-17 (mAb) exhibits specificity for CEACAM1 that is expressed on the surface of melanoma cells and is absent in normal melanocytes. The combination of MXenes and the anti-CEACAM1 mAb emerges as a promising platform for developing an innovative model of targeted treatment for melanoma.

Methods. Delaminated Ti3C2 MXenes in aqueous dispersion were used to prepare the MXene-anti-CEACAM1 complex for PTT. The polydopamine (PDA) modification of MXene surface provided before the anti-CEACAM1 mAb binding. The affinity (flow cytometry, bright field microscopy, IC50), specificity and cross-reactivity (flow cytometry, ELISA) of the MXene-PDA-anti-CEACAM1 complex were analysed.

Results. Flow cytometry and ELISA assays demonstrate high affinity and specificity with MaMel8bIV melanoma cells, while the MXene-PDA-anti-CEACAM1 complex does not bind to CEACAM3, CEACAM5, CEACAM6 and CEACAM8 transfected cells. Furthermore, there is no difference be- tween the affinity and specificity of the MXene-PDA-antiCEACAM1 complex and the anti-CEACAM1 mAb. Thus, binding to MXenes does not affect the properties of the anti-CEACAM1 mAb.

Conclusion. Our preliminary results demonstrate that MXene-PDA-anti-CEACAM1 complex holds promise for the development of a new model of targeted melanoma treatment.

Acknowledgements. This research received support from the Horizon Europe Framework Pro- gramme (HORIZON) Call: MSCA Staff Exchanges 2021 (HORIZON-MSCA-2021-SE-01).

Primary author: KONIEVA, Anastasia (Sumy State University, Sumy, Ukraine; Department of Anatomy, University Clinic Essen, Essen, Germany)

Co-authors: WENNEMUTH, Gunther (Department of Anatomy, University Clinic Essen, Essen, Germany); POGORIELOV, Maksym (Institute of Atomic Physics and Spectroscopy, University of Latvia; Sumy State University, Sumy, Ukraine); IATSUNSKYI, Igor (NanoCarbonTech, Poznan, Poland, NanoBioMedical Centre, Adam Mickiewicz University, Poznan, Poland); KUBE-GOLOVIN, Irina (Department of Anatomy, University Clinic Essen, Essen, Germany); GOGOTSI, Oleksiy (Materials Research Centre, Kyiv, Ukraine)

Presenter: Ms KONIEVA, Anastasia (Sumy State University, Sumy, Ukraine; Department of Anatomy, University Clinic Essen, Essen, Germany)

Status: ACCEPTED

Submitted by **KONIEVA, Anastasia** on **Friday, February 9, 2024**

Abstract ID: **8**

2D Nanosheets of Niobium Carbide (Nb_4C_3) as a Universal Photosynthesizer for Photothermal Therapy

Content

Cancer remains one of the leading causes of death worldwide, necessitating the development of more effective and less invasive treatment modalities. Traditional cancer treatments, such as chemotherapy and radiation, often come with severe side effects and can harm healthy tissues, highlighting the need for targeted therapies. Photothermal therapy (PTT) using MXene nanoparticles represents a cutting-edge approach that precisely targets cancerous cells while minimizing damage to surrounding healthy tissues. MXenes, as a class of two-dimensional nanomaterials, exhibit exceptional optical and thermal properties, making them ideal candidates for photothermal cancer therapy. The ability of MXene nanoparticles to convert near-infrared light into heat can be harnessed to ablate tumour cells with minimal invasiveness effectively. Unlike traditional therapies, PTT with MXenes can be precisely controlled by adjusting the intensity and duration of the near-infrared light, offering a customizable approach to cancer treatment. The high surface area of MXene nanoparticles facilitates the loading of therapeutic agents, enabling combined pho- tothermal and drug therapy for a synergistic effect against cancer cells. MXene-based PTT can significantly reduce the likelihood of cancer recurrence and metastasis by ensuring the thorough eradication of tumor cells. The localized nature of MXene-mediated PTT minimizes systemic side effects, improving the quality of life for patients undergoing cancer treatment.

Since the most popular titanium carbide MXenes have moderate toxicity, our work aimed to investigate the biocompatibility and cytotoxicity of MXenes with niobium carbide (Nb4C3) as a photo- sensitizer for PPT.

The results of our studies demonstrated that niobium carbide is non-toxic for both tumour and primary cells, even at extremely high concentrations (100 μg/ml). Incubation of cells with nanosheets of Nb4C3 for 24 hours demonstrated a negligible number of apoptotic cells, almost the same as un- treated cells. Even though the maximum absorption spectrum of Nb4C3 is in the range of 1000 - 1100 nm, which corresponds to biological window II. Our data demonstrate the versatility of this type of MXenes, the photothermal effect of which was observed at a laser wavelength of 808 nm. This makes it promising to use universal 2D Nb4C3 nanosheets as a photosensitizer for PTT using NIR I and NIR II lasers.

