



**31st Summer School and
International Symposium on
the Physics of Ionized Gases**

Belgrade, Serbia,
September 5 - 9, 2022

CONTRIBUTED PAPERS
&
**ABSTRACTS of INVITED LECTURES,
TOPICAL INVITED LECTURES and PROGRESS REPORTS**

Editors:
**Dragana Ilić, Vladimir Srećković,
Bratislav Obradović and Jovan Cvetic**



**БЕОГРАД
2022**

**31st Summer School and
International Symposium on
the Physics of Ionized Gases**



September 5 – 9, 2022, Belgrade, Serbia

S P I G 2022

CONTRIBUTED PAPERS

&

ABSTRACTS OF INVITED LECTURES,
TOPICAL INVITED LECTURES AND
PROGRESS REPORTS

Editors

Dragana Ilić, Vladimir Srećković,
Bratislav Obradović and Jovan Cvetić

University of Belgrade –
School of Electrical
Engineering

University of Belgrade –
Faculty of Physics
Serbian Academy of
Sciences and Arts

Belgrade, 2022

PUBLICATIONS OF THE ASTRONOMICAL OBSERVATORY OF BELGRADE

FOUNDED IN 1947

EDITORIAL BOARD:

Dr. Srdjan SAMUROVIĆ, Editor-in-Chief (Astronomical Observatory, Belgrade)

Dr. Rade PAVLOVIĆ (Astronomical Observatory, Belgrade)

Dr. Miroslav MIĆIĆ (Astronomical Observatory, Belgrade)

Dr. Branislav VUKOTIĆ (Astronomical Observatory, Belgrade)

All papers in this Publication are peer reviewed.

Published and copyright © by Astronomical Observatory, Volgina 7, 11060 Belgrade
38, Serbia

Director of the Astronomical Observatory: Dr. Gojko Djurašević

Typesetting: Tatjana Milovanov

Internet address <http://www.aob.rs>

ISSN 0373-3742

ISBN 978-86-82296-02-7

Number of copies / tiraž : 200

Production: Skripta Internacional, Mike Alasa 54, Beograd

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

537.56(082)

539.186.2(082)

539.121.7(082)

533.9(082)

**SUMMER School and International Symposium on the Physics of Ionized Gases
(31 ; 2022 ; Belgrade)**

Contributed papers & abstracts of invited lectures, topical invited lectures and progress reports / 31st Summer School and International Symposium on the Physics of Ionized Gases - SPIG 2022, September 5-9, 2022, Belgrade, Serbia ; editors Dragana Ilić ... [et al.]. - Belgrade : Astronomical Observatory, 2022 (Beograd : Skripta Internacional). - 302 str. : ilustr. ; 24 cm. - (Publications of the Astronomical Observatory of Belgrade, ISSN 0373-3742)

Na nasl. str.: University of Belgrade, School of Electrical Engineering; University of Belgrade, Faculty of Physics; Serbian Academy of Sciences and Arts. - Tiraž 200. - Str. 17-18: Preface / editors Dragana Ilić ... [et al.]. - Bibliografija uz svaki rad. - Registar.

ISBN 978-86-82296-02-7

1. Ilić, Dragana, 1978- [urednik] [аутор додатног текста]

а) Јонизовани гасови – Зборници б) Атоми – Интеракција – Зборници в) Плазма – Зборници

COBISS.SR-ID 72751881

SPIG 2022

SCIENTIFIC COMMITTEE

D. Ilić (Co-chair), Serbia
V. Srećković (Co-chair), Serbia

A. Antoniou, Greece
D. Borka, Serbia
J. Burgdörfer, Austria
J. Cvetić, Serbia
V. Guerra, Portugal
M. Ivković, Serbia
K. Kutasi, Hungary
I. Mančev, Serbia
D. Marić, Serbia
N. J. Mason, UK
A. Milosavljević, France
V. Milosavljević, Serbia
K. Mima, Japan
Z. Mišković, Canada
L. Nahon, France
B. Obradović, Serbia
G. Poparić, Serbia
P. Roncin, France
I. Savić, Serbia
Y. Serruys, France
N. Simonović, Serbia
M. Škorić, Japan
M. Trtica, Serbia
S. Tošić, Serbia
R. White, Australia