The lack of toxicity at the level of cell cultures and efficient photothermal transition make further research on Nb4C3 nanosheets promising.

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Primary author: Dr DEINEKA, Volodymyr (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: DIEDKOVA, Kateryna (Institute of Atomic Physics and Spectroscopy, University of Latvia); GOGOTSI, Oleksiy (Materials Research Centre, Ukraine); KONIEVA, Anastasia (Sumy State University); ZAHORODNA, Veronika (Materials Research Centre, Ukraine)

Presenter: Dr DEINEKA, Volodymyr (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **DEINEKA, Volodymyr** on **Monday, February 12, 2024**

Abstract ID: **5**

An Alternative Immune Cell Labelling System Based on the New Two-Dimensional Nanomaterials MXenes

Content

Deepening our understanding of immune cell behaviour is vital for creating safe, effective treatments, particularly as immune cell therapy, also known as cellular immunotherapy or cell-based immunotherapy, represents a groundbreaking approach in the treatment of various diseases, including cancer. Transition metal carbides and nitrides (MXenes),1 a novel family of 2D nano- materials, show promise as advanced trackers for immune cells – key for precise diagnostics and therapies. 2-4 Traditional cell labelling methods have stagnated due to limited chemical options, impeding progress in applied medicine. Moreover, these methods are incompatible with single-cell mass cytometry by time-of-flight (CyTOF), a globally adopted technology that improves classical flow cytometry. We propose an innovative solution utilizing MXenes to overcome these challenges. Our method, Label-free sINgle-cell tracKing of 2D matErials by mass cytometry (LINKED), leverages a novel, biocompatible, multiplexed, label-free detection approach via CyTOF and Mass Ion Beam Imaging by Time-of-Flight (MIBI-TOF). 2 This technique overcomes chemical limitations and integrates seamlessly with CyTOF, allowing for nanomaterial detection and simultaneous measurement of diverse immune cell and tissue features. Our work promises to advance immunological research significantly, offering refined cell labelling and tracking techniques crucial for the advancement of translational medicine.

Primary author: GIRO, Linda (Department of Biomedical Sciences, University of Padua, Italy)

Co-authors: BENJAMIN, Chacon Benjamin (A. J. Drexel Nanomaterials Institute and Department of Materials Science and Engineering, Drexel University, Philadelphia, PA, United States); Ms DELOGU, Lucia Gemma (Department of Biomedical Sciences, University of Padua, Italy); FUSCO, Laura (Department of Biomedical Sciences, University of Padua, Italy); Ms GAZZI, Arianna (Department of Biomedical Sciences, University of Padua, Italy); GOGOTSI, Yury (A. J. Drexel Nanomaterials Institute and Department of Materials Science and Engineering, Drexel University, Philadelphia, PA, United States); LEY, Klaus (Augusta University, Immunology Center of Georgia, Georgia, United States); ORECCHIONI, Marco (Augusta University, Immunology Center of Georgia, Georgia, United States); SHUCK, Christopher Eugene (A. J. Drexel Nanomaterials Institute and Department of Materials Science and Engineering, Drexel University, Philadelphia, PA, United States)

Presenter: GIRO, Linda (Department of Biomedical Sciences, University of Padua, Italy)

Status: ACCEPTED

Submitted by **GIRO, Linda** on **Thursday, February 8, 2024**

Abstract ID: **1**

MXene-Based Photothermal Therapies for Antibacterial Applications

Content

Nanomaterials, particularly two-dimensional (2D) variants, have garnered attention for their inherent antibacterial properties, holding promise across various sectors. This study investigates the antimicrobial efficacy of 2D nanomaterials, focusing on their potential as alternatives to conventional antibiotics. Leveraging recent advancements, we explore the application of photothermal therapy (PTT) using MXene, a type of 2D nanomaterial, as a strategy for antibiotic-free bacterial treatment. Our experimental findings reveal MXene's remarkable antibacterial performance under near-infrared (NIR) light irradiation, showcasing its potential for combating drug-resistant bacterial infections. Through a comprehensive analysis of the antibacterial efficacy and optimization strategies, this study underscores MXene's role as a promising platform for photothermal antibacterial therapy based on the time-dependent approach of irradiation as well as the post-treatment period. Ti3C2Tx MXene depicted antibacterial capacity (with bacterial reduction exceeding 99.99%) against E. coli under continuous mode laser treatment at 4 W-10 Hz for 10 and 15 minutes. How- ever, further research is warranted to delineate optimal PTT protocols, considering factors such as laser parameters and bacterial concentrations, to maximize bactericidal efficacy.

Primary authors: Dr POGORIELOV, Maksym (Institute of Atomic Physics and Spectroscopy, University of Latvia; Sumy State University, Sumy, Ukraine); GOGOTSI, Oleksiy; HAIDAMAK, Olena; KORNIIENKO, Valeriia (Biomedical Research Center, Sumy State University, Ukraine); ZAHORODNA, Veronika; KORNIIENKO, Viktoriia (Institute of Atomic Physics and Spectroscopy, University of Latvia; Sumy State University); VARAVA, Yuliia (Biomedical Research Center, Sumy State University, R.-Korsakova, 2, 40007, Sumy, Ukraine)

Presenter: Dr KORNIIENKO, Valeriia (Biomedical Research Center, Sumy State University, Ukraine)

Status: ACCEPTED

Submitted by **KORNIIENKO, Viktoriia** on **Tuesday, February 6, 2024**

Abstract ID: **2**

New MXene-containing electroconductive polymer scaffolds for tissue engineering

Content

Tissue engineering (TE) is promising as a regenerative therapy for tissue and organ injuries, functional reduction, and loss. The TE method incorporates cells, biomolecules, and biological scaffolds, subsequently implanting this intricate combination into injured tissues or organs within the body to facilitate the repair of damage and restoration of function. The main impetus for integrating conductive nanomaterials into tissue engineering is to create biomimetic scaffolds that replicate the electrical characteristics of the native extracellular matrix. This aspect is often neglected in many existing tissue-engineered materials. In the realm of TE, the anticipation is that a TE device should not only foster tissue regeneration but also undergo degradation, ideally in synchrony. Central to this concept is carefully considering the materials utilized and their degradation kinetics. Among the synthetic polymers widely embraced in TE, polycaprolactone (PCL) stands out, cherished for its blend of biocompatibility, structural robustness, and commendable mechanical attributes, all harmonized with inherent biodegradability. Yet, owing to the semi-crystalline and hydrophobic traits inherent in PCL, its gradual degradation pace (spanning 2–4 years) poses a limitation for the regeneration of conductive tissues. Hydrophilic surface functionalization strategy with oxygen plasma provides a layer-by-layer assembly of MXene on electrospun PCL nanofibrous membranes. The research aimed to determine the physicochemical and biological properties of novel MXene- containing electrically conductive PCL membranes.

Overall, results show that additional treatment of the electrospun membranes with oxygen plasma imparted hydrophilicity and accelerated scaffold degradation. FTIR analysis identified characteristic functional groups for PCL membranes and demonstrated the presence of functional bonds associated with their exposure to oxygen plasma treatment and the addition of MXenes on the surface of the samples. Irrespective of the multiple layers applied, the resazurin reduction assay unveiled a persistent cell proliferation trend when exposed to PCL membranes incorporating immobilized MXenes. Intriguingly, the MXene deposited on the electrospun PCL membrane demonstrated non- cytotoxic characteristics, hinting at their promising role in producing scaffolds tailored for diverse biomedical applications in tissue engineering.

Primary author: DIEDKOVA, Kateryna (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: BEBRE, Evelina; GOGOTSI, Oleksiy (Materials Research Centre, Ukraine); GREBŅEVS, Vladlens; YANKO, Ilya (Sumy State University); ZAHORODNA, Veronika (Materials Research Centre, Ukraine)

Presenter: DIEDKOVA, Kateryna (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **DIEDKOVA, Kateryna** on **Wednesday, February 7, 2024**

Abstract ID: **3**

Copper nanoparticles (CuNPs) and their application in biomedicine

Content

Nowadays, the scientific and technological community has been deeply looking into nanostructured materials due to their unique physicochemical properties and applications in various fields. Along with other metallic nanomaterials, copper nanoparticles (CuNPs) are a well-known mate- rial that has been used from ancient times to the present day. Copper nanoparticles have a wide range of applications in major fields of life sciences, biotechnology and have attracted attention in biomedicine due to their unique properties and potential applications.

Our work aims to summarize the latest data on copper nanoparticles, their properties, and their potential for use in biomedicine, perspective, and challenges.

There are almost nine thousand documents found in the Scopus database by the keywords "copper nanoparticles", although only 56 documents were found together with «biomedicine». Thus, CuNPs have been studied in various fields, whereas applications in biomedicine were less investigated and need to be more explored.

In biomedicine, CuNPs can be used as an alternative to antibiotic treatment due to their remarkable antimicrobial properties. Copper ions can penetrate bacterial cell membranes, terminate protein function, damage DNA, and produce reactive oxygen species (ROS). Research studies and clinical trials have provided support for the efficacy of copper in reducing the viability of bacteria, viruses, and other pathogens.