ADVISORY COMMITTEE

D. Belić
N. Bibić
M. S. Dimitrijević
S. Đurović
N. Konjević
M. M. Kuraica
J. Labat
G. Malović
B. P. Marinković
Z. Mijatović
M. Milosavljević
Z. Lj. Petrović
L. Č. Popović
J. Purić
B. Stanić

ORGANIZING COMMITTEE

J. Cvetić (Co-chair)
B. Obradović (Co-chair)

M. Ignjatović (Co-secretary)
L. Gavanski (Co-secretary)

N. Konjević
N. Cvetanović
T. Gajo
I. Krstić
N. Sakan

CONTENTS

Dragana Ilić, Vladimir Srećković, Bratislav Obradović and Jovan Cvetić <i>Preface</i>	17
--	----

Section 1. ATOMIC COLLISION PROCESSES

Invited Lectures

Sergio Diaz-Tendero <i>Ultrafast Dynamics of Ionized Molecules and Molecular Clusters in the Gas Phase</i>	21
---	----

Darryl B. Jones <i>Electron Spectroscopies for Probing Electronic Structure and Collision Dynamics</i>	22
---	----

James Sullivan <i>Experiments with Positrons - From Fundamental to Applied Science</i>	23
---	----

Topical Invited Lectures

G. J. Boyle, M. J. E. Casey, D. G. Cocks, R. D. White and R. J. Carman <i>Thermalisation Time of Electron Swarms in Noble Gases for Uniform Electric Fields</i>	24
--	----

Saša Dujko, Danko Bošnjaković, Ilija Simonović and Christoph Köhn <i>Electron Transport, Transient Plasmas and High-Energy Phenomena in Planetary Atmospheres</i>	25
--	----

Teodora Kirova and Jelena Tamulienė <i>Numerical Investigations of the Impact of the Magnetic Field of Radiation on Amino Acids</i>	26
--	----

Minna Patanen <i>Electron-Ion Coincidence Experiments with Electron and Photon Ionization</i>	27
--	----

L. Schwob, J. Leroux, A. Kotobi, S. Dörner, K. Schubert, I. Unger, K. Atak, V. Zamudio-Bayer, J. T. Lau and S. Bari <i>X-Ray Action Spectroscopy of Gas-Phase Biomolecular Ions</i>	28
---	----

Progress Reports

Danilo Delibašić <i>Relative Importance of the Electron Continuum Intermediate State in Single-Electron Capture into Any State of Fast Protons from Helium- Like Atomic Systems</i>	29
--	----

S. Ganguly and S. Maclot <i>Fragmentation of Core-Ionized Adamantane Molecule</i>	30
--	----

M. Roy Chowdhury, G. A. Garcia, E. Rouquet, H. Hrodmarsson, J. C. Loison and L. Nahon <i>VUV Photoionization and Fragmentation of Cyano-Pahs</i>	31
--	----

Contributed Papers

J. Atić, D. Bošnjaković, I. Simonović, Z. Lj. Petrović and S. Dujko <i>Formation and Propagation of Streamers in CF_3I-SF_6 Gas Mixtures</i>	33
---	----

S. Dujko, D. Bošnjaković, M. Vass, I. Korolov, P. Hartmann, N. Pinhao, D. Loffhagen and Z. Donko <i>Electron Transport Coefficients in CO: Scanning Drift Tube Measurements and Kinetic Computations</i>	37
--	----

Nenad Milojević, Danilo Delibašić and Ivan Mančev <i>Single-Electron Capture From He by Fast Alpha Particles</i>	41
---	----

Ž. Nikitović and Z. Raspopović <i>Reduced Mobility of H^+ Ions in n-Butanol Gas</i>	45
---	----

I. Simonović, D. Bošnjaković, Z. Lj. Petrović and S. Dujko <i>Third-Order Transport Coefficients for Electrons in C_3F_8</i>	49
--	----

N. S. Simonović, D. B. Popović and A. Bunjac <i>Photoelectron Energy Spectra in Sequential Two-Photon Ionization of Hydrogen by Gaussian and Half-Gaussian Laser Pulses</i>	53
--	----

V. Stanković, M. Ristić, R. Ranković, M. Aoneas, M. Vojnović and G. B. Poparić <i>Dissociation of N_2 by Electron Impact in RF Electric Field</i>	57
--	----

Violeta V. Stanković, Mirjana M. Vojnović, Miroslav M. Ristić, Sava M. D. Galijaš and Goran B. Poparić <i>Excitation of $^1\Sigma^+_U$ and $^1\Pi_u$ States and Ionization of CO_2 in DC Electric Field</i>	61
Natalia Tańska, Kuba Wójcik, Sylwia Dylnicka, Elżbieta Ptasińska-Denga, Czesław Szmytkowski and Paweł Możejko <i>Total Cross Section Measurements for Electron Scattering on Methyl Formate ($HCOOCH_3$) Molecule: Methylation Effect</i>	65
M. M. Vojnović, M. M. Ristić and D. S. Belić <i>Rate Coefficients for O_3^+ Dissociation to O^+ and O_2^+ by Electron Impact</i>	69
Section 2. PARTICLE AND LASER BEAM INTERACTIONS WITH SOLIDS	
Invited Lecture	
J. Bonse, K. Wasmuth, H. Voss, J. Krüger and S. Gräf <i>Laser-Induced Periodic Surface Structures, Mechanisms, Applications, and Unsolved Problems</i>	75
Topical Invited Lectures	
J. Limpouch <i>High-Power Laser Interactions with Low Density Porous Materials and Their Applications</i>	76
Progress Reports	
Jovan Ciganović, Miloš Momčilović, Sanja Živković, Jelena Stasić and Milan Trtica <i>Action of Pulsed Lasers on Titanium Target: Surface Effects</i>	77
M. Hadžijojić and M. Ćosić <i>Study of Two Dimensional Crystals by Rainbow Scattering Effect</i>	78
Violeta N. Nikolić <i>Spectroscopic Investigation of the Influence of NO_3^- Anions on the Crystallization of SiO_2 Matrix</i>	80

D. M. Popovic, A. Kushima, A. A. Zekic, B. Kasalica, J. Stasic, J. Ciganovic, M. Bogdanovic and M. Trtica <i>Picosecond Pulsed Laser Ablation of Silicon Single Crystal</i>	81
N. Starčević <i>Ion-Crystal Rainbow Interaction Potential in Channeling</i>	82
Contributed Papers	
N. A. Bosak, A. N. Chumakov, L. V. Baran, V. V. Malyutina-Bronskaya, T. F. Raichonok, A. A. Ivanov, V. V. Kiris, E. M. Dyatlova, A. A. Shevchenok, A. V. Buka and A. S. Kuzmitskaya <i>Investigation of Properties of Yttrium Vanadate YVO₄ Films</i>	83
A. N. Chumakov, V. V. Lychkovsky and I. S. Nikonchuk <i>Features of Silicon Ablation in Air Under the Influence of Nd:YAG Laser Harmonics</i>	87
A. N. Chumakov, V. V. Luchkouski and I. S. Nikonchuk <i>Silicon Spalling Destruction and Ablation in Air Under Bichromatic Laser Radiation</i>	91
M. Ćosić, M. Hadžijojić and N. Nešković <i>Bohmian Dynamics of Positrons Channeled Through a Chiral Carbon Nanotubes</i>	95
H. Delibašić Marković, V. Petrović and I. Petrović <i>Analytical Prediction and Numerical Analysis of Plasma Mediated Ablation of Skin Tissue Samples with Nanosecond-to-Femtosecond Laser Pulses</i>	101
S. M. D. Galijaš, V. M. Milosavljević and G. B. Poparić <i>The Time-Symmetric Description of Electron Exchange in Ion-Ion Collision</i>	105
V. K. Goncharov, G. A. Gusakov and M. V. Puzyrev <i>Influence of Carbon Ions of Different Multiplicity on Regimes of Promising Laser Technologies for the Deposition of Diamond-Like Carbon Nanocoatings</i>	109
M. Hadžijojić and M. Ćosić <i>Study of Graphene by Rainbow Scattering Effect</i>	113