CuNPs have garnered significant interest in cancer therapy because they have inherent cytotoxic properties against cancer cells. Moreover, copper nanoparticles could be used as a delivery for anticancer drugs due to their size, which allows them to penetrate tumour tissue. Copper is a metal that can also be detected in the body with imaging techniques such as positron emission tomography (PET) to visualize tumours and monitor therapeutic efficacy.

CuNPs are very promising candidates in tissue engineering due to their biocompatibility. Incorporating CuNPs into scaffold materials could reduce the risk of post-implantation infections and enhance tissue regeneration.

Copper nanoparticles can be used in the production of biosensors, due to their ability to bind to antibodies, enzymes, or DNA. CuNPs can be incorporated with other nanomaterials (metal oxide, graphene, chitosan) to enhance the sensitivity of biosensors.

Compared to other metallic nanoparticles, copper nanoparticles have not been sufficiently studied from a biomedical perspective. The number of scientific publications on the biomedical applications of CuNPs has increased in the last decade, however, there are a lot of challenges that require additional research. Therefore, despite the great potential of CuNPs for use in the different fields of biomedicine, further research should be conducted to optimize their properties and study the effect on biological organisms and systems.

Primary authors: BUTSYK, Anna (Sumy State University); Dr MOSKALENKO, Roman (Sumy State University)

Presenter: BUTSYK, Anna (Sumy State University

Status: ACCEPTED

Submitted by **BUTSYK, Anna** on **Thursday, February 8, 2024**

Abstract ID: **4**

Silicates and phosphates anions cooperation during PEO of magnesium implants

Content

Magnesium holds significant promise as a material for temporary implants due to its bone-like properties. However, low corrosion resistance has challenges for their clinical use. Surface engineering, particularly through oxide ceramic layers, presents a viable solution to enhance wear and corrosion resistance, improving biocompatibility. Plasma electrolytic oxidation (PEO) was applied to modify pure magnesium samples using sodium silicate electrolytes with varying concentrations of phosphates. Surface analyses were performed by SEM, EDS, contact angle measurements, and profilometry. The results showed the impact of electrolyte composition and applied voltage on coating thickness, pore size, and elemental integration. The PEO coatings exhibited porous structures with diverse pore sizes influenced by electrolyte composition and voltage. Morphological analysis revealed a scaffold-like surface structure with spherical and irregularly shaped pores. Ele- mental analysis confirmed the uniform incorporation of silicon and phosphorus into the coatings. Anionic interaction plays a significant role in forming the oxide layer, critical for potential bio- implant applications. The research underscores PEO coatings' diverse thickness levels and quality, influenced by electrolyte composition and applied voltage. Coatings obtained by C2 250V electrolyte exhibited increased thickness, roughness, and uniform pore distribution. These coatings indicate the potential for bio-degradable magnesium alloys in biomedical contexts.

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Primary author: HUSAK, Yevheniia (Silesian University of Technology, Sumy State University)

Co-authors: KORNIIENKO, Viktoriia (Institute of Atomic Physics and Spectroscopy, University of Latvia); Prof. SIMKA, Wojciech (Silesian University of Technology); Ms SKOCZYLAS, Anna (Silesian University of Technology); Ms WALOSZCZYK, Natalia (Silesian University of Technology)

Presenter: HUSAK, Yevheniia (Silesian University of Technology, Sumy State University)

Status: ACCEPTED

Submitted by **HUSAK, Yevheniia** on **Thursday, February 8, 2024**

Abstract ID: **6**

Gold modified ZnO nanoparticles for biomedical application

Content

ZnO NPs with controlled morphology can find biomedical application due to their high surface- to-volume ratio, non-toxicity, high photosensitivity, efficient charge transport, chemical stability and high biocompatibility. ZnO nanostructures play important roles as the active sites where biological events occur, subsequently defining the sensitivity and stability of the electrochemical biosensors. 1D ZnO nanostructures provide a direct and stable pathway for rapid electron transport. At the same time, gold nanoparticles (NPs) are applied in various applications such as photovoltaic devices, sensors, photocatalysis, and biological labelling due to their extraordinary chemical, optical, and biological properties. They are relatively stable, catalytically active, water- soluble, optically sensitive, and biocompatible. The attachment of Au NPs to semiconductor ZnO nanorods or nanowires is a powerful approach for producing new chemically functionalized materials with improved photoelectrochemical activity. Our research mainly aimed to synthesize ZnO-Au nanohybrids for potential use as electrochemical imunosensors for L.Monocytogenes detection.

ZnO NRs were obtained by the sol-gel method. The Au NPs were deposited from HAuCl4 solutions directly onto ZnO NWs and ZnO NRs without adding any linking molecules.