A. Kalinić, I. Radović, L. Karbunar, V. Despoja and Z. L. Mišković <i>Analytical Expression for Stopping Force Acting on a Slow Charged Particle Moving Parallel to a Thick Graphene-Sapphire-Graphene Structure</i>	117
M. D. Majkić, N. N. Nedeljković and M. A. Mirković <i>Effect of the Ionic Type on the Shape of the Nanostructures Created by an Impact of Slow Highly Charged Ions on Gold Surface</i>	121
N. N. Nedeljković, M. D. Majkić, M. A. Mirković, I. Stabrawa and D. Banaś <i>The Influence of the Ion-Target Parameters on the Size of the Surface Nanohillocks Created by an Impact of Highly Charged Ions</i>	125
Natalie Tarasenko, Vladislav Kornev, Alena Nevar, Mikhail Nedel'ko, Anton Radomtsev and Nikolai Tarasenko <i>Combining Plasma-Assisted Synthesis of Metal Oxide Nanoparticles with Thin Films Deposition</i>	129
Natalie Tarasenko, Vladislav Kornev, Svetlana Pashayan and Nikolai Tarasenko <i>Pulsed Laser Assisted Fabrication of Co-doped ZnO Nanocrystalline Layers on a Glass Substrate</i>	133
I. Traparić, M. Jovanović, M. Kuzmanović and M. Ivković <i>Elemental Analysis of Austenitic Steel by Calibration-Free Laser-Induced Breakdown Spectroscopy (CF-LIBS)</i>	137
Nora Trklja Boca, Žarko Z. Mišković, Radivoje M. Mitrović, Bratislav M. Obradović and Milorad M. Kuraica <i>Treatment of Steel 16MnCr5 and Steel 42CrMo4 by Plasma Flow Generated in Magnetoplasma Compressor</i>	141
M. Trtica, J. Stasic, X. Chen and J. Limpouch <i>ODS+Hf and AISI 316L Steel Surface Variations at High Laser Intensity, 10^{13} W/cm², in Air and Vacuum: Comparative Study</i>	145
S. Živković, J. Petrović, M. Momčilović, M. Radenković, N. Krstulović, J. Car, D. Palasti, F. Casian Plaza and G. Galbács <i>Perspective on the Use of Nanoparticles to Improve the TEA CO₂ Based LIBS Analytical Performances: Copper Nanoparticles for NELIBS Analysis of Polypropylene</i>	149

Section 3. LOW TEMPERATURE PLASMAS

Invited Lectures

Ryo Ono

Measurement and Simulation of Atmospheric-Pressure Streamer Discharge..... 155

L. J. Overzet, A. Press, K. Hernandez, J. Poulouze and M. J. Goeckner
Measurements of RF Plasma Re-Ignition: RF-IV and Proes..... 156

Topical Invited Lectures

S. Béchu, J. L. Lemaire, M. Mitrou, N. De Oliveira and P. Svarnas
Investigation of the Ro-Vibrational Levels of H₂/D₂ Molecules by VUV-Absorption Spectroscopy for the Production of H/D Negative Ions for Fusion Application..... 157

M. T. Belmonte, P. R. Sen Sarma, C. P. Clear, F. Concepcion, M. Ding, J. C. Pickering and S. Mar
What Can Plasma Spectroscopy Do for Astronomers? Measuring Atomic Parameters of Astrophysical Importance..... 158

A. Derzsi
Surface Processes in Low-Pressure Capacitively Coupled Plasmas.... 159

P. Dvořák, R. Žemlička, R. Příbyl, M. Tkáčik, J. Pálenik, P. Vašina, P. Skopal, Z. Navrátil and V. Buršíková
Higher Harmonic Frequencies of Discharge Voltage and Current in Capacitively Coupled Discharges..... 160

C. Fromentin, T. C. Dias, T. Silva, V. Guerra, E. Baratte and O. Guaitella
Coupled Kinetics in CO₂-N₂ Plasmas..... 161

Mohammed Koubiti

Application of Machine-Learning to Spectroscopic Line Emission by Hydrogen Isotopes in Fusion Devices for Isotopic Determination and Prediction..... 162

Mikhail Pinchuk, Olga Stepanova, Mikhail Gromov and Anton Nikiforov

Control of Guided Streamer Propagation and Interaction with Substrate in Helium Atmospheric Pressure Plasma Jet..... 163