Several types of ZnO-Au nanohybrid were produced at room temperature, by varying type of ZnO nanostructures, namely the Au NPs were photo-deposited from pre-irradiated HAuCl4–ethanol solution directly onto ZnO nanostructures dissolved in toluene solution due to reduction of HAuCl4 salt at the ZnO interface. It was provided under continuous UV irradiation under following parameters: UV diode 370 ± 10 nm, power 64 mW, intensity 35 mW/cm^2. It is concluded that the optimal time of photo-deposition will be 20 min.

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Primary author: YANOVSKA, Anna (Sumy State University)

Co-authors: Dr BABAYEVSKA, Nataliya (NanoBioMedical Centre, Adam Mickiewicz University, Poznan, Poland); Dr. POGORIELOV, Maksym (Institute of Atomic Physics and Spectroscopy, University of Latvia; Sumy State University, Sumy, Ukraine); Prof. YATSUNSKII, Igor (NanoBioMedical Centre, Adam Mickiewicz University, Poznan, Poland)

Presenter: YANOVSKA, Anna (Sumy State University)

Status: ACCEPTED

Submitted by **YANOVSKA, Anna** on **Thursday, February 8, 2024**

Workshop
Chemical sensors, nanomaterials, measurement methods and prototyping

https://conferences.lu.lv/e/414

Programme

Chair: Dr. Roman Viter		
14.00–14.05	Dr. ***Roman Viter***, Institute of Atomic Physics and Spectroscopy, University of Latvia	Opening of workshop
14.05–14.20	Ms. ***Iryna Yakymenko***, UkraVit, Ukraine	Recent situation with sensors in agriculture
14.20–14.40	Prof. ***George Kostakis***, University of Sussex	Chemical Chartographisis in biological related examples
14.40–14.55	Mr. ***Viktor Zabolotnii***, Institute of Atomic Physics and Spectroscopy, University of Latvia	New organic luminofors as organic sensor platforms
14.55–15.15	Dr. ***Michela Alfe***, CNR, Naples, Italy	MOF synthesis for sensor applications: tuning structure and functional properties
15.15–15.40	Coffee break, discussions	
Chair: Dr. Roman Viter		
15.40–16.00	***Rayane Zribi***, University of Messina, Italy	CNT/WS2 heterostructures for the effective electrochemical sensing of riboflavin (vitamin B6)
16.00–16.15	Ms. ***Iryna Tepliakova***, Institute of Atomic Physics and Spectroscopy, University of Latvia	Detection of metal ions by Schiff base like compounds by using optical absorbance and photoluminescence
16.15–16.35	Prof. ***Vincent Noel***, University Paris Cite, France	Inkjet Printed Organic transistors for biosensing applications
16.35–16.55	Dr. ***Mikael Syväjärvi***, Alminica AB, Sweden	Technology transfer: from idea to application
16.55–17.00	Conclusions, discussions	

This Workshop supported by Horizon Europe MSCA-SE project:
'**Novel optical nanocomposite sensors for analysis of micro and macro elements in corn plants**'
- SENS4CORN (101086364)

Abstract ID: **7**

Recent situation with sensors in agriculture

Content

Smart farming requires permanent monitoring of soil, water, fertilizers, seeds and plants. Standard research methods used by laboratories are accurate and reliable. However, these traditional analytical methods are not suitable for rapid on-site monitoring because sample pre-processing is complex and requires expensive equipment and highly skilled specialists. The solution of this problem could be a development and use of sensor devices.
Recently, a lot of laboratories worldwide work on sensors for agriculture purposes. Despite the big number published sensor papers, real transfer from a laboratory to a market is time consuming.The existing commercial sensors are not in a big number.
In this work, we present a short overview of the main commercial sensors used in agriculture. Comparison of the commercial sensor performance with traditional methods of analysis of agriculture probes was reviewed. The main advantages of industrial sensors and future prospects are discussed.

Primary author: YAKYMENKO, Iryna (Ukravit Science Park)

Co-author: Ms TROKHYMETS, Marharyta (Ukravit Science Park)

Presenter: YAKYMENKO, Iryna (Ukravit Science Park)

Status: ACCEPTED

Submitted by **YAKYMENKO, Iryna** on **Friday, February 9, 2024**

Abstract ID: **4**

Chemical Chartographisis in biological related examples

Content

Chemical Chartographisis is a complementary synthetic approach exploiting compositional parameters and correlating topology (structure) and property relationships. This work presents examples of Chemical Chartographisis in Catalysis and Biochemistry. Specifically, we will describe:

a) the rational design of a tunable Cu(II) chelating scaffold which prevents the formation of reactive oxygen species; an essential aspect for diseases such as Alzheimer's, Prion, Wilson

d) the use of complexes to ease sense amines and amino acids.

Primary author: Dr KOSTAKIS, George (University of Sussex)

Presenter: Dr KOSTAKIS, George (University of Sussex)

Status: ACCEPTED

Submitted by **KOSTAKIS, George** on **Friday, February 9, 2024**

Abstract ID: **6**

New organic luminophores as potential optical sensor templates

Content

Nowadays sensors play a big role in detecting of different types of compounds. They are used in many areas such as agriculture, food quality control, control of harmful gas leakage, etc. Among different types of sensors, optical sensors provide a quick response to the desired compound and are easy to use.
Development of new materials for sensors is an actual topic. Organic luminofores are one of the prospective type of optical sensor materials. They demonstrate high quantum efficiency, variable chemical structure and functional groups.
In this work we report on investigation of structure and optical properties of novel organic compound 1-(2-(3,6-dimethyl-9H-carbazol-9-yl) benzyl) pyridin-1-ium methanesulfonate (KL_1421). Diffuse reflectance, photoluminescence life-time and FTIR spectra have been investigated. Photoluminescence spectra and photobleaching were studied at different excitation wavelengths and excitation powers. Prospects for sensor applications have been discussed.

Primary author: ZABOLOTNII, Viktor (ASI LU)**;** Mr DRAVA, Matiss (Faculty of Chemistry, LU); KINENS, Artis; Dr VITER, Roman (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: ZABOLOTNII, Viktor (ASI LU)

Status: ACCEPTED

Submitted by **ZABOLOTNII, Viktor** on **Friday, February 9, 2024**

Abstract ID: **5**

MOF synthesis for sensor applications: tuning structure and functional properties

Content

The need to monitor the concentration of a specific analyte in both gaseous and liquid environments is a key requirement in many fields, including industrial processes, medical applications, and workplace safety management. In addition to selectivity and high sensitivity, the characteristics of a sensor device include the cost-effectiveness of the materials manufacturing, the material stability, and hence to possibility of using them for long-lasting devices - and the possibility of exploit them for low-cost and possibly portable devices. Many gas sensors use well-defined transduction methods such as oxidation (or reduction) of the analyte in an electrochemical reactor, optical techniques and chemoresistive responses to gas adsorption. In recent years, much of the effort to improve these methods has been directed towards the use of certain classes of specific materials as metal-organic frameworks (MOFs). MOFs, solid porous materials classified accordingto the terminology officially adopted by IUPAC in 2013, as a subclass of coordination networks (one-dimensional, two-dimensional or three-dimensional), which are a subclass of coordination polymers, are widely used as highly porous and reactive materials in chemoresistive or optical sensors. Here, we report on the most recent developments in the use of MOFs in chemical sensing. Both MOFs used in pure form and, more extensively, composite materials in which a MOF is a component of the active sensing materials will be considered. In particular, we will discuss hybrid materials in which MOFs are integrated with metal oxides, carbon-based materials, metal nanoparticles and conducting polymers. The main characteristics of these materials and the reasons why they are considered interesting in the field of chemical sensing are discussed. A selectionof technological and scientific results published in the span of the last six years will be reported as the most interesting and useful ones in the field. Prospects for the use of these materials and the factors involved in their possible use for new generations of sensing devices will be reported.

Keywords: gas sensors; metal organic frameworks, MOF based composites; optical sensors; chemiresistors; electrochemical sensors; oxygen; hydrogen; chemical sensing.

Primary author: ALFE, Michela (CNR-STEMS)

Co-author: Dr GARGIULO, Valentina (CNR-STEMS)

Presenter: ALFE, Michela (CNR-STEMS)

Status: ACCEPTED

Submitted by **ALFE, Michela** on **Friday, February 9, 2024**

Abstract ID: **3**

CNT/WS2 heterostructures for the effective electrochemical sensing of riboflavin (vitamin B6)

Content

Tungsten disulfide (WS2) layers with different thicknesses were deposited on carbon nanotubes (CNTs) by atomic layer deposition (ALD) to obtain CNT/WS2 core-shell hetero-composites. WS2conformally grows like small platelets-flakes on the CNTs initially at low ALD cycles while, with increasing the number of ALD cycles, WS2 platelets further grow to form a continuous film. The electrochemical properties of the synthesized CNT/WS2 hierarchical heterostructures were evaluated for an effective electrochemical probe for detecting riboflavin. The results of electrochemical tests were discussed and correlated to morphology and surface coverage of WS2 shell on CNTs core. CNT/WS2 with 200-300 ALD cycles demonstrated the best performances because of the optimal electrocatalytic WS2 properties and the formation of CNT/WS2 junctions, allowing the sensitive and selective detection of riboflavin with a limit of detection (LOD) of 70 ppb and 0.4 µM.