Djordje Spasojević, Nikola V. Ivanović, Nikodin V. Nedić, Luka Rajačić, Nikola M. Šišović and Nikola Konjević <i>On the Application of Iterative Kinetic Model for Diagnostics of Abnormal Glow Discharges in Noble Gases</i>	164
---	-----

Progress Reports

Dejan Dojić, Miloš Skočić and Srdjan Bukvić <i>Measurements of Continuous Optical Spectrum During Nanosecond Laser Pulse Interaction with Metallic Target</i>	165
--	-----

Milan Ignjatovic <i>The Influence of Corona Discharge on the Lightning Surge Propagation Along the Transmission Lines</i>	166
--	-----

Amit Kumar, Nikola Škoro, Wolfgang Gernjak, Suzana Živković and Nevena Puač <i>Design, Development, and Characterization of Atmospheric Plasma System for Wastewater Treatment</i>	167
--	-----

Marija Puač and Zoran Lj. Petrović <i>Modeling of Radio-Frequency Breakdown by Monte Carlo Technique</i>	168
---	-----

Leo Sala and Jaroslav Kočišek <i>Interaction of Ionizing Radiation with DNA Nanostructures</i>	169
---	-----

N. Selaković, D. Maletić, N. Puač, G. Malović and Z. Lj. Petrović <i>Mass Spectrometry of Plasma Jet and Application of Electrical Discharges Operating at Atmospheric Pressure in Biomedicine</i>	170
---	-----

M. M. Vasiljević and Dj. Spasojević <i>Determination of the Electric Field Strength in Glow Discharges Using Argon Spectral Lines</i>	171
--	-----

Contributed Papers

O. Asvany, S. Thorwirth, P. C. Schmid, T. Salomon and S. Schlemmer <i>High-Resolution Spectroscopy of Astrophysically Relevant Molecular Ions</i>	173
---	-----

I. I. Filatova, V. A. Lyushkevich, S. V. Goncharik, U. I. Torchyk, Y. V. Kandratau and M. O. Slesarenka <i>The Effect of Plasma Seed Treatment on Germination and Early Growth of Thuja Koraiensis Nakai Plants</i>	175
Nikola Goleš, Neda Babučić, Nenad M. Sakan and Milivoje Ivković <i>Self-Mixing Interferometry for Plasma Diagnostics</i>	179
Miroslav Gulan and Vladimir Milosavljević <i>Characterization of the Dielectric Barrier-Free Atmospheric Plasma System</i>	183
Naveen Gupta <i>Laser Driven Electron Acceleration by q-Gaussian Laser Pulse in Plasma: Effect of Self Focusing</i>	187
Milan Ignjatovic, Jovan Cvetic, Vera Protic and Nemanja Grbic <i>Corona Model for Surge Wave Propagation Along the Transmission Lines</i>	191
N. V. Ivanović, N. V. Nedić, I. R. Videnović and D. Spasojević <i>Polarization Spectroscopy of Neon Lines for Electric Field Distribution Measurement in the Cathode Sheath of a Grimm-Type Glow Discharge</i>	195
Jovica Jovović and Gordana Lj. Majstorović <i>The Gas Temperature Diagnostics by Means of $AlO (B^2\Sigma^+ - X^2\Sigma^+)$ Molecular Band System from the Upgraded Atmospheric Pressure Pulsed Discharge Source in Argon</i>	199
V. V. Luchkouski and A. N. Chumakou <i>Formation and Heating of Silicon Plasma in Air Under Pulsed Bichromatic Laser Irradiation</i>	203
Jelena Marjanović, Dragana Marić, Gordana Malović and Zoran Lj. Petrović <i>Breakdown in Saturated Water Vapor</i>	207
N. V. Nedić, N. V. Ivanović, I. R. Videnović, D. Spasojević and N. Konjević <i>Looking Behind the Negative Glow Plasma: Estimating Cathode Sheath Parameters by End-On Optical Emission Spectroscopy in a Grimm-Type Glow Discharge Source</i>	211

B. M. Obradović, N. Cvetanović, I. B. Krstić and M. M. Kuraica <i>Detection of Fast Nitrogen and Oxygen Atoms via Emission Spectroscopy</i>	215
M. S. Rabasovic, B. P. Marinkovic and D. Sevic <i>Analysis of Printed Circuit Board LIBS Data Using Deep Learning</i>	219
Nenad M. Sakan, Milica L. Vinić, Vladimir A. Srećković, Ivan Traparić and Milivoje R. Ivković <i>Application of Artificial Neural Network in the Analysis of the Spectra from Laser Ablation Combined with Fast Pulse Discharge</i>	223
L. V. Simonchik and A. V. Kazak <i>Features of the HeI 492.2 nm Line Profile Registered at Diagnostics of DC and Streamer Discharges</i>	227
Miloš Skočić, Nikodin Nedić, Dejan Dojčić, Luka Rajačić and Srdjan Bukvić <i>Temperature Estimation in the Early Stage of Laser Induced Plasma Formation Relying on Black Body Radiation</i>	231
G. B. Sretenović, P. S. Iskrenović, V. V. Kovačević, B. M. Obradović and M. M. Kuraica <i>Study of Plasma-Flow Interaction in Low Temperature Plasma Jets</i>	235
Biljana Stankov, Marijana R. Gavrilović Božović, Jelena Savović and Milivoje Ivković <i>Spectroscopic Characterization of Laser-Induced Plasma on Doped Tungsten</i>	239
Irinel Tapalaga, Ivan Traparić, Nora Trklja Boca, Jagoš Purić and Ivan P. Dojčinović <i>Modeling of Stark Spectral Line Broadening by Machine Learning Algorithms</i>	243
M. M. Vasiljević, G. Lj. Majstorović, I. R. Videnović and D. Spasojević <i>Spectroscopic Determination of the Degree of Dissociation of Hydrogen in the Glow Discharge</i>	247

Tatiana Vasilieva, Elena Nikolskaya, Michael Vasiliev, Nikita Yabbarov, Maria Sokol, Mariia Mollaeva and Margarita Chirkina <i>Comparison of Biocompatibility of Organic Polymers Modified in Various Types of Non-Temperature Plasmas</i>	251
---	-----

Section 4. GENERAL PLASMAS

Invited Lecture

Sven Thorwirth, Oskar Asvany and Stephan Schlemmer <i>Action-Spectroscopic Studies of Transient Carbon-Rich Molecular Ions</i>	257
---	-----

Topical Invited Lectures

J. Rosato, Y. Marandet, I. Hannachi and R. Stamm <i>Line Shape Modeling for Magnetic Fusion and Astrophysical Plasmas: An Overview of Recent Results</i>	258
---	-----

Progress Reports

Antonios Antoniou, Emmanuel Danezis, Dimitrios Stathopoulos, Evagelia Lyratzi and Dimitrios Tzimeas <i>Describing the Matemathical Methods for Calculating Basic Physical Parameters of the Gaussian-Rotational (GR) Model</i>	259
--	-----

A. Cinins, M. S. Dimitrijević, V. A. Srećković, K. Miculis, N. N. Bezuglov and A. N. Klyucharev <i>Analysis of Adiabatic Processes in Multilevel N-pod Quantum Systems from the Perspective of Riemannian Geometry</i>	260
--	-----

Milena Jovanović <i>Matter Distribution in Nearby Galaxies</i>	261
---	-----

V. Radović, A. Kovačević, D. Ilić, R. Street, L. Č. Popović, M. Nikolić, N. Andrić Mitrović and I. Čvorović-Hajdinjak <i>Development of a Time-Domain Pipeline for Detecting Binary Supermassive Black Holes in the Upcoming Legacy Survey of Space and Time (LSST)</i>	262
---	-----

T. Salomon, S. Brackertz, O. Asvany, I. Savić, D. Gerlich and S. Schlemmer <i>Recent Progress on Action Spectroscopy of Loosely Bound Hydrogen-Helium Complexes</i>	263
--	-----

Contributed Papers

A. Arsenić, D. Borka, P. Jovanović and V. Borka Jovanović <i>Winged Dragn Source From Leahy's Atlas: 3C 315</i>	265
--	-----

S. Das and D. C. Das <i>Higher Order Non-Linear Dust Ion Acoustic (DIA) Solitary Waves in Plasmas with Weak Relativistic Effects in Electrons and Ions</i>	269
---	-----