Primary author: ZRIBI, Rayhane (University of Messina)

Co-author: Prof. NERI, Giovanni (University of Messina)

Presenter: ZRIBI, Rayhane (University of Messina)

Status: ACCEPTED

Submitted by **ZRIBI, Rayhane** on **Thursday, February 8, 2024**

Abstract ID: **8**

Effect of chemical structure of imine-based-ligands on sensitivity and selectivity to metal ions

Content

Detection of metal ions in liquid media is an important task for environmental protection and agriculture. Recent existing methods are expensive, complex and time consuming. Sensor technology offers alternative opportunity to monitor metal ions. Within different sensor technique, optical methods are low cost, fast and precise.

Organic ligands with chelating properties such as Schiff bases, Salan-type ligands, imines and others are prospective materials for the detection of metal ions. They can host metal ions in their structure. Their structure can be chemically modified what opens pathways of tailoring sensitive and selective properties to metal ions.

In this work, we report on effect of chemical structure of imine-based-ligands on their optical properties and sensitivity and selectivity to metal ions. For this purpose, an imine-based structure (mmd_4) was chemically modified to define the influence of the backbone (Fig.1), substituents of the 1st and 2nd type on the optical and sensor properties. The structures obtained were confirmed by high resolution mass spectrometry (HRMS).

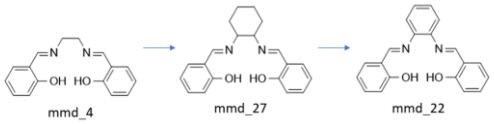

Figure 1. Chemical modification of the ligand backbone

The optical properties of the obtained compounds were investigated by photoluminescence and diffuse reflectance spectroscopy. The presence of a combination of N groups and cyclohexane or benzene leads to the appearance of intense photoluminescence in the visible region. Replacing the N groups with NH leads to the disappearance of the visible photoluminescence and the appearance of a weak peak in the ultraviolet range.

Sensitivity measurements of the ligand solutions were performed in a home-built cuvette system using the transmittance method. Steady-state spectra were recorded before and after each probe, and transmission kinetics were also measured at selected wavelengths.

For sensor testing, the ligands were dissolved in ethanol (concentration 2 mg/mL). Stock solutions of 1, 5, 10 mM/L metal chloride salts were used as probes.

Sensitivity measurements of the ligand solutions were performed in a home-built cuvette system using the transmittance method. Steady-state spectra were recorded before and after each probe, and transmission kinetics were also measured at selected wavelengths. Sensitivity of each ligand to target ions, the detection limits and time of sensor response were calculated.

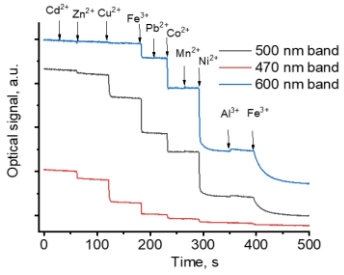

Figure 2. Sensor testing of ligands (mmd_22)

Primary author: TEPLIAKOVA, Iryna (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Co-authors: DRAVA, Matiss (Faculty of Chemistry, LU); KINENS, Artis; Dr VITER, Roman (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Presenter: TEPLIAKOVA, Iryna (Institute of Atomic Physics and Spectroscopy, University of Latvia)

Status: ACCEPTED

Submitted by **TEPLIAKOVA, Iryna** on **Friday, February 9, 2024**

Abstract ID: **2**

Inkjet Printed Organic transistors for biosensing applications

Content

Electrolyte-Gated Organic Field-Effect Transistors (EGOFET) are a subset of organic transistorsin which the capacitive coupling between the gate electrode and the organic semiconductor is achieved through an electrolyte. The intrinsic presence of a liquid within their structure as wellas the low biasing voltages (< 1 V) make these devices ideal candidates for the development of biosensors in liquid media.[1] In this talk, the structure and working principle of EGOFET willbe described. Some examples of functionalisation strategies to make the devices able to detect and quantify target biological molecules or even real-time monitoring of living organisms will be provided. Finally, a fabrication protocol exclusively based on inkjet-printing will be illustrated.[2]

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[1] Wang, D.; Noël, V.; Piro, B. Electrolytic Gated Organic Field-Effect Transistors for Applicationin Biosensors—A Review. Electronics 2016, 5, 9. https://doi.org/10.3390/electronics5010009