J. Kovačević-Dojčinović, I. Dojčinović, M. Lakićević and L. Č. Popović <i>Decomposition of the Blended $H\alpha+[N II]$ Lines in Spectra of the Active Galactic Nuclei Type 1.8-2</i>	271
---	-----

Amit Kumar and Jyotsna Sharma <i>The Effect of Negative Ions on Weibel Instability in the Presence of Large Amplitude Electrostatic Waves</i>	275
--	-----

V. A. Srećković, L. M. Ignjatović, V. Vujčić and M. S. Dimitrijević <i>The Chemi-Recombination Processes in Alkali-Metal Astrophysical and Low-Temperature Laboratory Plasmas: Rate Coefficients</i>	277
---	-----

The Workshop on X-ray and VUV Interaction with Biomolecules in Gas Phase (XiBiGP)

M. Berholts, P. H. W. Svensson, L. Pihlava, A. Vladyka, J. Niskanen, I. Unger, K. Kooser, C. Stråhlman, P. Eng-Johnsson, L. Schwob, A.-L. Vieli, O. Björneholm, C. Coleman, R. Lindblad and E. Kukk <i>Photofragmentation of the Radiation Therapy Enhancers: Can We Make Better Ones?</i>	283
---	-----

L. Carlini, P. Bolognesi, J. Chiarinelli, G. Mattioli, A. Casavola, M. C. Castrovilli, V. Valentini, A. De Stefanis, E. M. Bauer, E. Molteni, D. Sangalli and L. Avaldi <i>The "Lego Bricks" of Life: A Gas-Phase Study of Dipeptides</i>	284
--	-----

M. Di Fraia <i>Ultrafast Dynamics of Photo-Excited Molecules at Fermi Free Electron Laser</i>	286
--	-----

Bratislav P. Marinković <i>European Synchrotron and FEL User Organisation: Current Challenges and Prospects (COST Actions)</i>	287
Alexandra Mocellin, R. R. T. Marinho, O. Bjorneholm and A. Naves De Brito <i>Surface Propensity of Small Organic Biomolecules in Vapour-Water Interface by XPS</i>	288
Authors' Index.....	289
Programme of the SPIG 2022.....	293

ACTION OF PULSED LASERS ON TITANIUM TARGET: SURFACE EFFECTS

JOVAN CIGANOVIĆ, MILOŠ MOMČILOVIĆ, SANJA ŽIVKOVIĆ,
JELENA STASIĆ and MILAN TRTICA

VINČA Institute of Nuclear Sciences
– *National Institute of the Republic of Serbia*
University of Belgrade, PO Box 522 11351 Belgrade, Serbia
E-mail jovanc@vinca.rs

Abstract. The interaction of lasers with metals has been studied for decades, and has been especially intensified lately, due to the development of new, efficient pulsed lasers. Titanium has a number of excellent properties, making it applicable in various modern technologies. Treatment and processing of titanium is possible with various techniques, and the application of lasers gives a special quality, such as high precision machining or obtaining specific structures on the surface which cannot be generated by other methods.

During our research, surface processing of titanium was conducted by various pulsed lasers: nanosecond CO₂ laser, picosecond Nd:YAG laser and femtosecond Ti: sapphire laser. In order to find the optimal conditions for surface modification of titanium, the influence of different laser parameters (wavelength, pulse duration, pulse energy, etc.), as well as the influence of the ambient, was examined. The titanium samples were irradiated in different environments, ie. in air, oxygen, nitrogen, carbon dioxide, helium and in vacuum, which affected the chemical composition and morphology of the target surface.

Acknowledgments

This research was supported by the Ministry of Education, Science and Technological Development of Republic of Serbia; Grant number 451-03-68/2022-14/200017.

References

- Ciganovic, J., Stasic, J., et al.: 2012, *Appl. Surf. Sci.*, **258**, 2741-2748.
Trtica, M., Batani, D., et al.: 2013, *Laser Part. Beams*, **31**, 29-36.
Ciganovic, J., Zivkovic, S., et al.: 2016, *Opt. Quantum Electron.* **48**, 133.
Ciganovic, J., Matavulj, P., et al.: 2017, *Russ. J. Phys. Chem. A*, **91**, 2696-2701.
Trtica, M., Stasic J., et al.: 2018, *Appl. Surf. Sci.*, **428**, 669-675.