[2] Chennit, K.; Delavari, N.; Mekhmoukhen, S.; Boukraa, R.; Fillaud, L.; Zrig, S.; Battaglini, N.; Piro, B.; Noël, V.; Zozoulenko, I.; Mattana, G. Inkjet-Printed, Coplanar Electrolyte-Gated Organic Field-Effect Transistors on Flexible Substrates: Fabrication, Modeling, and Applications in Biodetection. Adv. Mater. Technol. 2023, 8(2), 2200300. https://doi.org/10.1002/admt.202200300

Primary authors: Dr NOËL, Vincent (Université Paris Cité); Dr ZRIG, Samia (Université Paris Cité); Dr MATTANA, Giorgio (Université Paris Cité)

Presenter: Dr NOËL, Vincent (Université Paris Cité)

Status: ACCEPTED

Submitted by **ZRIG, Samia** on **Wednesday, February 7, 2024**

Abstract ID: **1**

Technology transfer: from idea to application

Content

There is an increasing need to create impact from research. However, not all researchers are interested in or suitable for becoming entrepreneurs. It can be challenging for an external entrepreneur to adapt research outcomes if the researcher is not involved in the knowledge transfer. This is where shared data can act as a facilitator. Data from sensors can be used in various ways. This data can be linked with other data within a supply chain, leading to various types of optimisation, such as in energy, business, sustainability, etc., within the supply chain. Sharing data can lead to useful outcomes. A researcher might provide valuable input through the interpretation of the data. In this way, a researcher can be part of a platform where data is utilized, benefiting other platform users. To protect users, this can be managed through digitalization. The potential user does not have direct access to the data. Instead, an algorithm can process the data and provide output that is useful for another platform user, who then develops it further into a technological step (business). This can also be managed through digitalization, such as with blockchain technology. The shared data can also be used for business creation using a Web3 digital wallet, and also adding value by incorporating embedded climate impact accounting. This type of outcome represents the future of impact and business. For supply chain stakeholders to feel comfortable, it is important to have visibility of all steps. This is where a digital twin becomes an important part. Overall, this concept can bring ideas from research to application, even without researchers being actively involved in business. They can already use the shared data stage as a merit for impact creation, demonstrating that their research outcomes are utilised beyond just publishing.

Primary authors: BRODÉN, Mats (Play Safe Ecosystem AB); WAERN, Nicolas (Winniio AB)

Presenter: Dr SYVÄJÄRVI, Mikael (ICM Research Institute, Alminica AB)

Status: ACCEPTED

Submitted by **SYVÄJÄRVI, Mikael** on **Wednesday, February 7, 2024**

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Latvijas Universitātes **Atomfizikas un spektroskopijas institūts** (LU ASI) dibināts 1994.gadā uz LU Spektroskopijas problēmu laboratorijas (dibināta 1967.) un LZA Fizikas institūta (dibināts 1957.) Teorētiskās fizikas laboratorijas bāzes. Tas veic starptautiska līmeņa fundamentālus un lietišķus pētījumus atomfizikā, spektroskopijā, fotonikā, kvantu fizikā un ar tām saistītajās starpnozarēs, kā arī ar optisko frekvences standartu izveidi un precīzu optisko frekvenču mērījumiem ar femtosekunžu frekvenču ķemmi saistītus pētījumus. Institūtā tiek arī izstrādātas jaunas optiskās metodes un ierīces izmantošanai ražošanā, medicīnā un vides monitoringā.

Augstu zinātniskā darba kvalitāti nodrošina kvalificēts akadēmiskais personāls vadošie pētnieki, pētnieki, zinātniskie asistenti. LU ASI pētniecības projektu izstrādē piedalās bakalaura, maģistra un doktora programmu studenti, kā arī grāda pretendenti. 2024.gada sākumā ASI bija 80 darbinieki, no tiem 60 pamatdarbā.

LU ASI kā fundamentālo un lietišķo pētījumu ekselences centru ir atbalstījusi Eiropas Komisija. Aktīvu starptautisku zinātnisko sadarbību veicina Starptautiskā lietišķās optikas biedrība (SLOB) un Starptautiskās optikas komisijas (ICO) Latvijas reģionālā komiteja, kuras darbojas institūta paspārnē.

Institute of Atomic Physics and Spectroscopy (IAPS) of the University of Latvia was founded in 1994 based on the Spectroscopy Problem Laboratory (founded in 1967) and the Laboratory of Theoretical Physics (established in 1957 within the Latvian Academy of Sciences Institute of Physics). The institute performs recognised fundamental and applied research in atomic physics, spectroscopy, photonics, quantum physics and related areas. New optical methods and devices for applications in industry, medicine and environmental monitoring are being developed, as well. The Institute has been supported by the European Commission as the Centre for Excellence in Fundamental and Applied Studies.

At the beginning of 2024, IAPS had 80 employees, 60 of them as the primary occupation.